THE INSTITUTE OF PETROLEUM

VOLUME CORRECTION FACTORS BY VELOCITY OF SOUND

A Work Package by PM-L-4B
The Institute of Petroleum Oil Transportation Measurement Panel

Final Report
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1.0 Introduction

This report presents work, including laboratory measurements on a large number of hydrocarbon liquids, which demonstrates that the expansivity of hydrocarbon mixtures is better predicted by using a combination of density and velocity of sound in the liquid, than by density alone.

The work demonstrates that volume or density corrections made using simple equations based on the velocity of sound can provide results offering improved precision over existing API/ASTM Petroleum Measurement Tables.

The work was organised through the Energy Institute (Institute of Petroleum) Oil Transportation Measurement Committee, PM-L-4, and carried out by H&D Fitzgerald Limited. The project was managed and coordinated by Melverley Consultants Limited (Paul S. Harrison)

2.0 Acknowledgements

2.1 Finance

The following organisations provided funding for the work:

The American Petroleum Institute
The Energy Institute (formally the Institute of Petroleum)
BP Oil International Limited
ConocoPhillips
Caldon Inc
Krohne Altometer
Labor fuer Messtechnik Dr. H Stabinger GmbH
Paar Scientific
Shell International Trading and Shipping Company
Sunoco Inc
Wrt BV HFA Oil Additives

2.2 Samples

Samples were provided by the sponsor organisations noted above together with:

ChevronTexaco
Equiva
Total SA
ExxonMobil
Norske Shell

Additionally, members of the International Federation of Inspection Agencies (IFIA) provided valuable assistance in gathering and forwarding samples for measurement.

2.3 Software

Kelton Engineering, The MacKenzie Building, 168 Skene Street, Aberdeen, AB10 1PE, provided a copy of their Kelton Flocalc software v 2.1. This was used to convert observed densities to densities at 15°C as per the Petroleum Measurement Tables.

3.0 Summary

Precise measurements of density, temperature and velocity of sound have been made on a total of 222 hydrocarbon liquid samples covering a large percentage of currently traded crude oil volume and popular product grades. Measurements were made between 5°C and 60°C.

Analysis of these measurements has allowed development of two generalised equations:

1.

A generalised three term empirical equation to predict density$_{15}$ from observed density and VoS at a known temperature. When applied to all valid data points, it gives a residual standard deviation of 0.45 kgm^{-3}, compared with a residual standard deviation of 0.58 kgm^{-3} when using the Petroleum Measurement Tables.

table	density / VoS / temperature triplets *n*	experimental density$_{15}$ − density$_{15}$ from **PM Tables** kgm^{-3}	standard deviation kgm^{-3}	experimental density$_{15}$ − density$_{15}$ predicted from **3 term equation** kgm^{-3}	standard deviation kgm^{-3}
crudes	927	0.03	0.35	-0.09	0.31
gasolines	363	-0.18	0.65	-0.04	0.39
kerosines	143	0.08	0.91	0.19	0.42
fuel oils	225	0.20	0.95	0.20	0.80
lubes	263	0.02	0.33	0.09	0.45
All samples	**1921**	**0.01**	**0.58**	**0.00**	**0.45**

Table 3.1

2.

A generalised four-term empirical equation which allows expansivity ($\delta\rho/\delta t$) to be predicted from measured density and VoS at a known temperature. When this is applied to all samples, the average error between experimental density$_{15}$ and predicted density$_{15}$ is 0.03 kgm^{-3}, with a standard deviation of 0.39 kgm^{-3}.

This method is independent of temperature, and so can be used to convert density or volume at t_1 to t_2 without the need to refer to a reference temperature.

For simplicity, a linear expansion has been assumed. It is believed that errors could be reduced further by using a non-linear function.

These equations are presented below and can be used to perform volume corrections and density conversions more simply and with improved precision over existing Petroleum Measurement Tables, using velocity of sound measurements from a laboratory instrument, in-line instrument or from an ultrasonic flow meter.

The work has also shown the Petroleum Measurement Tables to be generally accurate, as can be seen from the above table 3.1, and has also demonstrated that negligible errors result from taking measurements below the wax appearance temperature.

Further, investigation of the 'damping values' produced by the Anton Paar density meter has shown that these values can be used to determine wax appearance temperature for many hydrocarbon liquids. It is recommended that this technique should be considered for development into a test method.

4.0 Background

4.1 The Petroleum Measurement Tables

The VCFs (Volume Correction Factors) which are used to convert liquid hydrocarbon volume measured at ambient temperature to volume at standard temperature (60°F or 15°C) are derived from API/ASTM Petroleum Measurement Tables (PM Tables), Table 54 or Table 6. In fact, the standard comprises the calculation routines which lie behind these tables and sister Tables 53 and 5 which convert observed density to density at 15°C (60°F).

The calculation routines and PM Tables (referred to as the 1980 tables) are based on laboratory work carried out by the US National Bureau of Standards (NBS) in the mid-1970's using samples of crude oil and products.

This work set out to derive a relationship between density and the thermal expansion coefficient, $\alpha = \frac{1}{V}\frac{\delta\rho}{\delta t}$. The results obtained by the NBS and accepted by the API/ASTM for use with crude oils, products and lube oils are shown in Figure 4.1 below:

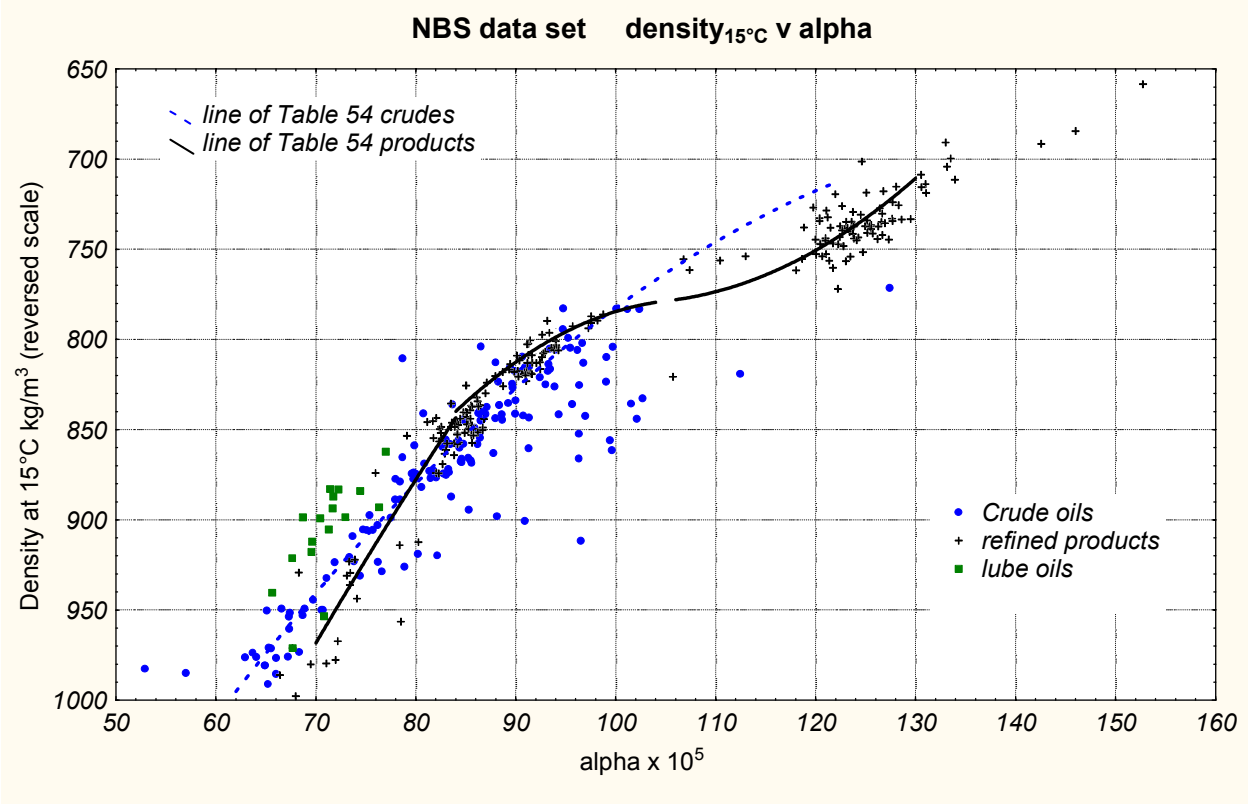


Figure 4.1

Due to the diverse molecular nature of hydrocarbon liquids there is no physical reason why α should be related to density alone and this is reflected in the above chart. The scattering of results was overcome in part by separating crude oils, products and lube oils and then using best-fit curves for each population. However results are fairly scattered around the curves as is seen from the crude oils and products curves shown above.

The above figure also illustrates a difficulty found with products in that they tended to fall into groups. The products curve is therefore defined by three separate equations depending on density$_{15}$, one for gasolines, (ρ 654-779), one for kerosines (ρ 779-839) and one for fuel oils (ρ 839-1075) with a linear transition between 770 and 787. This is not visible in the printed tables but the correct function must be selected when using the calculation routine.

The PM Tables were named 'generalised' tables, noting the fact that specific hydrocarbons can vary from the curves.

Other concerns have been expressed over the years since the work:

> Many new crudes are now being traded which were not included in the laboratory work
>
> Modern techniques would enable more precise results to be obtained
>
> Many of the NBS results were discarded by the API and suspicions have been voiced that some of these may have been discarded simply because they did not fit too well.

However, given that the underlying physical relationship is flawed these concerns have, probably rightly, not been pursued and the tables have fulfilled their purpose in providing the industry with a standard from which VCFs can be derived from density which in turn can be readily determined from samples – initially by hydrometer but increasingly by laboratory densitometer or in-line instrument.

It should be noted that the work reported here has shown the 1980 calculation routines to be reasonably reliable for a completely new set of samples.

4.2 The Concept of Velocity of Sound as a "correction factor"

H & D Fitzgerald operate a hydrostatic weighing system in their laboratories. This can determine density with a measurement uncertainty of $\pm 0.006\,\mathrm{kgm^{-3}}$ (k=2) over the temperature range of 5 to 55°C. Having run many hydrocarbon mixtures through this system, it became apparent that the expansivity of some of these samples was not being predicted too well by the PM Tables. Consideration of the chemical nature of these samples lead to the idea that they probably contained less aromatics than the "typical" samples which had been analysed by NBS.

It was felt that it might be feasible to measure some second parameter alongside the density, so as to apply some small "correction" to the PM Table's expansivity value to account for the molecular composition (paraffin/naphthene/aromatic ratio) of the sample.

Following some experience of measuring the velocity of sound in liquids, it seemed that this might be a worthwhile technique, especially since it was known that paraffins and aromatics with the same carbon number had appreciably different propagation speeds for ultrasound. It was also known that velocity of sound (VoS) is closely related to compressibility, which is heavily dependant on molecular composition.

The use of VoS as an additional factor in determining expansivity was also attractive as VoS cells are readily available as an accessory to laboratory density meters. In-line VoS cells for field use are also available and, with regard to field measurements, there is an increasing use of ultrasonic flow meters for custody transfer measurement. These devices offer a VoS output which could be used to assist in expansivity determinations.

4.3 The Characteristics of Pure hydrocarbons

Figure 4.3.1 shows the relationship of expansivity to density$_{15}$ for 55 pure hydrocarbons. It is clear that each molecular type exhibits a different relationship.

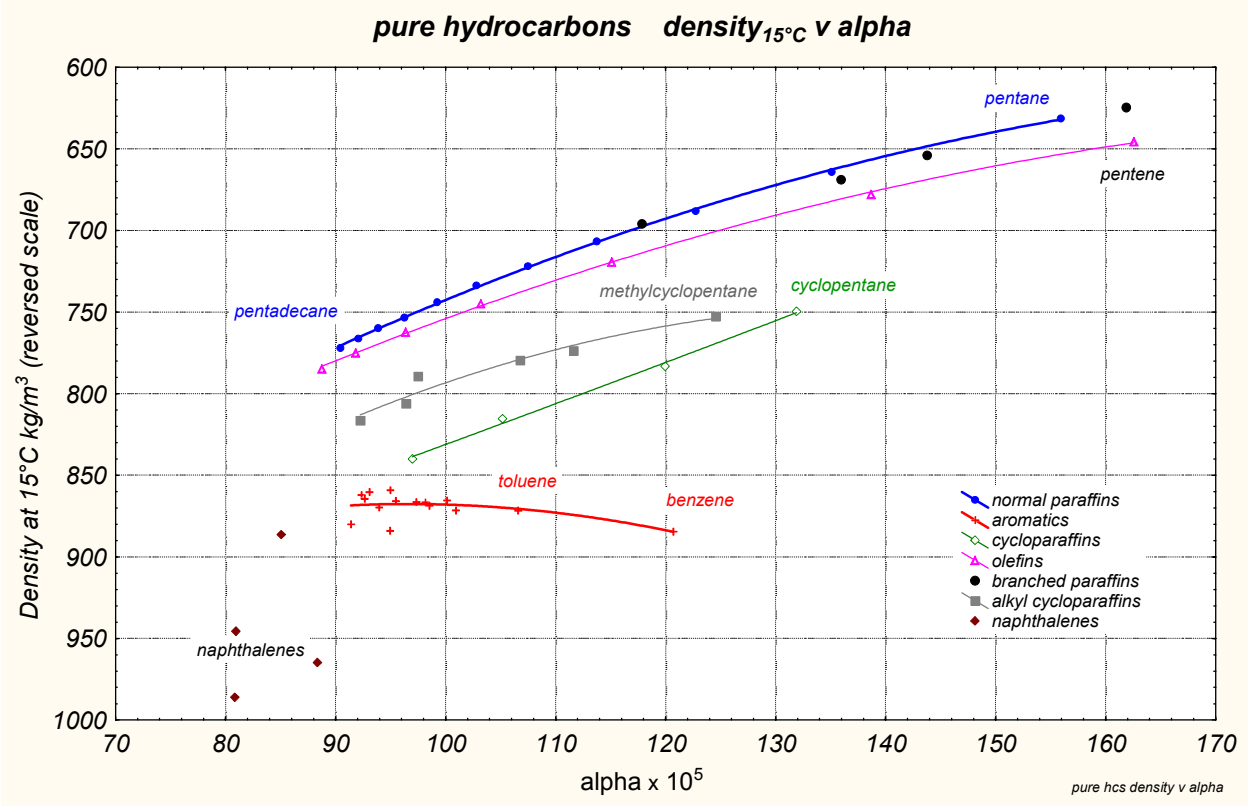


Figure 4.3.1

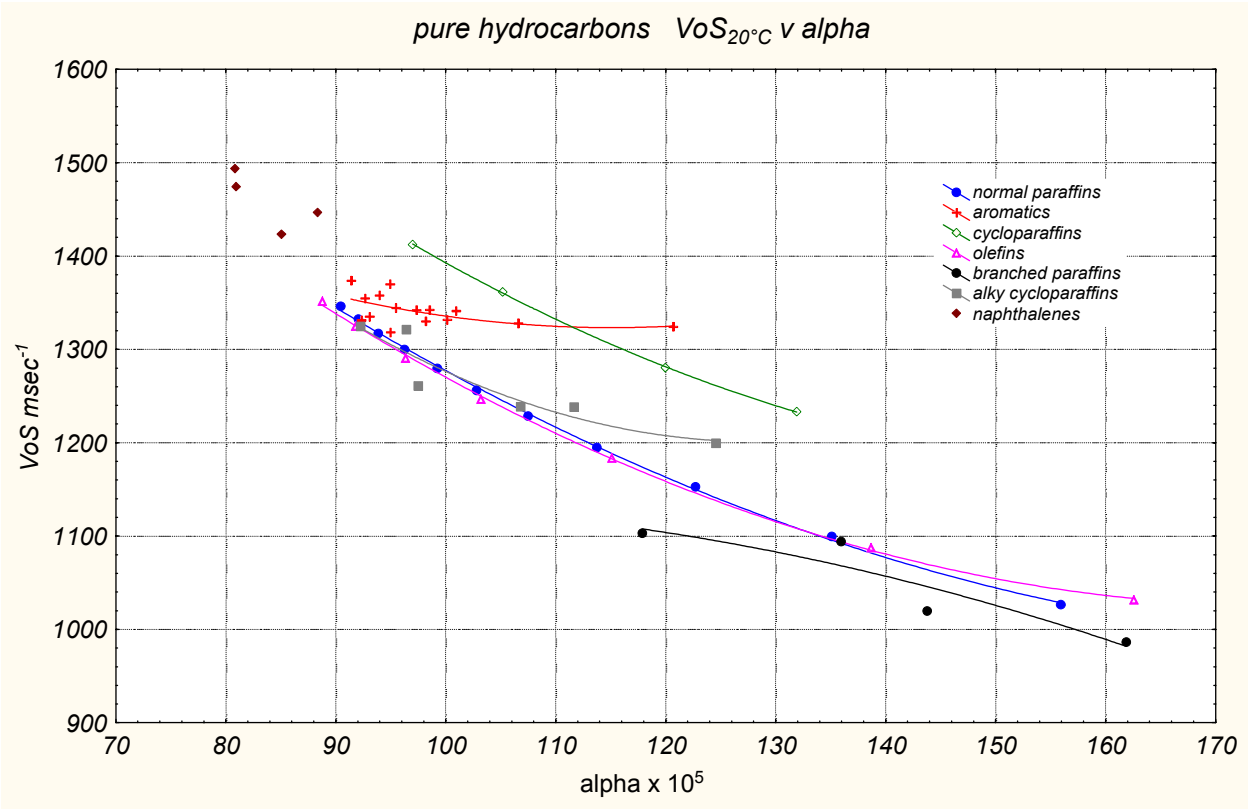


Figure 4.3.2

Figure 4.3.2 shows the relationship of expansivity to velocity of sound through the liquid at 20°C. Again, it can be clearly seen that the relationship is a function of molecular form, with ring structures showing higher VoS values than alkyl species having the same expansivity. However, this suggested that VoS might be of use in predicting the expansivity of hydrocarbon *mixtures*.

Predicting alpha from density at 20°C gives a correlation coefficient, R, of 0.74 whilst predicting alpha from VoS at 20°C gives a correlation coefficient, R, of 0.87.

4.4 Initial tests on Hydrocarbon Mixtures

In light of the results from the pure hydrocarbons, it was decided to acquire data from a number of crude oils and products. This data was only collected over the range of 15 to 25°C, and many of the samples were of unknown or dubious provenance.

However, the data obtained suggested strongly that α ($1/\rho \times \delta\rho/\delta t$) might be better predicted using the function $1/(VoS)^2$ than it could by density alone.

It was at this point that PM-L-4B was initially approached for assistance.

The work done in the present project covers a much wider temperature range, and the data gathered in these initial tests has therefore not been included in the final database.

5.0 Experimental Arrangements

5.1 Equipment and Procedure

The work was carried out using an Anton Paar DSA 5000 density meter, complete with a VoS (velocity of sound) cell in series with the standard vibrating tube density cell.

The DSA 5000 was controlled by specially written software. This provided multiple determinations of density and VoS whilst the temperature was varied randomly to cover the test range (5 to 60°C) in 5°C steps from 5 to 40°C and then at 50 and 60°C.

Density, VoS and temperature were measured at these 10 set temperatures with 20 sets of observations being made at each step.

The order in which the steps were run was determined at random by the data collection PC and whichever step was run first was always repeated as the last step. This allowed a check to be made for any compositional changes, wax deposition, out-gassing, etc., which may have occurred during the cycle. A total of 11 separate data points were therefore collected for each sample.

Samples were injected against a simple weighted piston back pressure device which maintained the sample at 2.15 bara throughout the analysis. This stopped out-gassing, even with volatile gasolines and crude oils. Measured densities were corrected to allow for this small overpressure.

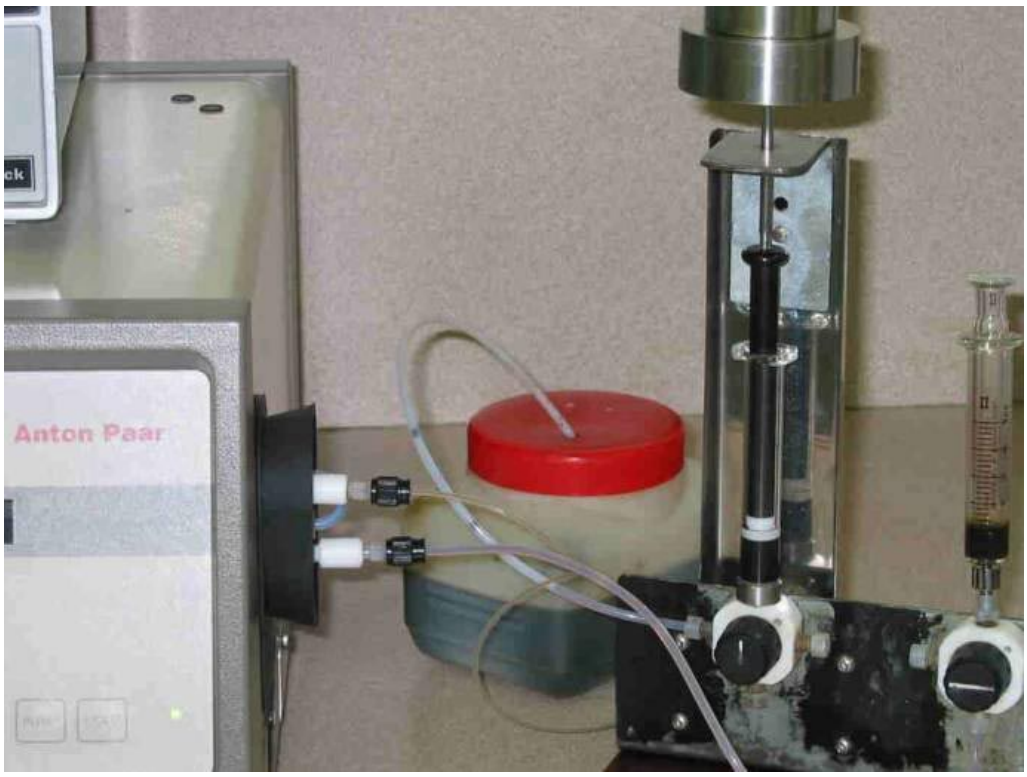


Figure 5.1

The test procedure ensured that each determination of temperature, density and velocity of sound (data triplet) was independent.

5.2 Temperature Traceability

Density and VoS cell temperatures were checked every couple of months during the project with either a micro platinum resistance probe or a high stability thermistor. Both of these devices were calibrated immediately before the checks using a Class 1 platinum resistance thermometer calibrated by the UK National Physical Laboratory (NPL). The micro probes were also calibrated at the two fixed points in water triple point and gallium melting point cells, both of which had UKAS accredited calibration.

The estimated uncertainty in quoted cell temperature is ±15 mK (*k=2*). Most of this is due to cell temperature drift between calibrations.

5.3 Density Traceability

The system was calibrated with 9 liquid density standards which had been calibrated at the H&D Fitzgerald UKAS accredited laboratory. These standards had an uncertainty of ± 0.01 kgm^{-3} (*k*=2), and covered the density range 692 to 1000 kgm^{-3} over the temperature range 5 to 60°C. Deaerated, distilled water of known isotopic ratio was also used as a calibrant, the density being derived from the CIPM equation with a correction for isotopic deviation from VSMOW.

Calibration was carried out with a cell pressure of 2.15 bara to avoid the formation of bubbles in high vapour pressure samples at the higher temperatures.

The calibration data was then used to generate a calibration surface which gave density as a function of oscillation period, cell damping factor and temperature.

Analysis of the residuals and uncertainty components for samples with viscosities up to 900 mPa·s suggests that this surface gives absolute densities with an uncertainty of ±0.08 kgm^{-3} (*k*=2). For a given sample, the density at any one temperature compared with the density at another temperature has an estimated uncertainty of ±0.04 kgm^{-3} (*k*=2).

5.4 Velocity of Sound Traceability

The VoS cell was calibrated using water and four nominally pure hydrocarbons (literature values from Landolt & Börnstein), together with tetrachloroethylene (calibrated at 10, 20, 40 and 50°C by NPL), and triethylene glycol (calibrated at 10, 20, and 50°C by NPL). NPL quoted a measurement uncertainty of about 1.5 $msec^{-1}$ for the triethylene glycol, and about 2.7 $msec^{-1}$ for tetrachloroethylene, with the actual uncertainties varying with the calibration temperature. The propagation speeds were derived over the frequency range of 2 MHz to 6 MHz.

Finding a suitable model surface to predict μ (propagation speed of sound) as a function of cell period and temperature initially proved difficult. A suitable one was eventually developed which gave a residual standard deviation of 1.7 $msec^{-1}$. Combining this with the uncertainty quoted by NPL and that of the literature values, the total uncertainty in the quoted VoS values is estimated to be of the order 3.5 ms^{-1}. This is satisfactory for the present work, but will be substantially reduced once the new NPL VoS calibration facility is operational. (See letter from NPL in Appendix 3)

5.5 Typical data

A typical set of data, in this case for a sample of crude oil from the Harding field, is shown in Table 5.5.1. (A page of data for each sample analysed is included in Appendix 2)

"time" − the time at which that particular temperature step finished.
"log" − the order in which the temperature steps were run.
"set t" − the nominal cell temperature.
"actual temp °C" − the actual sample temperature for that run.
"q" − the ratio of sample cell and reference cell oscillation periods.
"damp" − the damping factor; this is discussed further in section 7.
"density" − the density in kgm^{-3} calculated from the "q" and "damping".
"VoS τ" − the oscillation period of the VoS measurement cell.
"VoS" − the velocity of sound in the liquid in ms^{-1}, calculated from the "VoS τ" value.

time	log	set temp °C	actual temp °C	q	damp	density kgm^{-3}	VoS τ	VoS ms^{-1}
18:46	5	5	5.03	2.6889127	9.762	936.88	1918.45	1537.6
17:47	3	10	10.02	2.6867156	10.220	933.55	1942.38	1516.9
19:54	7	15	15.00	2.6845104	9.877	930.29	1966.26	1496.6
20:12	8	20	19.99	2.6823034	9.251	927.06	1988.89	1478.0
20:32	9	25	24.98	2.6800882	8.604	923.83	2011.39	1459.7
18:12	4	30	29.97	2.6778740	8.028	920.59	2033.12	1442.5
16:57	1	35	34.95	2.6756539	7.571	917.33	2055.40	1425.2
21:31	11	35	34.95	2.6756463	7.553	917.32	2056.50	1425.3
17:14	2	40	39.94	2.6734365	7.126	914.08	2078.14	1407.9
19:20	6	50	49.91	2.6690128	6.474	907.57	2124.37	1373.7
21:04	10	60	59.88	2.6646102	6.058	901.09	2171.80	1340.0

Table 5.5.1

Before being transferred to the analysis database, graphs of density against temperature, VoS against temperature, and density against VoS, were drawn for visual inspection. In the few cases in which unexpected results were found, the sample was re-analysed before inclusion in the database.

Fig 5.5.2 shows a plot of density and VoS against temperature for the above sample.

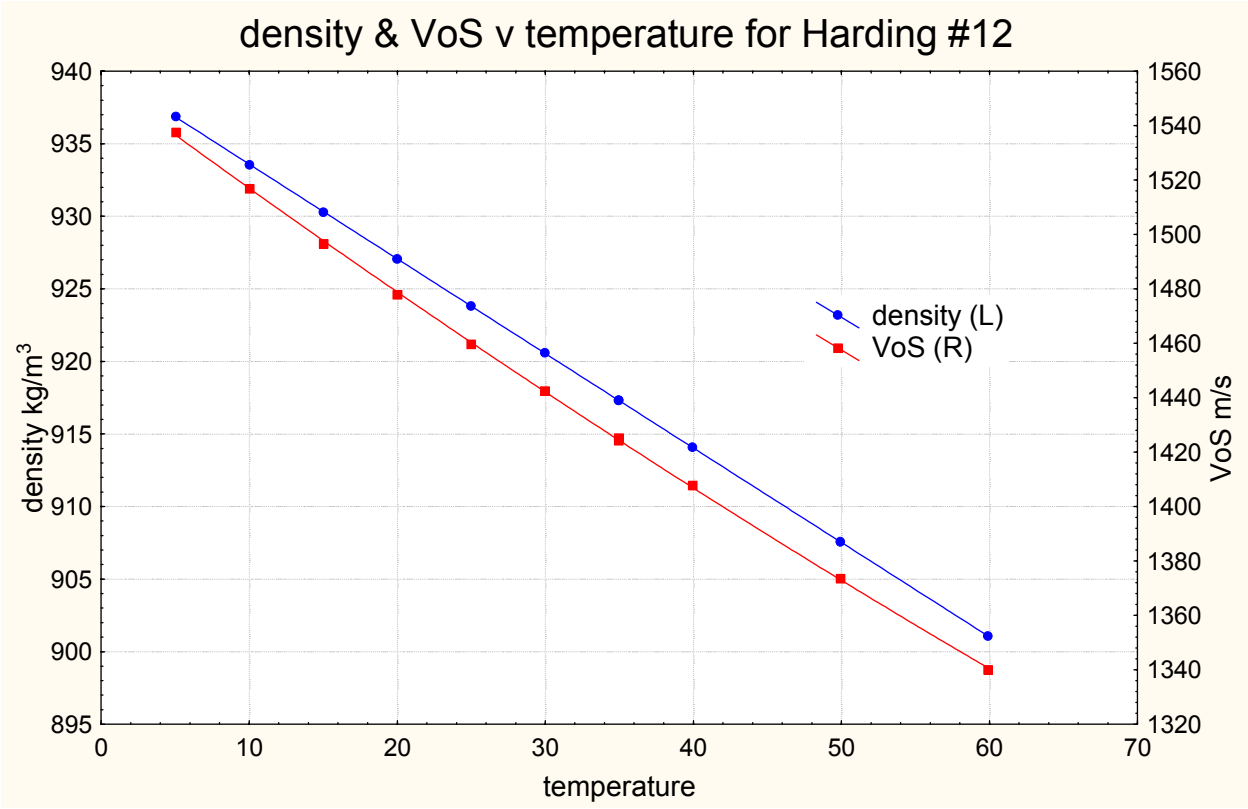

density & VoS v temperature for Harding #12
density kg/m3
VoS m/s
temperature
density (L)
VoS (R)
940
935
930
925
920
915
910
905
900
895
1560
1540
1520
1500
1480
1460
1440
1420
1400
1380
1360
1340
1320
0
10
20
30
40
50
60
70

Figure 5.5.2

6.0 Samples

6.1 Range

Samples were collected with the aim of covering as wide a range of crude oils as possible with an emphasis on covering those grades which represent the largest traded volumes as indicated by the Institute of Petroleum Marine Oil Transportation Database. Additionally, samples from all grades of products and a wide range of lubricating oils were collected, including products to European and US specifications.

A list of samples is included in Appendix 1. In summary these include:

117 Crude oils of which 28 were repeated grades received from different sampling sites.
16 'Distillates' (mostly naphthas)
21 Gasolines
8 Keros/Jets
7 Diesels
15 Gasoils
10 Fuel Oils
24 Lube Oils
4 'others'; benzene #11, a grease #29, a wax #34, and an unspecified 'D/SLTD fuels/crude' #93.

This gave a total of 222 samples.

Crude oil #1 was excluded from the database after analysis, since its results bore no resemblance to those for other samples of crude from this field.

The "benzene" #11 was analysed, but the results suggested that it was almost pure. Since the PM Tables are not meant to cover such chemicals, it has been excluded from the database.

The wax #34 remained solid up to 60°C and so could not be used.

The sample #93 was included as a fuel oil, based upon its observed results.

Sample #100 was labelled as "crude oil" and has been excluded as being of unknown provenance

The crude oil grades included represent 74% of the total crude volume in the IP database for 2002, which itself includes approximately 50% of the total global traded volume. This means that at least 37% of the total traded volume is represented. Since it is known that much of the crude volume which is missing from the IP database is comprised of crudes which have been sampled and included in this project, it is reasonable to assume that at least 60% of the total global traded volume, possibly appreciably more, has been covered.

6.2 Sample Provenance

Strenuous efforts were made to obtain full details of the origin of each sample, including the date and location where the sample was drawn (site and tank number or vessel name). This information is available for virtually all the samples and full records will be retained at the Institute of Petroleum and at the H&D Fitzgerald laboratory.

6.3 Sample Collection and Handling

Samples were provided by project sponsors and others as listed in 2.0 above. The majority of these were drawn from expired retained samples stored by independent inspection companies with the remainder from company laboratories.

7 lube oil samples and 5 crude samples were drawn from retained storage at H&D Fitzgerald. These had been obtained for the initial VoS study in 1988 and prior to inclusion in the database it was confirmed that there had been no change in density in the intervening period.

On receipt at the H&D Fitzgerald laboratory, sample details were recorded and the sub-samples for testing were decanted into 250ml bottles.

The water content of each decanted sample was determined by coulometric Karl Fisher to either IP 386 (ISO 10337:1997) or IP 438 (ISO 12937:2000) as relevant.

6.4 Storage

Samples are stored inverted in 250ml in amber type III glass bottles with polycone tops.

7.0 Wax Appearance Temperature

7.1 General

All modern Paar density meters calculate and display a ‘damping value’. This is used in internal calculations and is a complex function, related in part to sample viscosity.

It had been noted during the work that for some samples the damping value increased dramatically at lower temperatures. It seemed that this is due to formation of wax crystals with the increase occurring around or just above typical cloud points quoted for the samples involved.

The following graphs illustrate this effect.

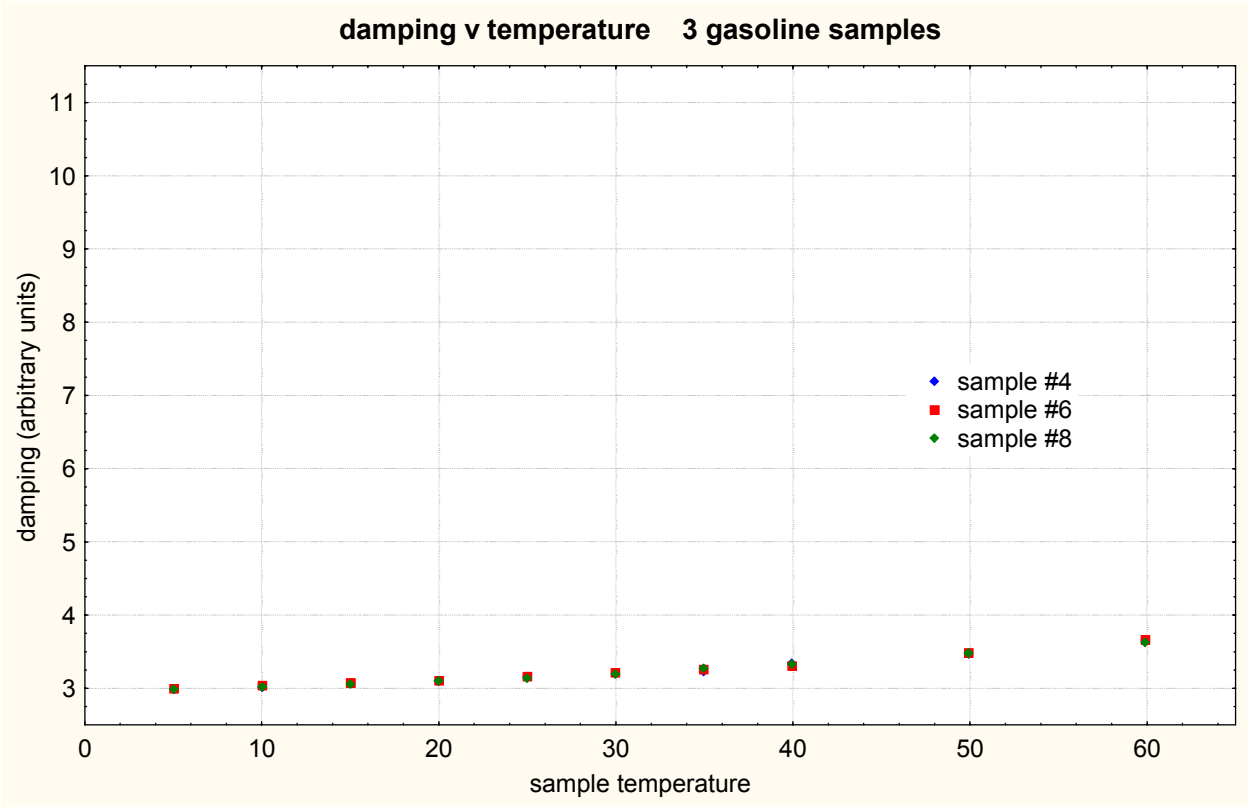


Figure 7.1.1

This shows damping value against temperature for 3 gasoline samples. They plot as fairly smooth curves, where the slope is a function of the behaviour of the glass wall of the cell and the change in viscosity of the sample with temperature. Obviously no crystal formation is anticipated here.

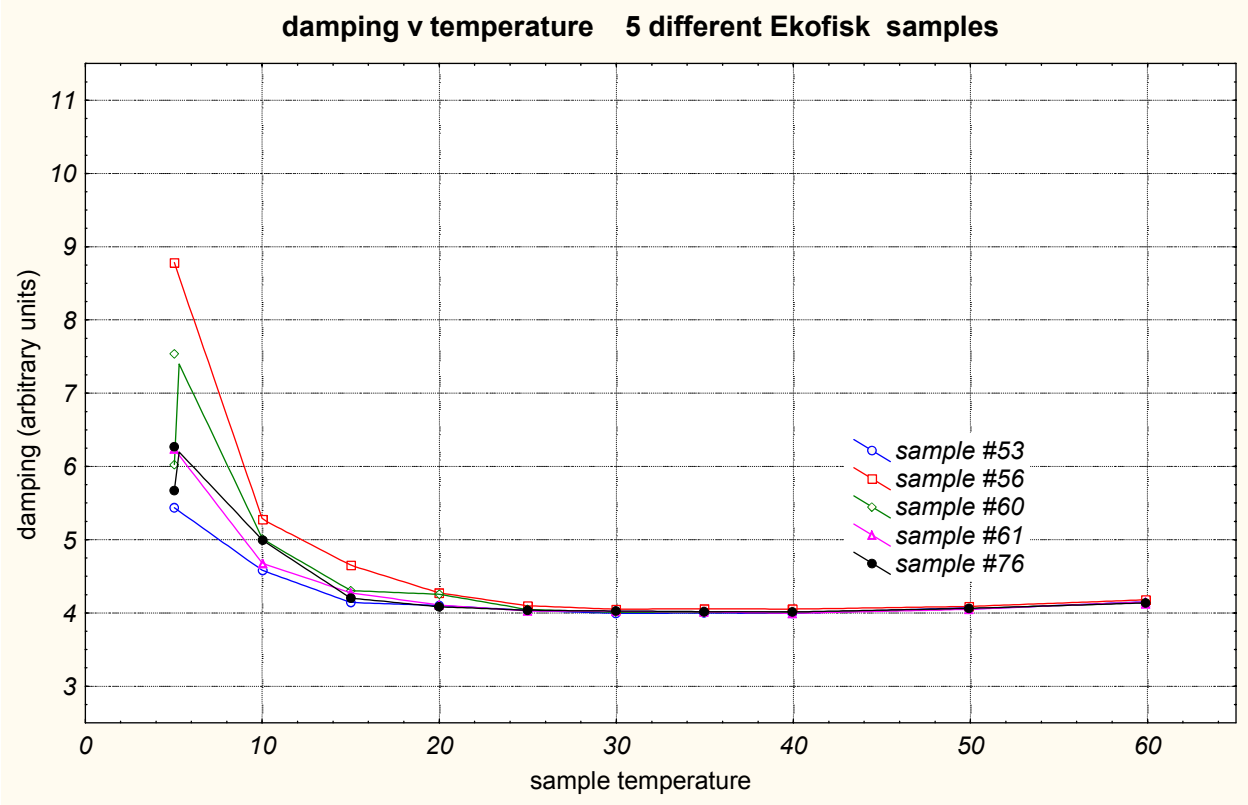


Figure 7.1.2

Five samples of Ekofisk crude have been analysed and damping value against temperature for these is shown in Fig 7.1.2 above. All show a consistent and stable damping value down to around 20°C when the value rises steeply with falling temperature. Ekofisk cloud point is typically 18-24°C.

Temperature points are run at random as for all of the test work with the initial point repeated as the final point. It is interesting to note that samples 60 and 76 started and finished at 5°C and show markedly different damping values for repeat points at this temperature, indicating some hysteresis in the effect. This hysteresis is a further indication that the damping value is being affected by crystalisation. Viscosity changes alone would not be expected to show hysteresis effects.

The following graph for three Statfjord samples show two samples with very little change at lower temperatures while the third sample from a different source shows a change in damping value from around 15°C. This could indicate that the samples have been treated differently, possibly with addition of inhibitors.

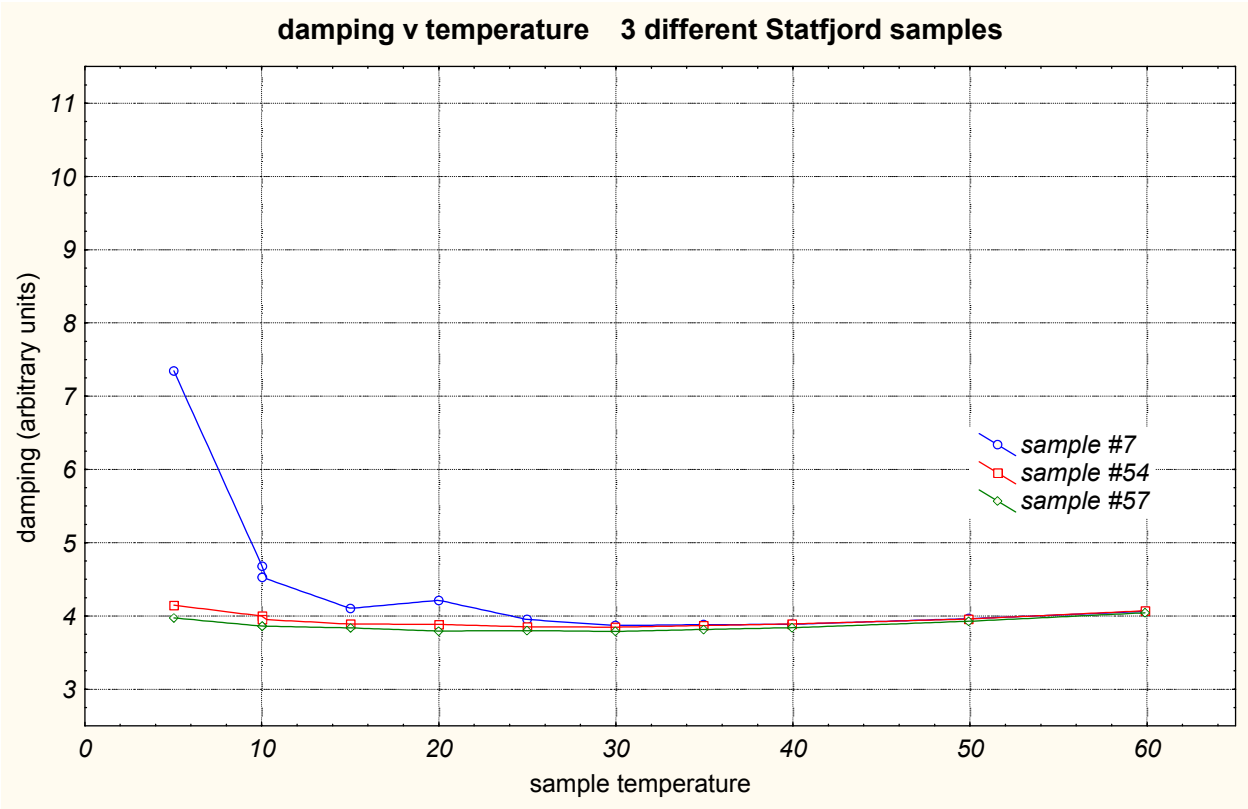


Figure 7.1.3

7.2 Viscous Samples

As was mentioned at the start of this section, the damping value is dependent on many factors, one of which is the sample viscosity. For viscous samples the damping value at 60°C can be quite high and it has been observed that once this damping value exceeds about 8 units, the damping curve cannot be used as an indicator of wax appearance temperature appearance. (Once the damping has exceeded about 11 units, the indicated value often decreases due to the nature of the calculation algorithm).

Figure 7.2.1 shows the plot of indicated damping against cell temperature for a sample of Merey crude, (viscosity about 2100 cSt at 20°C). In this example, the wax appearance temperature cannot be deduced from the damping, and instead is determined from the pattern of the residuals from a quadratic fit of density to temperature.

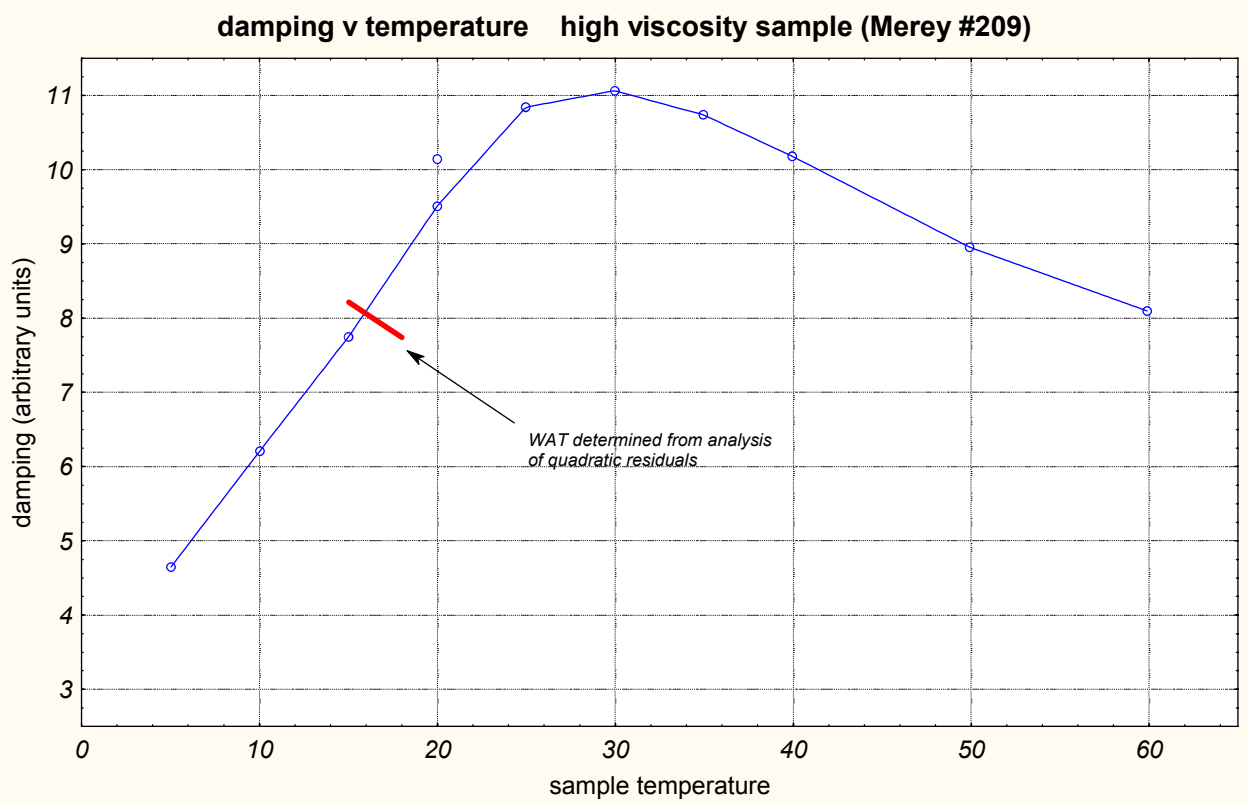


Figure 7.2.1

7.3 Conclusion

The plot of damping value against temperature has been used to define wax appearance temperature where appropriate for all the project samples. These plots are presented with the results in Appendix 2.

(Note: Selection of the wax appearance temperature may appear arbitrary but the same standard was applied to all graphs printed on the same scale by using a protractor.)

Damping value curves are also included for viscous samples where wax appearance temperature has been determined from density analysis and this has been noted.

This technique is fairly easy to carry out using a Paar density meter and it is recommended that it should be considered for development into a full test method.

8.0 Reference density

In order to begin assessing any new relationships to predict density$_{15}$ it is first necessary to define a method for determining 'actual' density$_{15}$ from the experimental measurements. This means deciding on an equation type which best describes the density/temperature relationship for all samples.

When examining the experimental data, it is obvious that for a number of samples, wax crystals are starting to appear at temperatures at or above 15°C. The appearance of this wax may sometimes cause a slight discontinuity in the $\delta\rho/\delta t$ curve of the sample.

It was therefore decided to fit the raw experimental data to a suitable curve, and determine density$_{15}$ from the curve.

This method also has the added advantage that all the mathematical procedures are no longer reliant on just one experimental point, since any error in the experimental density$_{15}$ has a likelihood of being detected during the fitting process.

There are three obvious alternatives:

A simple linear function: $\rho = a + b \times t$

A quadratic: $\rho = a + b \times t + c \times t^2$

The API equation: $$VCF = \frac{\rho}{\rho_{ref^oC}} = EXP[-\alpha_t \Delta t(1 + 0.8\alpha_t \Delta t)]$$

These methods are discussed and compared below.

8.1 Comparison of Methods - linear, quadratic, API

Table 8.1.1 shows a comparison of the experimental density$_{15}$ with the values predicted from the three fitting methods, for five different types of sample.

Table 8.1.2 shows the residual standard deviations for these fits, and shows that a quadratic equation is normally better than the API equation, often appreciably so.

Table 8.1.3 shows a comparison of the VCFs calculated via each of the curve fitting methods with the experimental VCF.

Sample	experimental density$_{15}$	density$_{15}$ predicted using		
		linear	quadratic	API
# 2 ULS diesel	828.10	828.11	828.11	828.11
# 5 SRAR	931.93	930.78	932.15	930.71
# 30 gasoline	748.61	748.64	748.63	748.64
# 80 Norne	863.00	863.59	863.34	863.70
# 120 Fuel oil	956.28	955.21	956.17	955.15

Table 8.1.1

Sample	residual standard deviation from fitting using		
	linear	quadratic	API
# 2 ULS diesel	0.01	0.01	0.03
# 5 SRAR	0.96	0.24	0.93
# 30 gasoline	0.18	0.01	0.08
# 80 Norne	0.01	0.02	0.01
# 120 Fuel oil	0.71	0.23	0.70

Table 8.1.2

Sample	experimental density$_{15}$	experimental density$_{60°C}$	$VCF_{60\text{-}15}$ from expt. data	$VCF_{60\text{-}15}$ predicted using		
				linear	quadratic	API
# 2 ULS diesel	828.10	796.28	0.9616	0.9616	0.9616	0.9616
# 5 SRAR	931.93	896.79	0.9623	0.9635	0.9621	0.9636
# 30 gasoline	748.61	707.27	0.9448	0.9447	0.9448	0.9447
# 80 Norne	863.00	836.94	0.9698	0.9692	0.9695	0.9690
# 120 fuel oil	956.28	922.23	0.9644	0.9655	0.9645	0.9655

Table 8.1.3

When the three equations were fitted to all 218 samples in the database, the average errors were as follows:

linear	$0.13\,\mathrm{kgm^{-3}}$
API equation	$0.13\,\mathrm{kgm^{-3}}$
quadratic	$0.06\,\mathrm{kgm^{-3}}$

There were four samples for which only 5 valid density / VoS / temperature triplets could be obtained, and density$_{15}$ for these has been obtained by a linear fit. For all other samples, a quadratic function has been used to provide values for 'actual' density$_{15}$.

A "valid" density / VoS / temperature point is one which is measured when the damping value and the quadratic residuals suggest that the measurement cells contain no solid phase due to waxes or asphaltenes crystallising.

9.0 Data available

A total of 2372 data points (density/VoS/temperature triplets) were determined and there were 263 points where data was marked as invalid due to the damping value or quadratic fit residuals indicating that wax crystals had formed at the test temperature.

	Valid data points	invalid data points	**Σ**
crudes	1092	173	**1265**
gasolines	363	0	**363**
kerosines	143	0	**143**
fuel oils	250	87	**337**
lube oils	263	41	**264**
Σ	**2109**	**263**	**2372**

	liquid at 15°C	crystals at 15°C	**Σ**
crudes	979	286	**1265**
gasolines	363	0	**363**
kerosines	143	0	**143**
fuel oils	227	110	**337**
lube oils	264	0	**264**
Σ	**1976**	**396**	**2372**

10.0 Predicting density$_{15}$ from Measured Density and VoS

The main aim of the work was to investigate whether, by using VoS to complement density, a more straightforward and precise method of obtaining density$_{15}$ from ambient measurements could be derived.

It has been possible to derive a single 'universal' equation for all hydrocarbon liquids in the data set which will provide density$_{15}$ from density and VoS measurements at ambient conditions with improved precision when compared with the existing API/ASTM calculation procedures. In some cases equations with further improved precision can be derived for individual liquid groups.

These equations, derivation and results are described below. There was some amount of discussion amongst members of the steering group as to whether samples should be included if they were not completely liquid at 15°C. This is covered further in Section 9 above. Two equations have therefore been produced for each sample category, firstly for all valid samples which, judging from their damping values, did not show any wax crystal formation at 15°C, and then for all valid samples.

As already mentioned in Section 8.1, almost all references to density$_{15}$ actually refer to the value predicted from a quadratic fit of density to temperature & temperature^2.

10.1 Crudes

For crudes which show no wax crystallisation at 15°C

$n = 927$ R = 0.999983

$$\begin{aligned} density_{15} = & -23.840 \\ & +(1.01421 \cdot density_t) \\ & +\left(704.140 \cdot \frac{t}{density_t}\right) \\ & -\left(10.7894 \cdot \frac{t^2}{density_t}\right) \\ & +\left(13.70302 \cdot \frac{t^2}{VoS_t}\right) \end{aligned}$$

Equation 10.1A

The residual standard deviation is $0.22\,\mathrm{kgm^{-3}}$.

This should be compared with a standard deviation for the difference between the experimental density 15°C and the values predicted from the PM Tables for these samples of $0.35\,\mathrm{kgm^{-3}}$.

For all crudes including those which show wax crystallisation at 15°C

$n = 1092$ R = 0.999981

$$\begin{aligned} density_{15} = & -24.284 \\ & +(1.01475 \cdot density_t) \\ & +\left(701.3408 \cdot \frac{t}{density_t}\right) \\ & -\left(10.2253 \cdot \frac{t^2}{density_t}\right) \\ & +\left(12.95556 \cdot \frac{t^2}{VoS_t}\right) \end{aligned}$$

Equation 10.1B

The residual standard deviation is $0.24\,\mathrm{kgm^{-3}}$.

This should be compared with a standard deviation for the difference between the experimental density 15°C and the values predicted from the PM Tables for these samples of $0.38\,\mathrm{kgm^{-3}}$.

10.2 Products

For products which show no wax crystallisation at 15°C

$n = 731$ R = 0.999980

$$density_{15} = -21.951 + (1.01207 \cdot density_t) + \left(1288.150 \cdot \frac{t}{VoS_t}\right) - \left(2.45258 \cdot \frac{t^2}{density_t}\right) - \left(82694.58 \cdot \frac{t}{density_t^2}\right)$$

Equation 10.2A

The residual standard deviation $0.48\,\mathrm{kgm^{-3}}$.

This should be compared with a standard deviation for the difference between the experimental density 15°C and the values predicted from the PM Tables for these samples of $0.82\,\mathrm{kgm^{-3}}$.

For all products including those which show wax crystallisation at 15°C

$n = 748$ R = 0.999977

$$density_{15} = -22.297 + (1.01246 \cdot density_t) + \left(1313.484 \cdot \frac{t}{VoS_t}\right) - \left(2.492658 \cdot \frac{t^2}{density_t}\right) - \left(92786.11 \cdot \frac{t}{density_t^2}\right)$$

Equation 10.2B

The residual standard deviation $0.54\,\mathrm{kgm^{-3}}$.

This should be compared with a standard deviation for the difference between the experimental density 15°C and the values predicted from the PM Tables for these samples of $0.85\,\mathrm{kgm^{-3}}$.

10.3 Lubes

All lube oil samples,

$n = 262$ R = 0.999959

$$density_{15} = -24.607 + (0.005321 \cdot VoS_t) + (1.00764 \cdot density_t) + \left(1033.477 \cdot \frac{t}{VoS_t}\right) - \left(1.702504 \cdot \frac{t^2}{density_t}\right)$$

Equation 10.3

The residual standard deviation $0.14\,\mathrm{kgm^{-3}}$.

This should be compared with a standard deviation for the difference between the experimental density 15°C and the values predicted from the PM Tables for these samples of $0.33\,\mathrm{kgm^{-3}}$.

10.4 Products & Lubes

For products and lubes combined as one set which show no wax crystallisation at 15°C

$n = 993 \qquad R = 0.999978$

$$\begin{aligned} density_{15} = & -25.674 \\ & + (1.01704 \cdot density_t) \\ & + \left(1111.465 \cdot \frac{t}{VoS_t}\right) \\ & - \left(5.14747 \cdot \frac{t^2}{density_t}\right) \\ & + \left(4.171165 \cdot \frac{t^2}{VoS_t}\right) \end{aligned}$$

Equation 10.4A

The residual standard deviation $0.49\,\mathrm{kgm^{-3}}$.

This should be compared with a standard deviation for the difference between the experimental density 15°C and the values predicted from the PM Tables for these samples of $0.72\,\mathrm{kgm^{-3}}$.

For all products & lubes combined as one set, including those which show wax crystallisation at 15°C

$n = 1010 \qquad R = 0.999975$

$$\begin{aligned} density_{15} = & -26.493 \\ & + (1.0180 \cdot density_t) \\ & + \left(1117.822 \cdot \frac{t}{VoS_t}\right) \\ & - \left(5.63679 \cdot \frac{t^2}{density_t}\right) \\ & + \left(4.83597 \cdot \frac{t^2}{VoS_t}\right) \end{aligned}$$

Equation 10.4B

The residual standard deviation $0.54\,\mathrm{kgm^{-3}}$.
This should be compared with a standard deviation for the difference between the experimental density 15°C and the values predicted from the PM Tables for these samples of $0.75\,\mathrm{kgm^{-3}}$.

10.5 All Samples

For samples which show no wax crystallisation at 15°C combined as one set.

$n = 1921 \qquad R = 0.999973$

$$\begin{aligned} density_{15} = & -23.605 \\ & + (1.01448 \cdot density_t) \\ & + \left(1093.9461 \cdot \frac{t}{VoS_t}\right) \\ & - \left(2.200616 \cdot \frac{t^2}{density_t}\right) \end{aligned}$$

Equation 10.5A

The residual standard deviation 0.45 kgm^{-3}.

This should be compared with a standard deviation for the difference between the experimental density 15°C and the values predicted from the PM Tables for these samples of 0.58 kgm^{-3}.

A normal probability plot of the residuals from this fitting is shown in Figure 10.5.1. The curve is approximately symmetrical about the 0,0 point, which suggests that a further, as yet undiscovered, function might well improve the quality of fit.

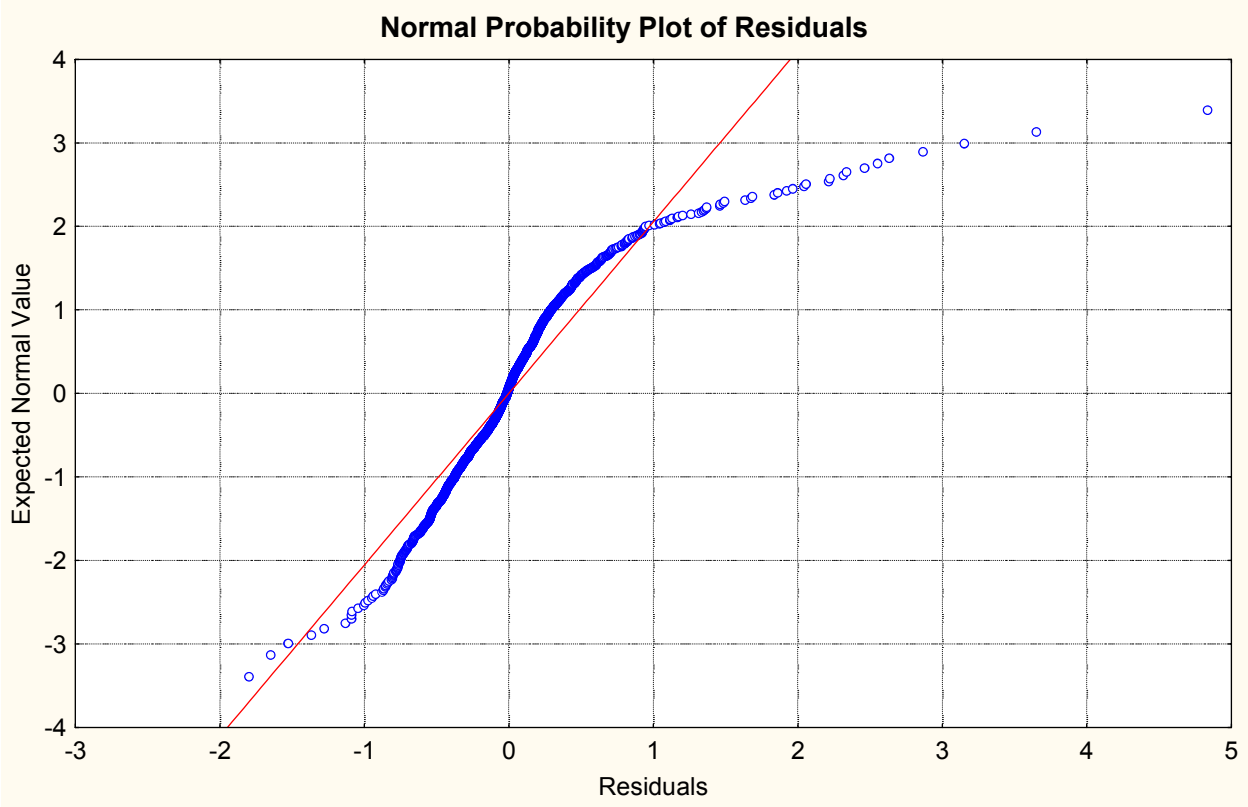


Figure 10.5.1

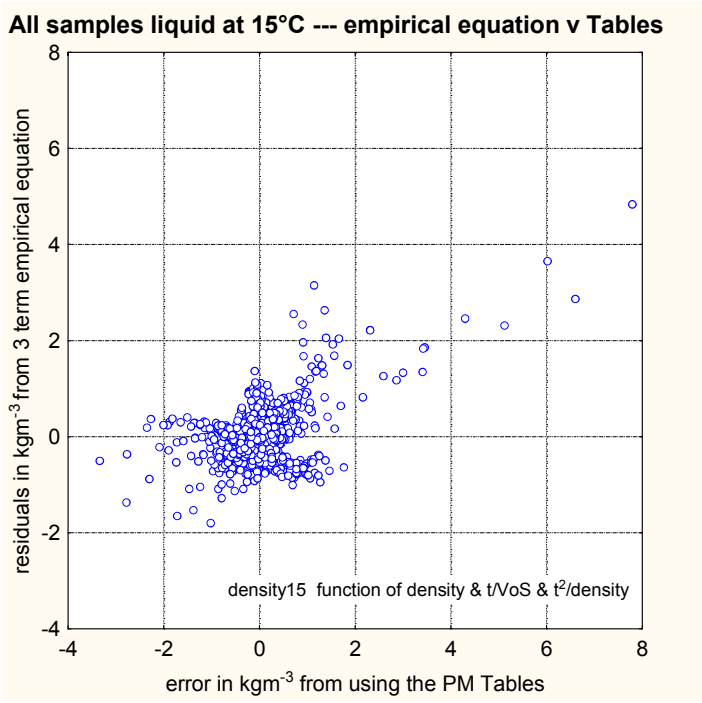


Figure 10.5.2

For all valid samples which show no crystal formation at 15°C, figure 10.5.2 shows the residuals from the generalised equation (10.5A) plotted against the difference between the density$_{15}$ predicted by the PM Tables for that data point and the density$_{15}$ predicted from a quadratic equation.

For all samples combined as one set, including those which show wax crystallisation at 15°C

$$n = 2102 \qquad R = 0.999968$$

$$density_{15} = -24.147 + (1.01512 \cdot density_t) + \left(1094.6146 \cdot \frac{t}{VoS_t}\right) - \left(2.185587 \cdot \frac{t^2}{density_t}\right)$$

Equation 10.5B

The residual standard deviation 0.50 kgm^{-3}.

This should be compared with a standard deviation for the difference between the experimental density 15°C and the values predicted from the PM Tables for these samples of 0.59 kgm^{-3}.

10.6 Influence of crystal formation

As can be seen from the residual standard deviations given above, the generalised equations for both the sample sets – those which do not exhibit wax formation at 15°C, and those which do – show very similar residual standard deviations. It therefore seems probable that in generalised terms, it is unimportant whether a sample has crystals present or not. When examining the behaviour of individual samples however, the presence of wax crystals does play a more important role in the $\delta\rho/\delta t$ relationship.

10.7 Sensitivity of the generalised equation

Considering the sensitivity of the generalised equation (10.5A) to small errors in measuring density, VoS, and temperature.

Example - Forties blend sample #62
Experimental density at 59.88°C is 775.36 kgm^{-3}
Experimental density at 15°C is 809.59 kgm^{-3}
A quadratic fit density at 15°C is 809.56 kgm^{-3}

Density at 15°C predicted from generalised equation 10.5A is 809.68 kgm^{-3} , an error of 0.12 kgm^{-3}.

Density at 15°C predicted from the PM Tables is 809.78 kgm^{-3}, an error of 0.22 kgm^{-3}.

If the temperature is reported as 60.38°C, a measurement error of 0.5 K, equation 10.5A predicts a density at 15°C of 809.99 kgm^{-3}, an error of 0.43 kgm^{-3}.

The PM Tables predict a density 15°C from 60.38°C of 810.15 kgm^{-3}, an error of 0.59 kgm^{-3}.

If the density has a measurement error of 0.5 kgm^{-3}, equation 10.5A predicts a density at 15°C of 810.20 kgm^{-3}, an error of 0.64 kgm^{-3}.

The PM Tables predict a density 15°C from a density at 59.88°C of (775.36 + 0.5 = 775.86) kgm^{-3}, of 810.26 kgm^{-3}, an error of 0.70 kgm^{-3}.

If the measured VoS is in error by 0.5 ms^{-1}, equation 10.5A predicts a density at 15°C of 809.66 kgm^{-3}, an error of 0.1 kgm^{-3}.

11.0 Predicting δρ/δt from Measured Density and VoS

In addition to the main aim of the work noted above it has always been hoped that it might be possible to derive a relationship which would enable density at any temperature to be calculated from a single determination of density, VoS, and temperature.

This requires us to assume that the δρ/δ*t* curves for all samples is of the same form, and then derive an empirical equation from the experimental data set to predict the coefficient(s) to be used for this curve. As can be seen from Section 8, the three obvious candidate curves are the API equation, a quadratic, or a linear equation.

Considering each of these:-

> The API equation appears to give the same errors as a linear fit, but is much more complex. It cannot be solved easily on a pocket calculator. It has therefore not been considered.
>
> A quadratic gives errors which on average are half those of a linear fit, but unfortunately, it transpires that the coefficients can not be reliably predicted from the database.
>
> A linear fit has the benefit of simplicity, even though it gives larger errors.

It was therefore decided that for the purpose of establishing whether this method might work, the assumption would be made that δρ/δ*t* was linear. This would give the equation

$$density_{t2} = density_{t1} + \delta\rho/\delta t \times (t_1 - t_2)$$

A linear regression of density against temperature had already been carried out for every sample in the database, which gave the best fitting δρ/δ*t* for each sample. A stepwise multiple regression of δρ/δ*t* was therefore carried out against observed density, temperature, VoS values, together with a variety of interaction terms. This allowed the following empirical equation to be developed.

$$\begin{aligned}\delta\rho/\delta t = {} & 8.627785 \\ & -0.0120172 \times density_t \\ & +0.000005344 \times density_t^2 \\ & -2602.6770 \times \left(\frac{t}{density_t^2}\right) \\ & -782.2974 \times \left(\frac{VoS_t}{density_t^2}\right)\end{aligned}$$

Equation 11.1

R = 0.9816 n = 1921 residual standard deviation = 0.1696

This equation was then used to predict density$_{15}$ for all the valid data points for samples which did not show crystal formation at 15°C.

Table 11.1 shows for each class of liquid the average error (bias) and its standard deviation for each valid sample which is fully liquid at 15°C.

Column (a) shows the difference between the density$_{15}$ predicted by the Petroleum Measurement Tables and the experimental value (taken from a quadratic see section 8.1).

Column (b) shows the difference between the density$_{15}$ calculated by applying the generalised $\delta\rho/\delta t$ derived from equation 11.1 to the observed data and the experimental value.

Column (c) shows the difference between density$_{15}$ predicted from equation 10.5A and the experimental value.

It can be seen that predicting $\delta\rho/\delta t$ from a generalised equation gives a lower standard deviation for each type of sample than using the individual PM Tables.

If $\delta\rho/\delta t$ is calculated specifically for crude oils, the average error between the predicted and experimental density$_{15}$s becomes 0.02 kgm^{-3}, with a standard deviation of 0.26 kgm^{-3}, which compares well with the PM Tables average of 0.03 kgm^{-3} and a standard deviation of 0.35 kgm^{-3}.

It is suggested that one possible advantage of using this method is that it is easy to convert an observed density or volume to another temperature, without having to go through a reference density.

		a		b		c	
table	density / VoS / temperature triplets *n*	Qdensity$_{15}$ − density$_{15}$ from **PM Tables** kgm^{-3}	standard deviation kgm^{-3}	Qdensity$_{15}$ − density$_{15}$ from **predicted slope equation 11.1** kgm^{-3}	standard deviation kgm^{-3}	Qdensity$_{15}$ − density$_{15}$ predicted from **equation 10.5A** kgm^{-3}	standard deviation kgm^{-3}
crudes	927	0.03	0.35	-0.01	0.28	-0.09	0.31
gasolines	363	-0.18	0.65	-0.13	0.31	-0.04	0.39
kerosines	143	0.08	0.91	0.06	0.33	0.19	0.42
fuel oils	225	0.20	0.95	0.33	0.71	0.20	0.80
lubes	263	0.02	0.33	0.11	0.30	0.09	0.45
All samples	**1921**	**0.01**	**0.58**	**0.03**	**0.39**	**0.00**	**0.45**

Table 11.1

Table 11.2 tabulates the differences between the density calculated by applying the generalised $\delta\rho/\delta t$ derived from equation 11.1 to the observed data, and the experimental value, for a range of temperatures.

table	$Qdensity_{20}$ − $density_{20}$ from predicted slope equation 11.1 kgm^{-3}	st.dev kgm^{-3}	$Qdensity_{25}$ − $density_{25}$ from predicted slope equation 11.1 kgm^{-3}	st. dev kgm^{-3}	$Qdensity_{30}$ − $density_{30}$ from predicted slope equation 11.1 kgm^{-3}	st. dev kgm^{-3}	$Qdensity_{40}$ − $density_{40}$ from predicted slope equation 11.1 kgm^{-3}	st. dev kgm^{-3}
crudes	-0.04	0.24	-0.05	0.23	-0.05	0.24	0.02	0.29
gasolines	-0.06	0.25	-0.02	0.22	-0.00	0.22	-0.07	0.30
kerosines	0.07	0.30	0.06	0.28	0.06	0.29	0.02	0.37
fuel oils	0.23	0.60	0.13	0.54	0.05	0.53	-0.10	0.62
lubes	0.08	0.26	0.06	0.26	0.05	0.27	0.05	0.33
All samples	**0.01**	**0.33**	**-0.00**	**0.30**	**-0.01**	**0.30**	**-0.01**	**0.36**

Table 11.2

This approach was outside the scope of the project but could provide a useful method with many applications. There are indications that further statistical analysis should be able to substantially reduce the residual standard deviation which already shows a small improvement over the PM Tables.

12.0 Unusual samples / Interferences

12.1 Effect of Water Content

Any non-homogeneity of the sample in either the density cell or the VoS cell will result in large errors. There can therefore be no gas breakout, and no free water present. However, for any method which uses VoS to be viable, results must not be affected by 'normal' quantities of dissolved water in the samples.

All samples have therefore been tested "as received" with no artificial drying.

However, to obtain more a direct indication of the effects of absorbed water on the measurements, particularly VoS determinations, a brief study was carried out, using toluene, derv, and a crude oil.

The toluene was dried, subdivided, and then different amounts of water added. The change in VoS was found to lie well within the experimental uncertainty. In addition, it appears that a water / toluene mix shows positive shrinkage, in that the density decreased very slightly as water content increased.

Water ppm	VoS
32	1326.85
161	1326.89
260	1326.78
362	1326.98
499	1326.75

On repeating the test with derv, small changes in VoS were noted, the differences being just above the experimental uncertainty. It was also found that if a true water/derv emulsion (2%) was injected into the meter, the reading from VoS cell was unstable.

Water ppm	VoS
17	1368.39
48	1367.98
71	1367.96
89	1367.98
189	1368.14

Having tried a pilot run with Ekofisk which failed due to loss of light ends on mixing, the crude work was repeated with Heidrun. Below 0.15% water, the change in VoS was very small, and again within experimental error. Above this level, emulsifier was needed to hold the water in the sample, together with high energy mixing. This again caused light ends loss resulting in density and VoS changes which appear to mask any changes due to the addition of water.

Water ppm	VoS
86	1422.44
205	1422.46
295	1422.41
696	1422.49
865	1422.43
1705	1422.36

From the above short investigation it appears that the effect of dissolved water in "normal" quantities is very small.

12.2 Unleaded Gasolines

A number of unleaded gasoline have been analysed, and there is no indication that their results are in any way unusual.

12.3 Oxygenates (from H&D earlier work)

Several gasoline samples known to contain oxygenates were analysed in the initial project in 1997, and there is no indication that the results are unusual. It is not known whether any of the samples received for this project contained oxygenates.

12.4 Biodiesel/FAME (from H&D earlier work)

Five nominally pure samples of different fatty acid methyl esters were analysed over the temperature range of 15 to 25°C during the initial project. Over this temperature range their expansivities were predictable from density & VoS.

Tests were also carried out over the same temperature range with blends of 5% by volume FAME in Derv, and 20% by volume FAME in gas oil, with similar results.

Unfortunately, these samples did not store well, and had to be disposed of before the current project started.

13.0 Practical Application of Velocity of Sound Relationships

The empirical methodologies outlined in Sections 10 and 11 can both be applied using VoS and density data gathered in the laboratory, or by combining online densities with VoS values measured by ultrasonic flow meters or in-line VoS instruments.

This will allow volume or density corrections with temperature for hydrocarbon liquids to be calculated simply and with greater precision than the existing PM Tables without the need to refer to separate calculation routines based on the class of the product.

13.1 VoS Standards

In order for any method which relies on velocity of sound measurements to be accepted, it will be necessary to obtain suitable standards for instrument calibration. Fortunately the UK National Physical Laboratory has been developing its equipment and techniques and should be able to supply standards with uncertainties around ± 0.2 ms^{-1} from mid 2004. (See Appendix 3)

APPENDIX 1

SAMPLE LIST

Sample List

Number	Name	Type	Number	Name	Type
1	abandoned	crude	53	Ekofisk	crude
2	ULS Diesel	derv	54	Statfjord	crude
3	Vacuum Gas Oil	gas oil	55	Asgård	crude
4	Motor Spirit Premium	gasoline	56	Jotun	crude
5	Straight Run Atmospheric Residue	fuel oil	57	Statfjord	crude
6	Gasoline unleaded US regular	gasoline	58	White Spirit de aromatised	kero
7	Statfjord	crude	59	Ekofisk	crude
8	Motor Spirit PU50	gasoline	60	Ekofisk	crude
9	Light Cycle Oil	distillate	61	Ekofisk	crude
10	Pygas	distillate	62	Forties Blend	crude
11	Benzene	other	63	Kerosene K5	kero
12	Harding	crude	64	Kerosene SPK-05	kero
13	Eurodiesel	derv	65	Light Cycle Oil	distillate
14	Gas Oil G102	gas oil	66	Fuel Oil LS	fuel oil
15	Fuel Oil Domestic	gas oil	67	Mexican ?	crude
16	Straight Run Atmospheric Residue	fuel oil	68	Naphtha MSR	distillate
17	Raffinate	distillate	69	Naphtha LSR	distillate
18	Motor Spirit PU50	gasoline	70	Naphtha N&A	distillate
19	Eurodiesel EN 590	derv	71	Njord	crude
20	Euroregular motor spirit	gasoline	72	Naphtha LSR	distillate
21	ULS Diesel	derv	73	Fuel Oil Domestic	gas oil
22	Gas Oil EN 590	gas oil	74	no such sample	
23	Naphtha	distillate	75	Welton	crude
24	Straight Run Atmospheric Residue	fuel oil	76	Ekofisk	crude
25	Lube oil	lube oil	77	Fuel Oil HS	fuel oil
26	Gas Oil UKSG	gas oil	78	Heidrun	crude
27	ULS Diesel	derv	79	Glitne	crude
28	Avgas 100	gasoline	80	Norne	crude
29	SOL 30 Mobilsol30	other	81	Norne	crude
30	Motor Spirit SU	gasoline	82	High Cat Cracked Spirit	distillate
31	Forties Blend	crude	83	Welton	crude
32	Heavy Fuel Oil UKSG	fuel oil	84	Vacuum Gas Oil	gas oil
33	Jet A1	jet	85	Motor Spirit Premium	gasoline
34	Prowax 364	wax	86	Vacuum Gas Oil LS	gas oil
35	Njord	crude	87	Naphtha LSR	distillate
36	Triton	crude	88	Naphtha	distillate
37	Arab Extra Light	crude	89	Fuel Oil Domestic (Base)	gas oil
38	Saharan Blend	crude	90	Aktobinsk	crude
39	Asgård	crude	91	Maya	crude
40	Arab Light	crude	92	Galeota blend	crude
41	Beryl	crude	93	D/SLTD (fuels crude)	fuel oil
42	Fife	crude	94	Vacuum Gas Oil	gas oil
43	Motor Spirit PU50	gasoline	95	Coban	crude
44	Gas Oil IGO dyed CIW	gas oil	96	Gasoline M1-315 (blend 025060)	gasoline
45	Raffinate (Mogas comp)	gasoline	97	Gasoline #2 Coker	gasoline
46	GO Derv RVW	derv	98	Gasoline M3-351 (blend 02N180)	gasoline
47	Mogas LRP	gasoline	99	Gasoline	gasoline
48	Naphtha	distillate	100	crude oil	crude
49	Jet A1	jet	101	Maya	crude
50	Gas Oil IGO undyed	gas oil	102	Arab Medium	crude
51	Light Fuel Oil UKSG	fuel oil	103	Forcados	crude
52	Heavy Fuel Oil UKSG	fuel oil	104	Gas Oil HV (lubes)	gas oil

Number	Name	Type
105	Maya	crude
106	Reformate	distillate
107	Galeota blend	crude
108	Gasoline 83CB	gasoline
109	Gasoline 87 RFG	gasoline
110	Gasoline 87 CONV	gasoline
111	Gasoline 93 RFG	gasoline
112	Gasoline 94 RFG	gasoline
113	Gasoline GT unleaded	gasoline
114	LS diesel	derv
115	Jet A	jet
116	Chemical Naphtha	distillate
117	Chemical mineral spirits	distillate
118	Vacuum Gas Oil	gas oil
119	Fuel Oil #2	fuel oil
120	Fuel Oil #6	fuel oil
121	Troll	crude
122	Qua Iboe	crude
123	Rabi Light	crude
124	Palanca	crude
125	Escravos	crude
126	Hibernia	crude
127	Nemba	crude
128	Arab Heavy	crude
129	Qing Huang Dao	crude
130	Didon	crude
131	Yombo	crude
132	Karachaganak Condensate	crude
133	Arab Medium	crude
134	Iranian Light	crude
135	Iranian Light	crude
136	Basrah Light	crude
137	Syrian Light	crude
138	Aktobinsk	crude
139	Thevenard	crude
140	Saharan Blend	crude
141	Kyle/Curlew	crude
142	Souedie	crude
143	Ross/Blake	crude
144	Russian Export Blend	crude
145	Iranian Light	crude
146	Val d'Agri	crude
147	Turkish Indigenous (ex Selmo)	crude
148	Western Desert	crude
149	Miskar Condensate	crude
150	Glitne	crude
151	Tempa Rossa	crude
152	Legendre	crude
153	HS Russian Condensate	crude
154	Onako Light	crude
155	Senipah Condensate	crude
156	Alexandria	crude
157	Dubai	crude
158	Gullfaks	crude
159	Azeri Light	crude
160	West Texas Intermediate	crude
161	Alaskan North Slope	crude
162	Bonny Light	crude
163	Forcados	crude
164	Kirkuk	crude
165	Murban	crude
166	Qua Iboe	crude
167	Iranian Heavy	crude
168	Amna	crude
169	Kuwait	crude
170	Bach Ho	crude
171	Azeri Light	crude
172	Russian Export Blend	crude
173	Arab Extra Light	crude
174	Cabinda	crude
175	Upper Zakum	crude
176	Brent Blend	crude
177	Foinaven	crude
178	Draugen	crude
179	HVI 650	lube oil
180	HVI 115	lube oil
181	VHVi 5.4	lube oil
182	HVI 60	lube oil
183	MVIN 40	lube oil
184	Transformer Oil	lube oil
185	Jet A1	jet
186	Isthmus	crude
187	Maya	crude
188	Alba	crude
189	Oman Export Blend	crude
190	Danish	crude
191	Zarzaitine	crude
192	Zarzaitine	crude
193	Anasuria	crude
194	Balder	crude
195	Kittiwake	crude
196	Kittiwake	crude
197	SN90	lube oil
198	Header Core 2500	lube oil
199	Core 600	lube oil
200	Core 100	lube oil
201	Core 150	lube oil
202	Core 145	lube oil
203	Jet A1	jet
204	Gas Oil undyed	gas oil
205	Olmeca	crude
206	800N	lube oil
207	Mesa 30	crude
208	225N	lube oil
209	Merey	crude
210	110N	lube oil
211	80N	lube oil
300	60 Solvent pale	lube oil
301	150SN	lube oil
302	SBS 150	lube oil
303	500 SN	lube oil
304	Bouri	crude
305	600 SN	lube oil
306	Gach Saran	crude
307	Flotta	crude
308	A90	lube oil
309	Wytch Farm	crude
310	Oseberg	crude
312	WBS 160	lube oil

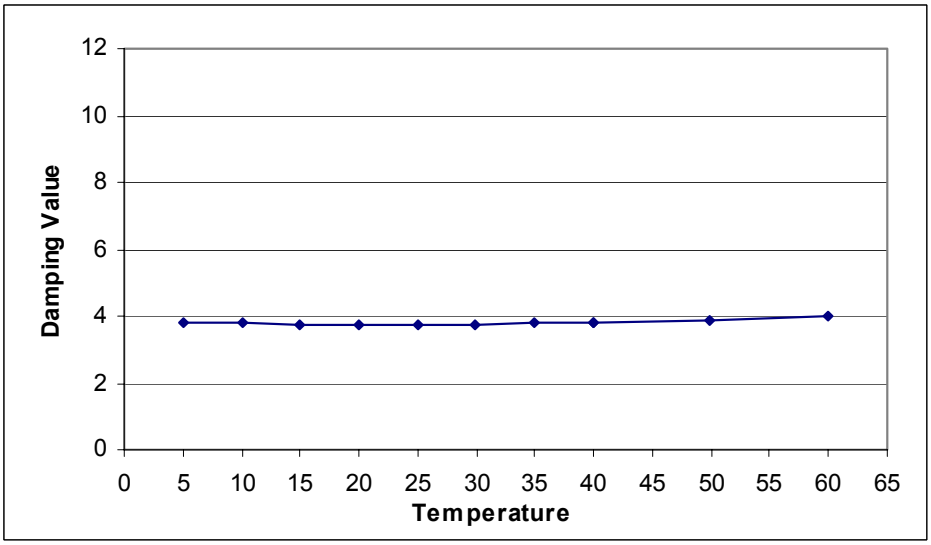
APPENDIX 2

EXPERIMENTAL RESULTS

Sample Details and Data

Sample Name:	ULS Diesel	**Sample Number:**	2
Sample Type:	Diesel	**Sample date :**	20/04/2001

Damping Curve



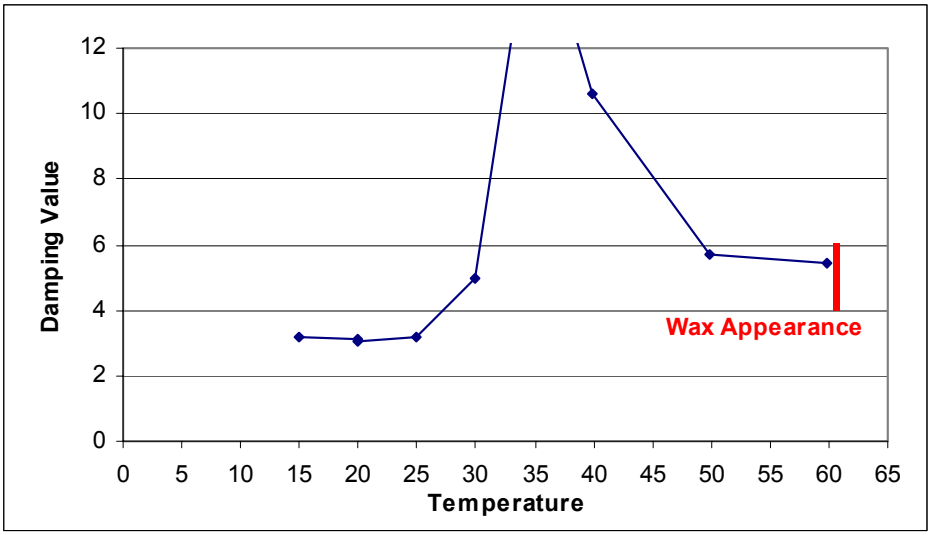
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.93	810.46	1288.3	3.79
2	25.00	24.97	821.05	1342.5	3.74
3	50.00	49.91	803.38	1252.9	3.85
4	15.00	15.00	828.10	1379.1	3.76
5	35.00	34.95	813.98	1306.5	3.77
6	60.00	59.88	796.28	1217.8	3.99
7	20.00	19.99	824.58	1360.8	3.73
8	5.00	5.03	835.16	1416.2	3.82
9	30.00	29.97	817.52	1324.6	3.74
10	10.00	10.02	831.63	1397.6	3.78
11	40.00	39.94	810.45	1288.6	3.79

Sample Details and Data

Sample Name:	Vacuum Gas Oil	**Sample Number:**	3
Sample Type:	Gas oil	**Sample date :**	06/04/2001

Damping Curve



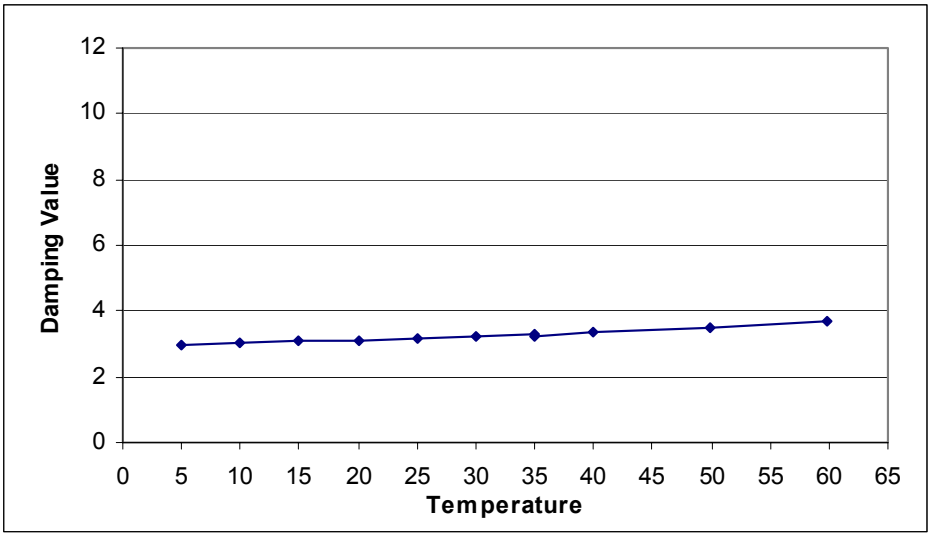
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	908.87	1487.8	3.09
2	15.00	15.01	912.94	1512.5	3.20
3	60.00	59.88	879.18	1336.7	5.43
4	40.00	39.93	892.32	1404.6	10.63
5	25.00	24.98	904.65	1465.0	3.21
6	30.00	29.96	900.47	1443.5	4.99
7	35.00	34.95	895.41	1423.7	16.69
8	50.00	49.91	885.60	1369.9	5.72
9	20.00	19.99	908.86	1488.6	3.07

Sample Details and Data

Sample Name:	Motor Spirit Premium	**Sample Number:**	4
Sample Type:	Gasoline	**Sample date :**	21/04/2001

Damping Curve



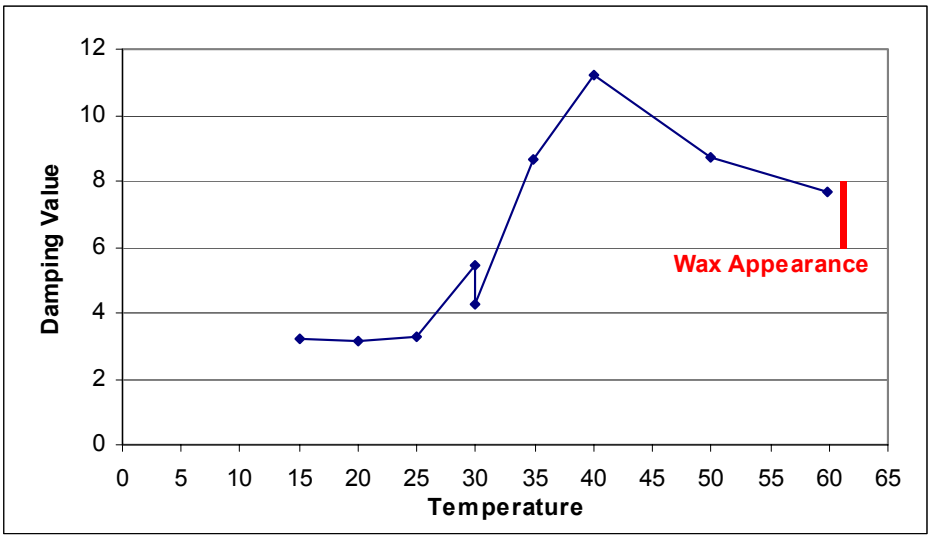
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	717.26	1083.7	3.23
2	5.00	5.03	744.95	1213.8	2.98
3	60.00	59.89	693.30	978.9	3.66
4	15.00	15.00	735.82	1170.4	3.07
5	25.00	24.98	726.59	1127.4	3.16
6	10.00	10.02	740.40	1192.1	3.02
7	30.00	29.97	721.94	1106.0	3.21
8	20.00	19.99	731.22	1148.9	3.10
9	50.00	49.91	703.00	1021.2	3.47
10	40.00	39.93	712.54	1063.4	3.34
11	35.00	34.95	717.26	1084.7	3.27

Sample Details and Data

Sample Name:	Straight Run Atmospheric Residue	**Sample Number:**	5
Sample Type:	Fuel oil	**Sample date :**	09/04/2001

Damping Curve



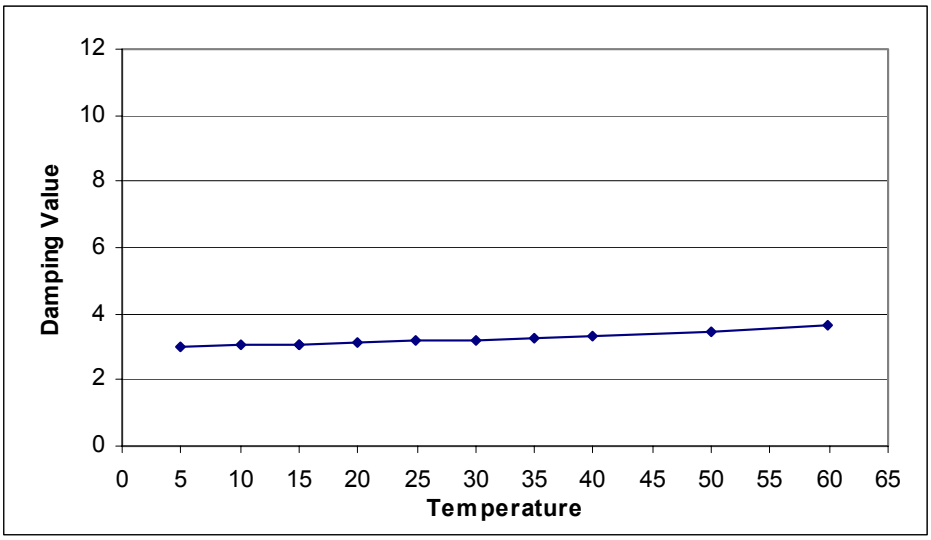
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	918.34	1485.3	5.42
2	40.00	39.94	909.99	1441.4	11.22
3	15.00	15.00	931.93	1579.1	3.22
4	60.00	59.89	896.79	1370.4	7.68
5	20.00	19.99	927.45	1544.5	3.16
6	35.00	34.95	914.05	1462.5	8.63
7	50.00	49.91	903.25	1404.4	8.69
8	25.00	24.97	922.97	1512.6	3.25
9	30.00	29.97	918.67	1486.6	4.24

Sample Details and Data

Sample Name:	Gasoline unleaded US regular	**Sample Number:**	6
Sample Type:	Gasoline	**Sample date :**	05/04/2001

Damping Curve



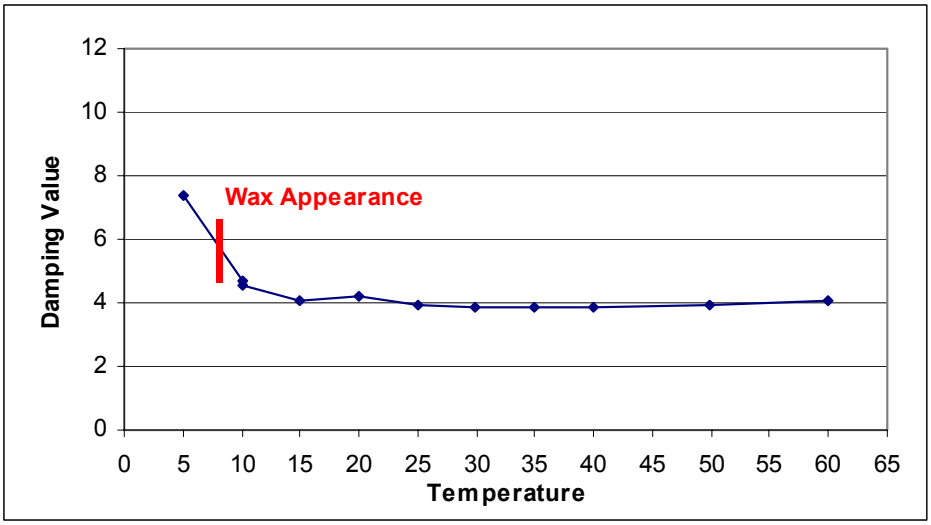
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	737.28	1184.6	3.08
2	20.00	19.99	732.84	1163.7	3.11
3	10.00	10.02	741.71	1206.2	3.04
4	35.00	34.95	719.36	1100.5	3.26
5	60.00	59.88	696.27	996.8	3.67
6	30.00	29.96	723.85	1120.8	3.22
7	40.00	39.94	714.80	1079.3	3.31
8	50.00	49.91	705.58	1037.7	3.49
9	5.00	5.03	746.13	1227.8	3.00
10	25.00	24.98	728.38	1142.7	3.17
11	15.00	15.00	737.29	1184.9	3.08

Sample Details and Data

Sample Name:	Statfjord	**Sample Number:**	7
Sample Type:	Crude oil	**Sample date :**	05/04/2001

Damping Curve



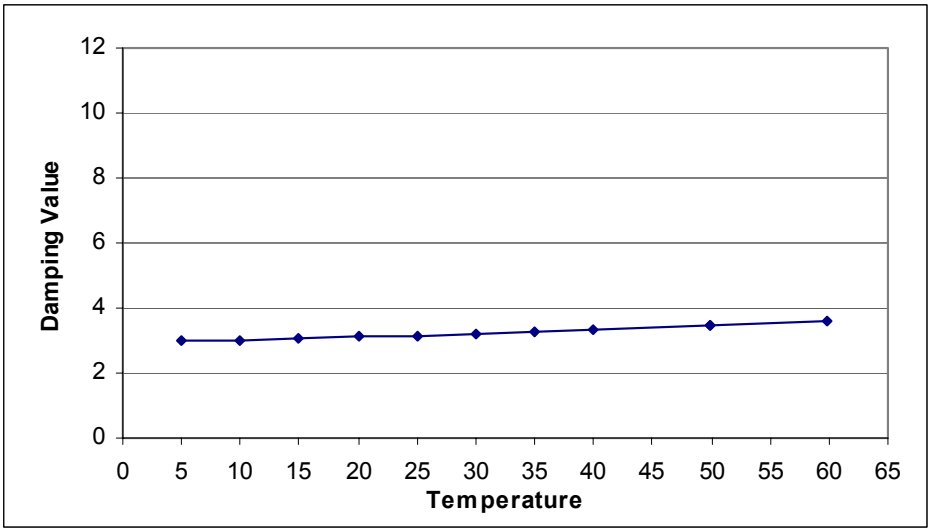
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	836.17	1374.0	4.53
2	25.00	24.98	824.62	1317.4	3.95
3	15.00	15.00	832.14	1354.6	4.10
4	50.00	49.91	806.10	1226.3	3.96
5	5.00	5.03	840.54	1393.7	7.35
6	20.00	19.99	828.37	1336.4	4.21
7	40.00	39.94	813.42	1262.6	3.89
8	60.00	59.88	798.77	1190.7	4.06
9	35.00	34.95	817.03	1280.1	3.88
10	30.00	29.96	820.68	1298.5	3.87
11	10.00	10.02	836.13	1374.0	4.68

Sample Details and Data

Sample Name:	Motor Spirit PU50	**Sample Number:**	8
Sample Type:	Gasoline	**Sample date :**	27/04/2001

Damping Curve



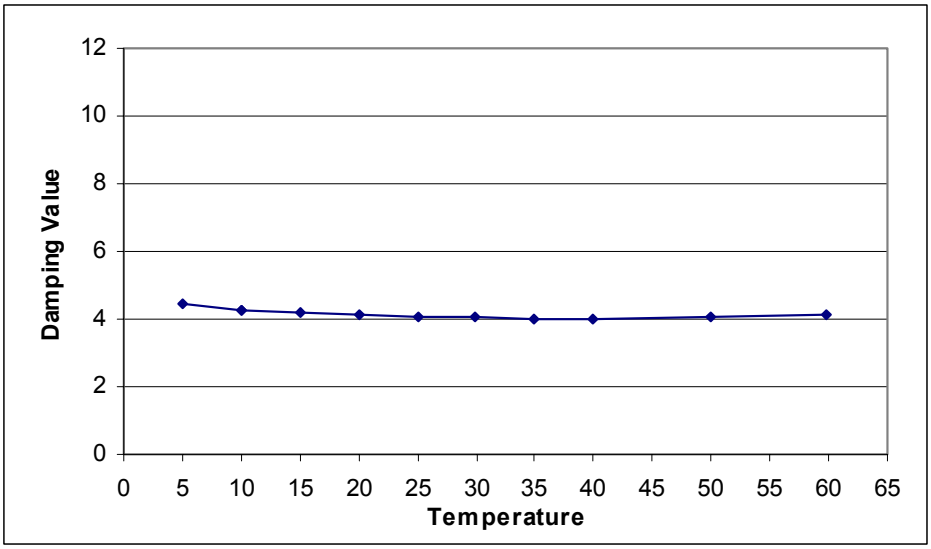
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	717.64	1039.8	3.48
2	35.00	34.95	731.70	1102.0	3.27
3	15.00	15.00	750.09	1187.2	3.06
4	30.00	29.97	736.37	1123.9	3.19
5	40.00	39.94	727.09	1081.9	3.33
6	60.00	59.88	708.07	998.6	3.63
7	20.00	19.99	745.52	1165.8	3.10
8	25.00	24.98	740.97	1145.0	3.14
9	5.00	5.03	759.12	1230.4	2.99
10	10.00	10.02	754.60	1208.9	3.02
11	50.00	49.91	717.67	1040.4	3.49

Sample Details and Data

Sample Name:	Light Cycle Oil	**Sample Number:**	9
Sample Type:	Distillate	**Sample date :**	04/04/2001

Damping Curve



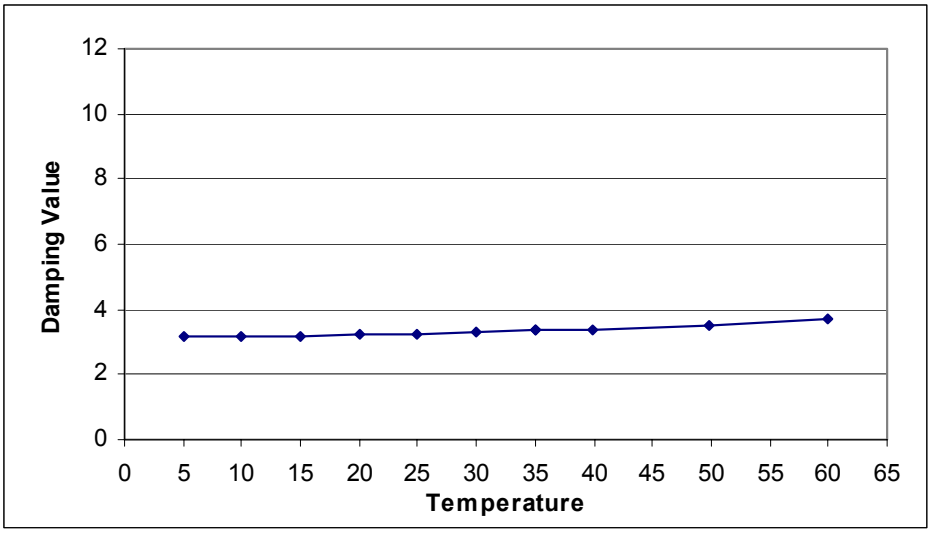
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	952.91	1498.1	4.26
2	15.00	15.01	949.30	1480.2	4.17
3	40.00	39.94	931.21	1392.3	4.03
4	50.00	49.91	923.98	1357.6	4.05
5	60.00	59.88	916.74	1323.2	4.13
6	30.00	29.96	938.44	1426.8	4.05
7	35.00	34.95	934.83	1409.5	4.02
8	20.00	19.99	945.69	1462.0	4.11
9	5.00	5.03	956.66	1515.7	4.42
10	25.00	24.98	942.16	1444.7	4.06
11	10.00	10.02	953.01	1497.8	4.26

Sample Details and Data

Sample Name:	Pygas	**Sample Number:**	10
Sample Type:	Distillate	**Sample date :**	15/04/2001

Damping Curve



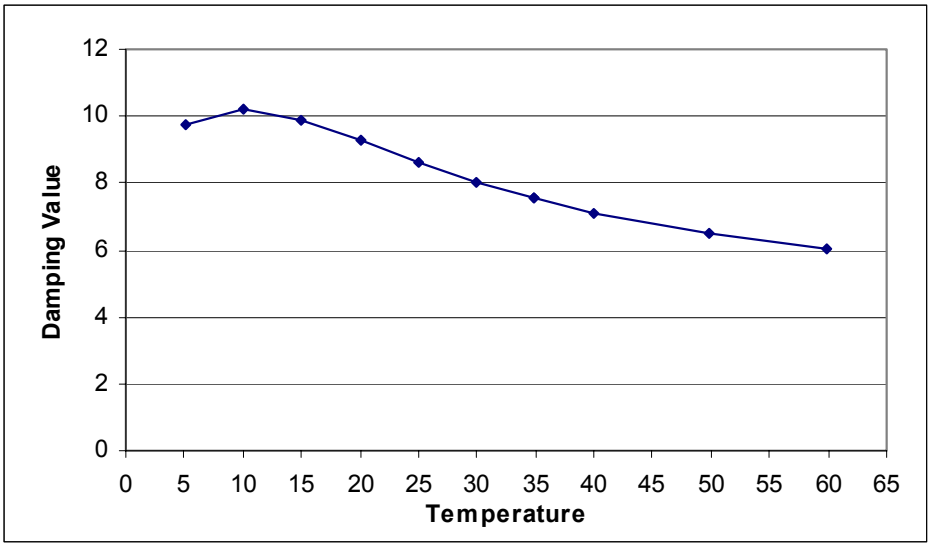
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	848.35	1267.4	3.35
2	40.00	39.94	843.95	1247.3	3.40
3	30.00	29.96	852.75	1287.3	3.31
4	60.00	59.88	826.18	1168.3	3.69
5	10.00	10.02	870.24	1369.2	3.18
6	15.00	15.01	865.88	1348.7	3.18
7	25.00	24.98	857.16	1308.2	3.25
8	50.00	49.91	835.11	1207.8	3.54
9	5.00	5.03	874.59	1389.9	3.18
10	20.00	19.99	861.51	1328.1	3.21
11	35.00	34.95	848.38	1267.7	3.35

Sample Details and Data

Sample Name:	Harding	**Sample Number:**	12
Sample Type:	Crude oil	**Sample date :**	18/03/2001

Damping Curve



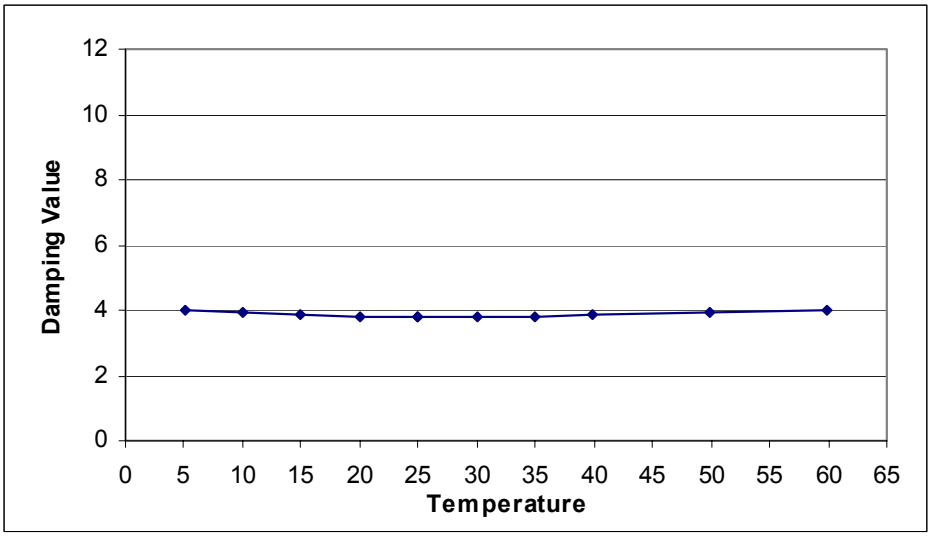
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	917.33	1425.2	7.57
2	40.00	39.94	914.08	1407.9	7.13
3	10.00	10.02	933.55	1516.9	10.22
4	30.00	29.97	920.59	1442.5	8.03
5	5.00	5.03	936.88	1537.6	9.76
6	50.00	49.91	907.57	1373.7	6.47
7	15.00	15.00	930.29	1496.6	9.88
8	20.00	19.99	927.06	1478.0	9.25
9	25.00	24.98	923.83	1459.7	8.60
10	60.00	59.88	901.09	1340.0	6.06
11	35.00	34.95	917.32	1424.3	7.55

Sample Details and Data

Sample Name:	Eurodiesel	**Sample Number:**	13
Sample Type:	Diesel	**Sample date :**	12/03/2001

Damping Curve



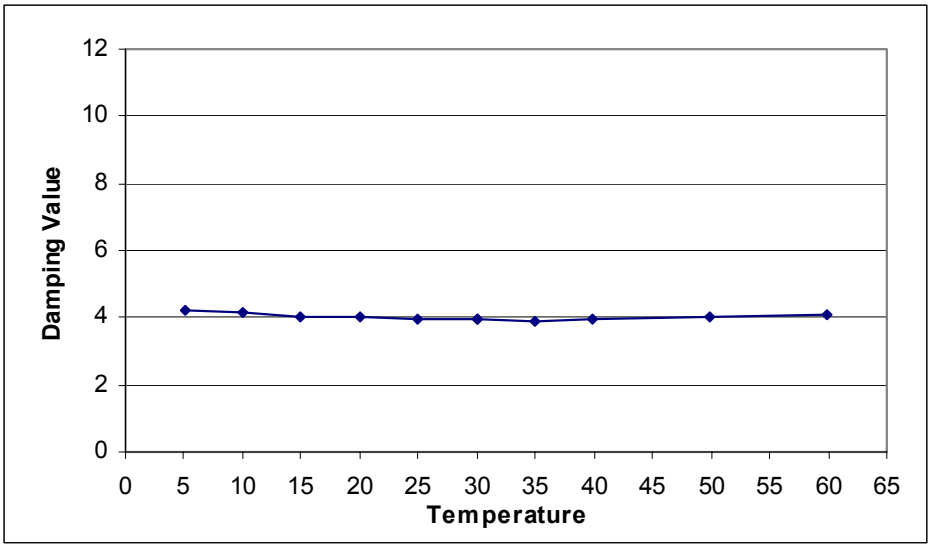
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	837.27	1357.4	3.81
2	60.00	59.89	812.67	1233.3	4.02
3	10.00	10.02	847.75	1411.8	3.92
4	35.00	34.95	830.22	1321.3	3.83
5	30.00	29.96	833.72	1339.2	3.81
6	50.00	49.91	819.68	1268.2	3.91
7	20.00	19.99	840.74	1375.2	3.82
8	5.00	5.03	851.26	1430.0	3.97
9	40.00	39.94	826.70	1303.3	3.85
10	15.00	15.00	844.24	1393.3	3.88
11	25.00	24.98	837.22	1357.1	3.81

Sample Details and Data

Sample Name:	Gas Oil G102	**Sample Number:**	14
Sample Type:	Gas oil	**Sample date :**	29/03/2001

Damping Curve



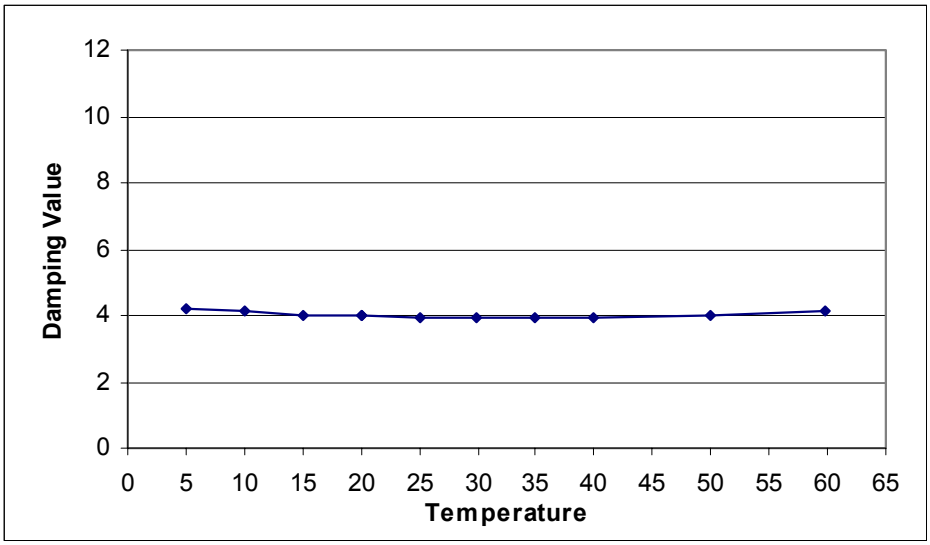
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	857.82	1363.2	3.94
2	35.00	34.95	854.32	1345.4	3.91
3	5.00	5.03	875.34	1452.9	4.21
4	15.00	15.01	868.32	1416.8	4.03
5	40.00	39.94	850.83	1327.9	3.94
6	10.00	10.02	871.83	1434.7	4.12
7	60.00	59.88	836.83	1258.6	4.07
8	20.00	19.99	864.83	1398.5	3.99
9	50.00	49.91	843.83	1293.1	4.00
10	25.00	24.97	861.32	1380.5	3.97
11	30.00	29.97	857.83	1362.9	3.93

Sample Details and Data

Sample Name:	Fuel Oil Domestic	**Sample Number:**	15
Sample Type:	Gas oil	**Sample date :**	21/03/2001

Damping Curve



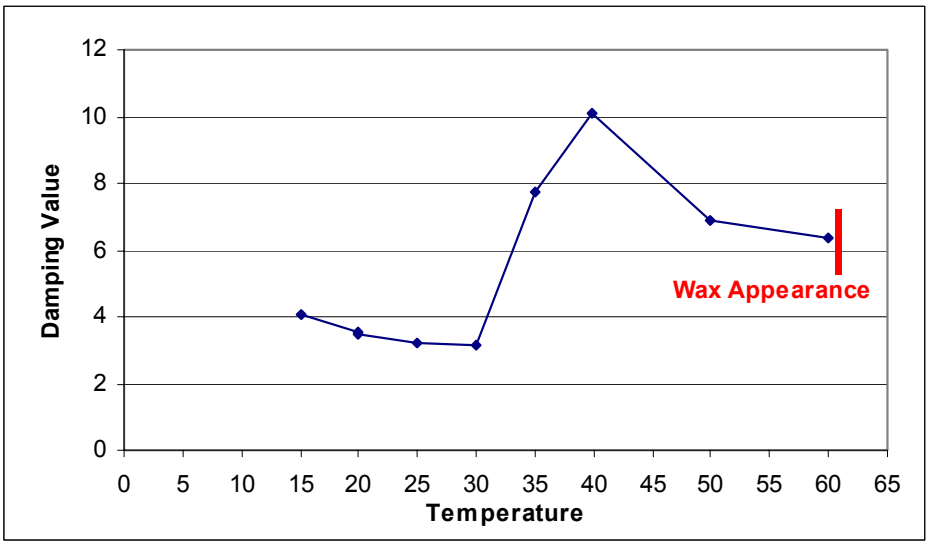
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	867.38	1401.1	3.97
2	35.00	34.95	856.87	1347.6	3.93
3	15.00	15.00	870.89	1418.8	4.01
4	50.00	49.91	846.36	1294.8	4.00
5	60.00	59.88	839.34	1260.2	4.10
6	10.00	10.02	874.41	1436.6	4.11
7	30.00	29.97	860.38	1364.9	3.93
8	5.00	5.03	877.92	1454.8	4.19
9	25.00	24.98	863.88	1382.8	3.93
10	40.00	39.94	853.37	1329.6	3.94
11	20.00	19.99	867.39	1400.5	3.97

Sample Details and Data

Sample Name:	Straight Run Atmospheric Residue	**Sample Number:**	16
Sample Type:	Fuel oil	**Sample date :**	19/03/2001

Damping Curve



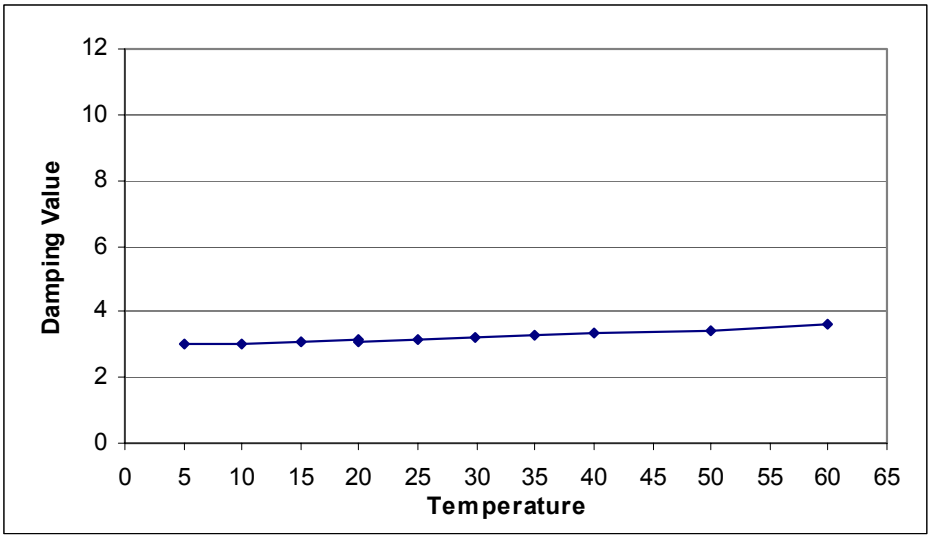
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	911.89	1551.9	3.45
2	60.00	59.88	875.34	1344.6	6.34
3	35.00	34.95	894.40	1439.5	7.71
4	40.00	39.94	889.55	1415.5	10.07
5	15.00	15.01	917.52		4.08
6	30.00	29.97	900.88	1465.1	3.12
7	25.00	24.98	906.40	1254.2	3.22
8	50.00	49.91	882.20	1377.1	6.89
9	20.00	19.99	912.07	1537.3	3.54

Sample Details and Data

Sample Name:	Raffinate	**Sample Number:**	17
Sample Type:	Distillate	**Sample date :**	15/03/2001

Damping Curve



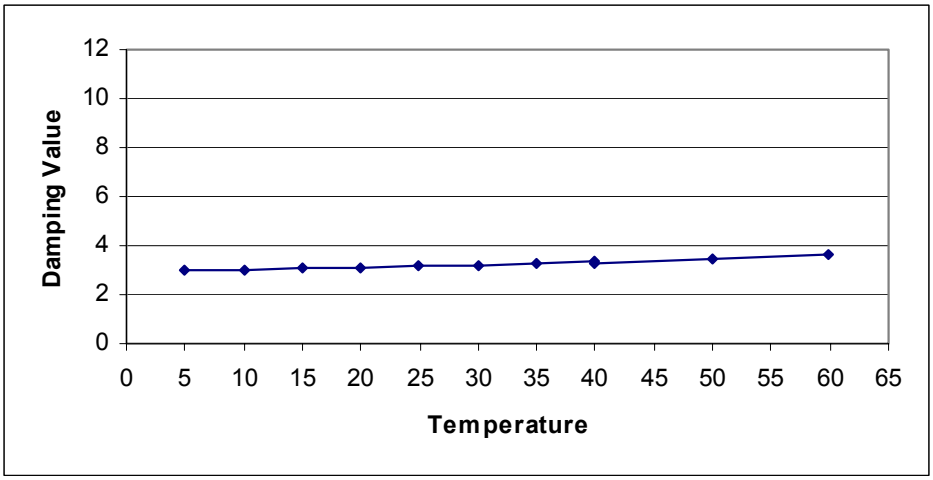
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	693.25	1140.8	3.10
2	50.00	49.91	666.86	1015.6	3.44
3	10.00	10.02	701.85	1183.4	3.04
4	40.00	39.94	675.80	1057.3	3.33
5	30.00	29.96	684.54	1098.3	3.25
6	5.00	5.03	706.10	1204.8	2.99
7	25.00	24.98	688.94	1120.1	3.15
8	60.00	59.89	657.79	974.5	3.61
9	15.00	15.00	697.55	1161.8	3.08
10	35.00	34.95	680.22	1078.2	3.29
11	20.00	19.99	693.23	1140.4	3.12

Sample Details and Data

Sample Name:	Motor Spirit PU50	**Sample Number:**	18
Sample Type:	Gasoline	**Sample date :**	24/03/2001

Damping Curve



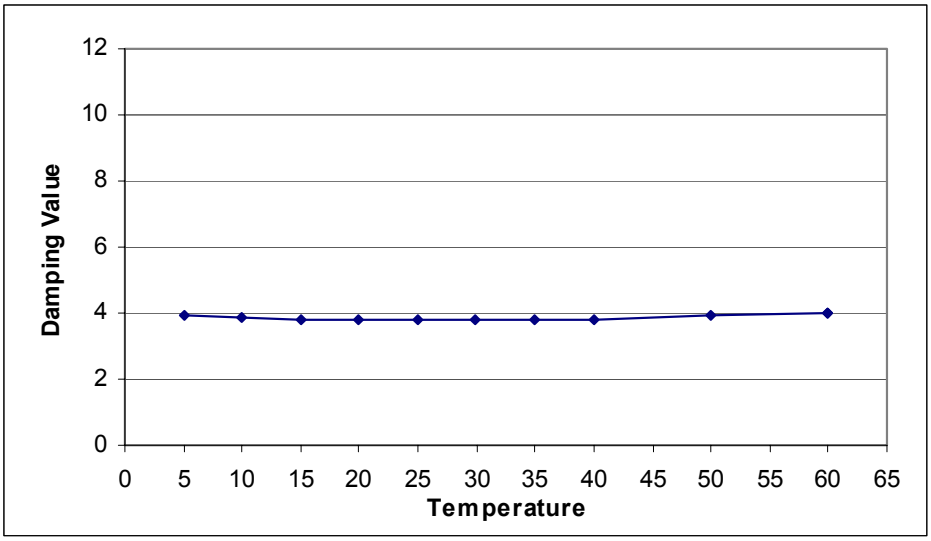
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	714.41	1071.4	3.30
2	15.00	15.00	737.16	1177.6	3.07
3	5.00	5.03	746.10	1220.7	2.99
4	20.00	19.99	732.71	1156.4	3.09
5	10.00	10.02	741.69	1199.2	3.02
6	30.00	29.97	723.69	1114.1	3.18
7	50.00	49.91	705.21	1030.2	3.47
8	25.00	24.97	728.21	1134.8	3.15
9	35.00	34.95	719.12	1093.0	3.24
10	60.00	59.88	695.73	988.5	3.65
11	40.00	39.93	714.48	1071.3	3.33

Sample Details and Data

Sample Name:	Eurodiesel EN 590	**Sample Number:**	19
Sample Type:	Diesel	**Sample date :**	22/03/2001

Damping Curve



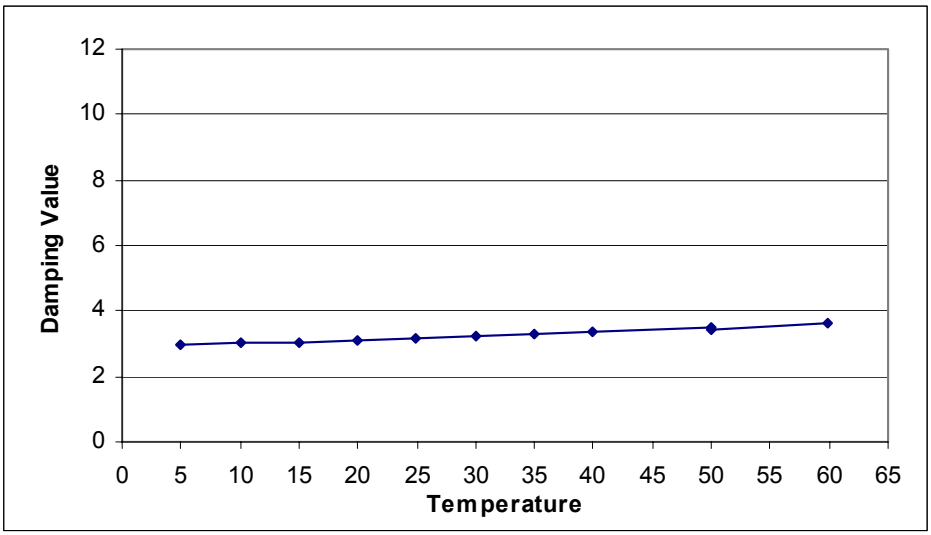
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	812.47	1230.8	4.03
2	20.00	19.99	840.65	1372.9	3.82
3	15.00	15.01	844.17	1391.1	3.83
4	40.00	39.94	826.58	1300.9	3.83
5	10.00	10.02	847.68	1409.4	3.88
6	50.00	49.91	819.53	1265.5	3.92
7	25.00	24.97	837.13	1354.6	3.80
8	35.00	34.95	830.09	1318.7	3.81
9	30.00	29.96	833.61	1336.6	3.80
10	5.00	5.03	851.20	1427.8	3.94
11	60.00	59.88	812.47	1230.3	4.02

Sample Details and Data

Sample Name:	Euroregular motor spirit	**Sample Number:**	20
Sample Type:	Gasoline	**Sample date :**	24/03/2001

Damping Curve



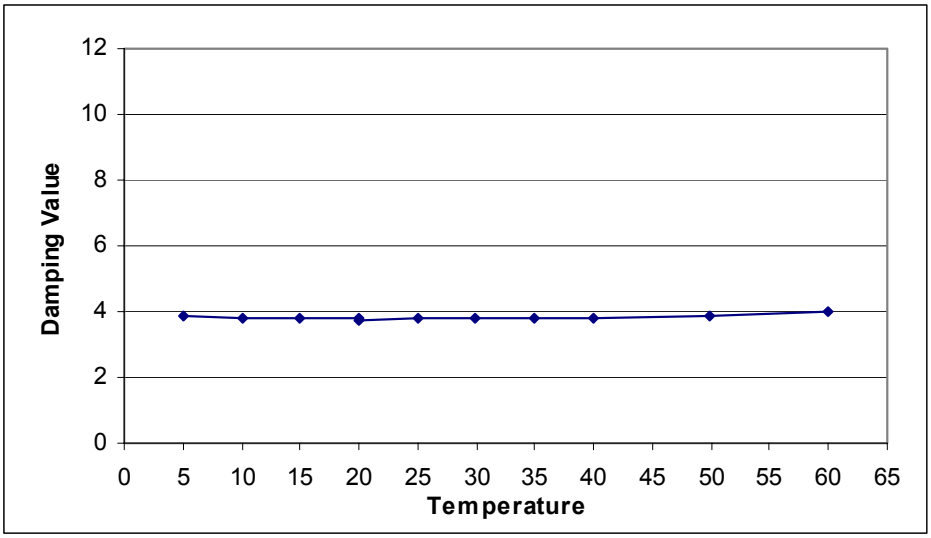
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	700.67	1028.9	3.46
2	10.00	10.02	737.18	1198.4	3.02
3	20.00	19.99	728.21	1155.6	3.10
4	5.00	5.03	741.63	1220.2	2.99
5	25.00	24.98	723.68	1134.2	3.15
6	15.00	15.00	732.70	1176.9	3.06
7	35.00	34.95	714.57	1091.8	3.27
8	30.00	29.96	719.13	1112.7	3.23
9	40.00	39.94	709.97	1070.8	3.33
10	60.00	59.88	691.18	987.2	3.61
11	50.00	49.91	700.62	1028.3	3.46

Sample Details and Data

Sample Name:	ULS Diesel	**Sample Number:**	21
Sample Type:	Diesel	**Sample date :**	13/03/2001

Damping Curve



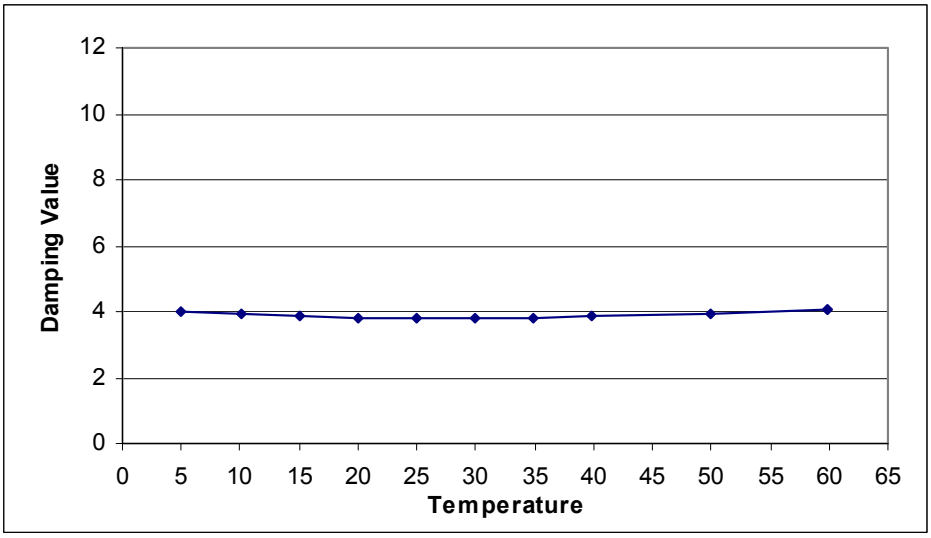
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	830.45	1367.0	3.77
2	30.00	29.97	823.44	1330.7	3.77
3	25.00	24.98	826.94	1348.8	3.77
4	5.00	5.03	840.95	1422.2	3.89
5	15.00	15.01	833.94	1385.4	3.79
6	60.00	59.89	802.37	1223.8	4.01
7	50.00	49.91	809.41	1258.8	3.90
8	40.00	39.93	816.43	1294.4	3.82
9	35.00	34.95	819.94	1312.4	3.80
10	10.00	10.02	837.46	1403.6	3.82
11	20.00	19.99	830.45	1366.9	3.77

Sample Details and Data

Sample Name:	Gas Oil EN 590	**Sample Number:**	22
Sample Type:	Gas oil	**Sample date :**	15/03/2001

Damping Curve



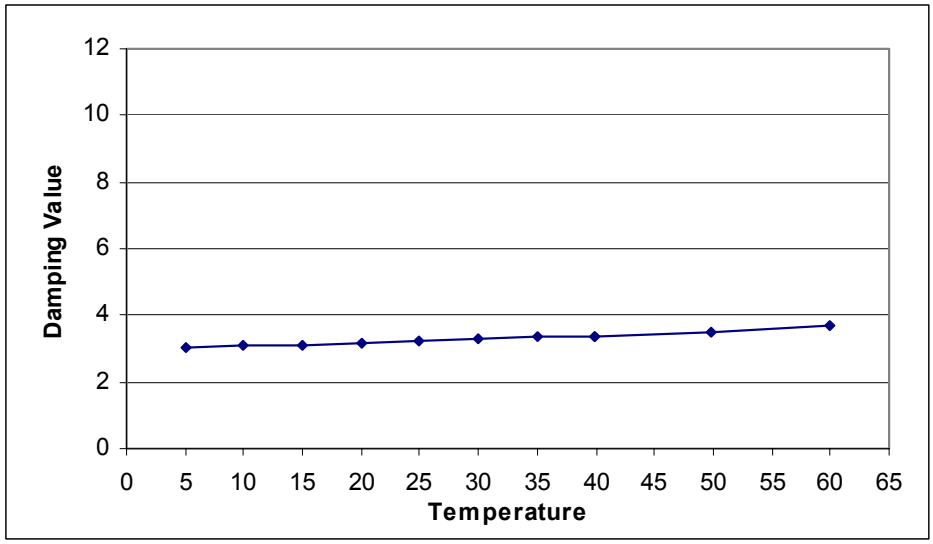
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.89	813.55	1233.5	4.03
2	40.00	39.93	827.61	1303.6	3.86
3	20.00	19.99	841.64	1375.3	3.83
4	35.00	34.95	831.12	1321.4	3.83
5	30.00	29.96	834.63	1339.2	3.81
6	15.00	15.00	845.15	1393.5	3.87
7	25.00	24.98	838.13	1357.3	3.81
8	5.00	5.03	852.17	1430.1	3.99
9	50.00	49.91	820.60	1268.2	3.94
10	10.00	10.02	848.66	1411.5	3.92
11	60.00	59.89	813.57	1233.2	4.05

Sample Details and Data

Sample Name:	Naphtha	**Sample Number:**	23
Sample Type:	Distillate	**Sample date :**	09/03/2001

Damping Curve



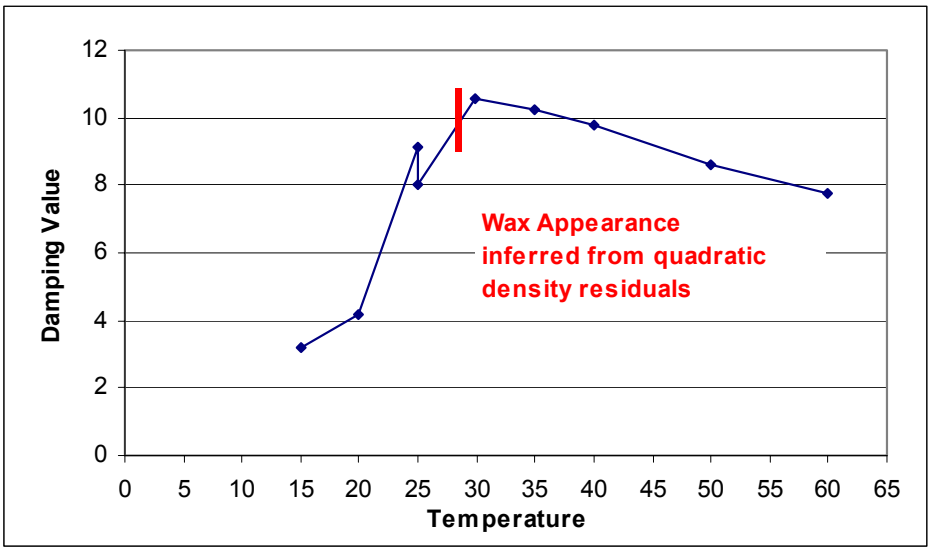
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	729.31	1124.8	3.39
2	20.00	19.99	746.37	1206.4	3.15
3	50.00	49.91	720.71	1084.7	3.52
4	35.00	34.95	733.61	1144.6	3.34
5	10.00	10.02	754.77	1247.8	3.09
6	5.00	5.03	758.96	1268.9	3.05
7	15.00	15.01	750.56	1227.5	3.11
8	60.00	59.88	711.93	1045.4	3.67
9	30.00	29.96	737.86	1165.4	3.29
10	25.00	24.98	742.11	1186.0	3.21
11	40.00	39.94	729.33	1125.5	3.39

Sample Details and Data

Sample Name:	Straight Run Atmospheric Residue	**Sample Number:**	24
Sample Type:	Fuel oil	**Sample date :**	26/03/2001

Damping Curve



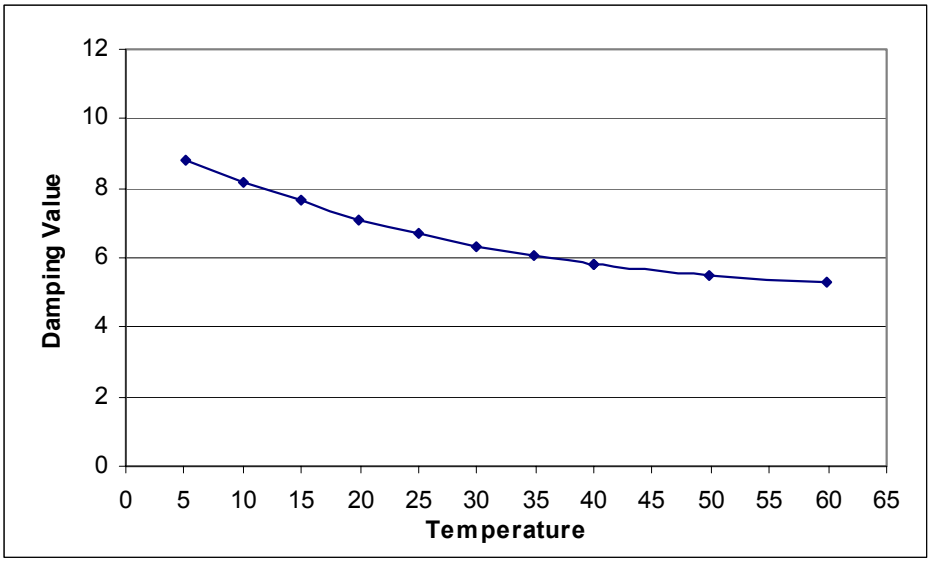
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.97	968.40	1526.4	9.13
2	40.00	39.94	957.93	1465.4	9.75
3	30.00	29.96	964.50	1502.7	10.59
4	15.00	15.00	977.63	1590.3	3.20
5	20.00	19.99	973.27	1556.7	4.15
6	60.00	59.88	945.02	1396.7	7.75
7	35.00	34.95	961.13	1482.4	10.25
8	50.00	49.91	951.48	1429.9	8.61
9	25.00	24.97	968.48	1525.5	8.01

Sample Details and Data

Sample Name:	Lube oil	**Sample Number:**	25
Sample Type:	Lube oil	**Sample date :**	24/04/2001

Damping Curve



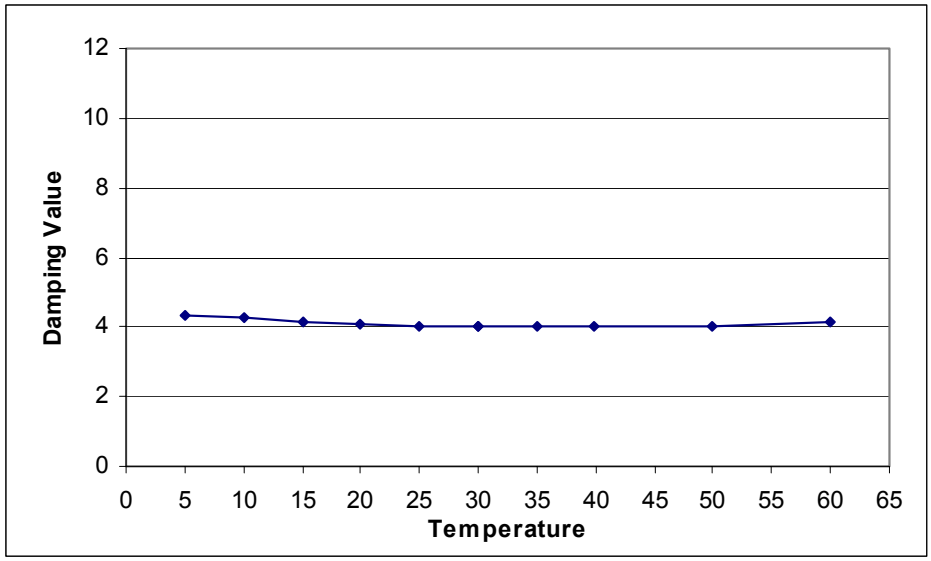
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	859.30	1389.1	5.81
2	10.00	10.02	878.38	1493.6	8.18
3	15.00	15.01	875.18	1475.7	7.63
4	25.00	24.98	868.81	1440.5	6.70
5	35.00	34.95	862.47	1405.9	6.05
6	20.00	19.99	872.00	1457.7	7.11
7	5.00	5.03	881.56	1511.8	8.80
8	60.00	59.89	846.68	1321.9	5.30
9	50.00	49.91	852.99	1354.7	5.48
10	30.00	29.96	865.64	1422.4	6.33
11	40.00	39.94	859.30	1388.3	5.81

Sample Details and Data

Sample Name:	Gas Oil UKSG	**Sample Number:**	26
Sample Type:	Gas oil	**Sample date :**	26/04/2001

Damping Curve



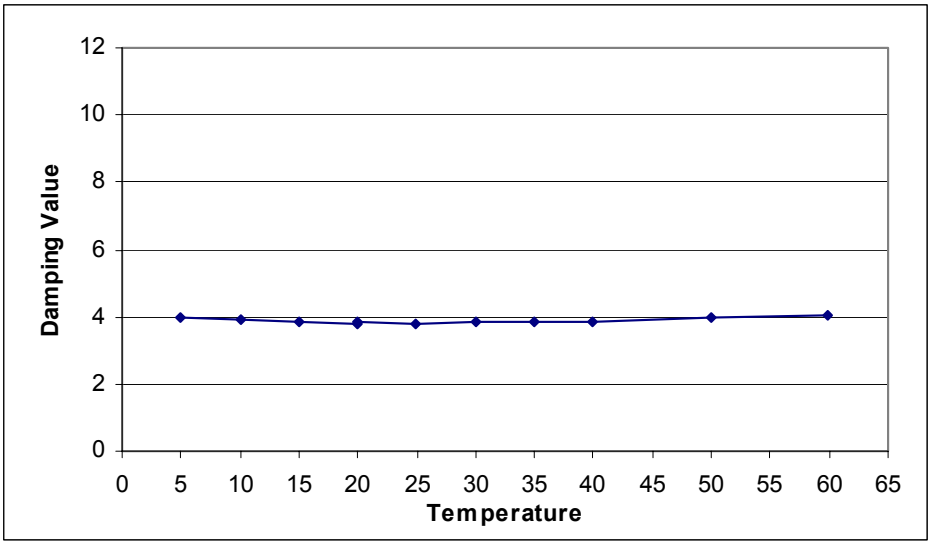
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	857.68	1446.5	4.36
2	10.00	10.02	854.23	1428.5	4.24
3	15.00	15.00	850.78	1410.4	4.15
4	20.00	19.99	847.34	1392.6	4.08
5	25.00	24.98	843.89	1374.7	4.05
6	30.00	29.97	840.45	1356.9	4.03
7	30.00	29.96	840.46	1356.5	4.02
8	35.00	34.95	837.01	1338.9	4.01
9	40.00	39.93	833.57	1321.3	4.03
10	50.00	49.91	826.69	1286.9	4.04
11	60.00	59.88	819.79	1252.7	4.16

Sample Details and Data

Sample Name:	ULS Diesel	**Sample Number:**	27
Sample Type:	Diesel	**Sample date :**	26/04/2001

Damping Curve



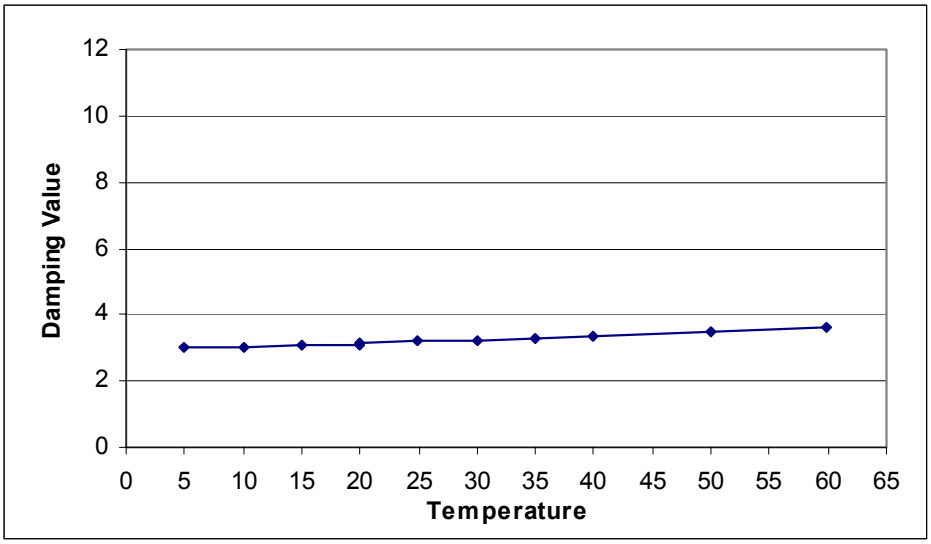
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	827.90	1370.2	3.81
2	10.00	10.02	834.86	1406.4	3.91
3	35.00	34.95	817.43	1316.0	3.83
4	15.00	15.00	831.37	1387.9	3.85
5	60.00	59.89	799.97	1227.9	4.04
6	40.00	39.93	813.94	1297.7	3.87
7	30.00	29.96	820.91	1333.5	3.83
8	25.00	24.98	824.39	1351.5	3.81
9	50.00	49.91	806.95	1262.7	3.95
10	5.00	5.03	838.34	1424.4	3.98
11	20.00	19.99	827.88	1369.8	3.82

Sample Details and Data

Sample Name:	Avgas 100	**Sample Number:**	28
Sample Type:	Gasoline	**Sample date :**	27/04/2001

Damping Curve



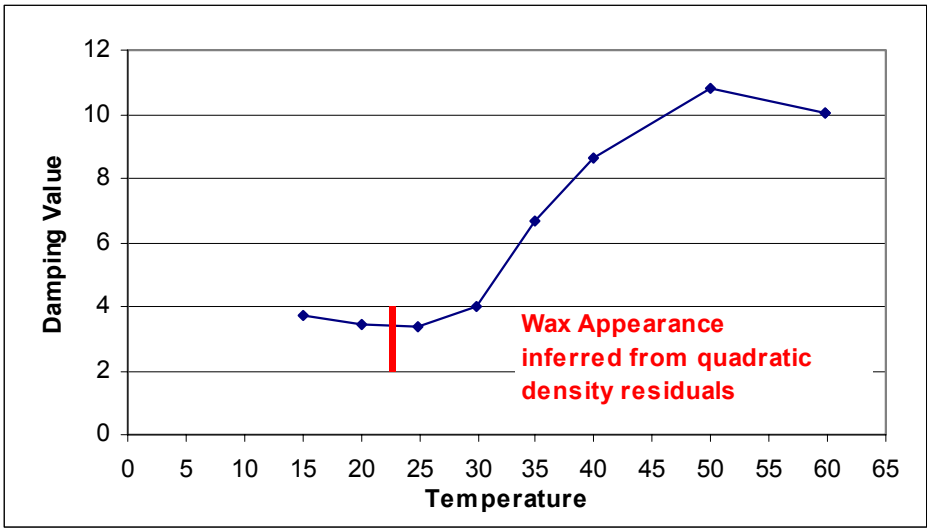
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	717.70	1140.8	3.11
2	15.00	15.00	722.08	1162.1	3.05
3	60.00	59.88	681.66	973.9	3.65
4	5.00	5.03	730.76	1205.0	3.01
5	30.00	29.97	708.87	1098.6	3.24
6	10.00	10.02	726.42	1183.5	3.04
7	40.00	39.94	699.95	1057.0	3.37
8	35.00	34.95	704.41	1077.4	3.31
9	50.00	49.91	690.90	1015.5	3.48
10	25.00	24.97	713.29	1119.5	3.20
11	20.00	19.99	717.69	1140.8	3.12

Sample Details and Data

Sample Name:	SOL 30 Mobilsol30	**Sample Number:**	29
Sample Type:	Grease	**Sample date :**	25/04/2001

Damping Curve



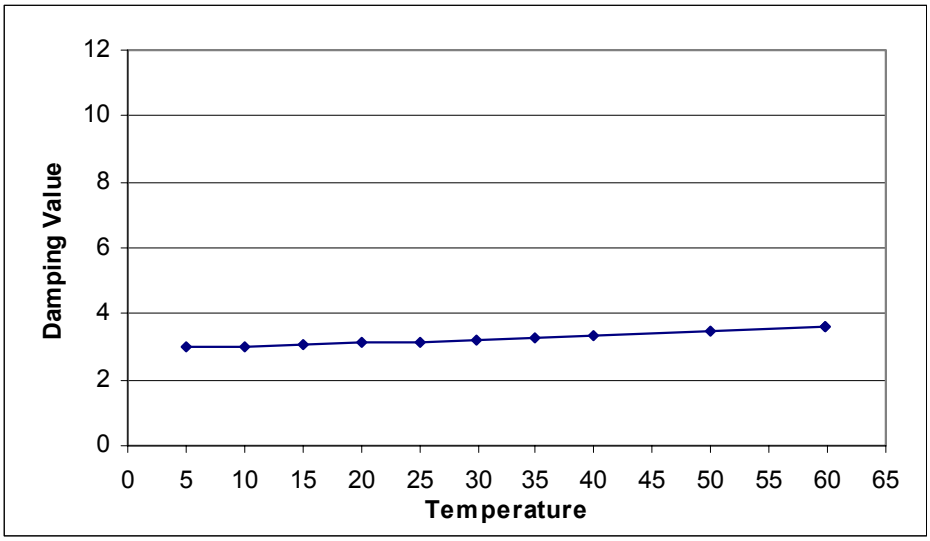
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	969.10	1415.9	10.05
2	35.00	34.95	985.42	1527.7	6.69
3	50.00	49.91	975.41	1453.3	10.81
4	40.00	39.93	982.01	1498.8	8.63
5	25.00	24.97	993.07		3.38
6	20.00	19.99	996.61		3.41
7	15.00	15.01	1000.07		3.75
8	30.00	29.97	989.47	1568.0	3.99
9	60.00	59.88	969.12	1415.7	10.06

Sample Details and Data

Sample Name:	Motor Spirit SU	**Sample Number:**	30
Sample Type:	Gasoline	**Sample date :**	25/04/2001

Damping Curve



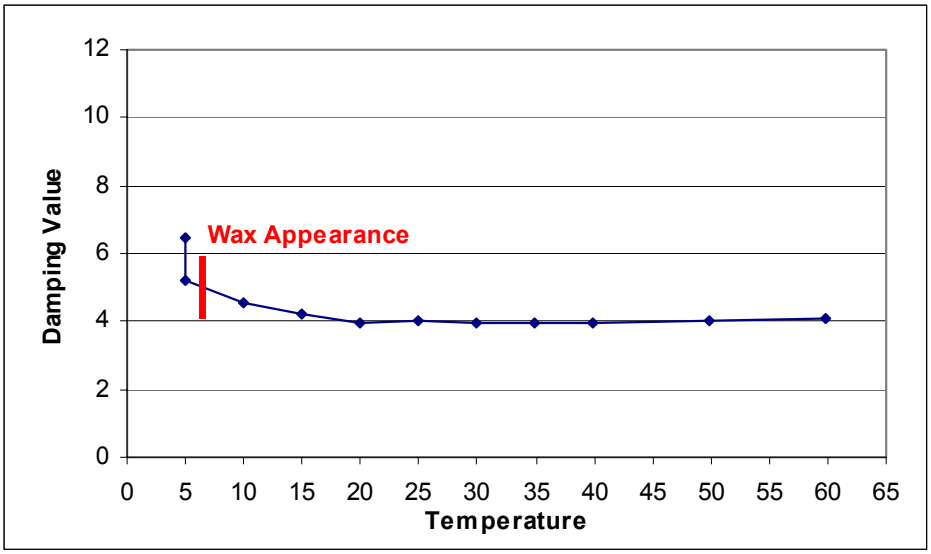
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.89	707.27	1005.2	3.62
2	35.00	34.95	730.53	1108.8	3.28
3	20.00	19.99	744.13	1172.3	3.11
4	10.00	10.02	753.07	1215.1	3.03
5	30.00	29.97	735.10	1130.3	3.19
6	50.00	49.91	716.69	1046.6	3.47
7	40.00	39.93	725.94	1087.9	3.35
8	15.00	15.00	748.61	1193.7	3.06
9	5.00	5.03	757.52	1236.6	2.99
10	25.00	24.98	739.63	1151.3	3.13
11	60.00	59.89	707.29	1005.4	3.63

Sample Details and Data

Sample Name:	Forties Blend	**Sample Number:**	31
Sample Type:	Crude oil	**Sample date :**	25/04/2001

Damping Curve



Density and Velocity of Sound Data Set

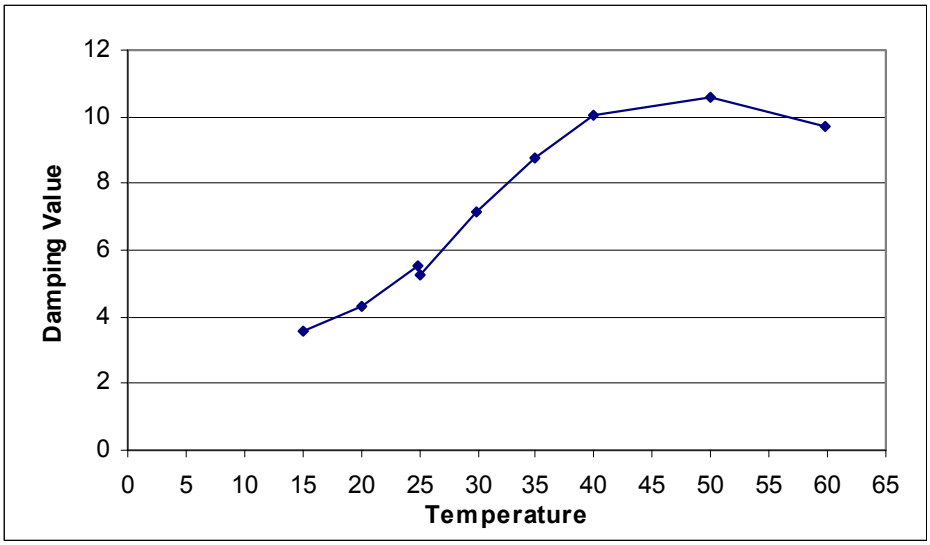
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	838.96	1396.8	6.48
2	25.00	24.98	823.19	1321.0	3.99
3	50.00	49.91	804.98	1230.5	4.02
4	60.00	59.88	797.72	1194.9	4.12
5	15.00	15.00	830.65	1358.0	4.21
6	40.00	39.94	812.22	1266.4	3.94
7	10.00	10.02	834.67	1377.3	4.55
8	30.00	29.97	819.47	1302.8	3.92
9	35.00	34.95	815.84	1284.5	3.93
10	20.00	19.99	826.76	1339.1	3.98
11	5.00	5.03	838.74	1396.9	5.24

Sample Details and Data

Sample Name: Heavy Fuel Oil UKSG **Sample Number:** 32

Sample Type: Fuel oil **Sample date :**

Damping Curve



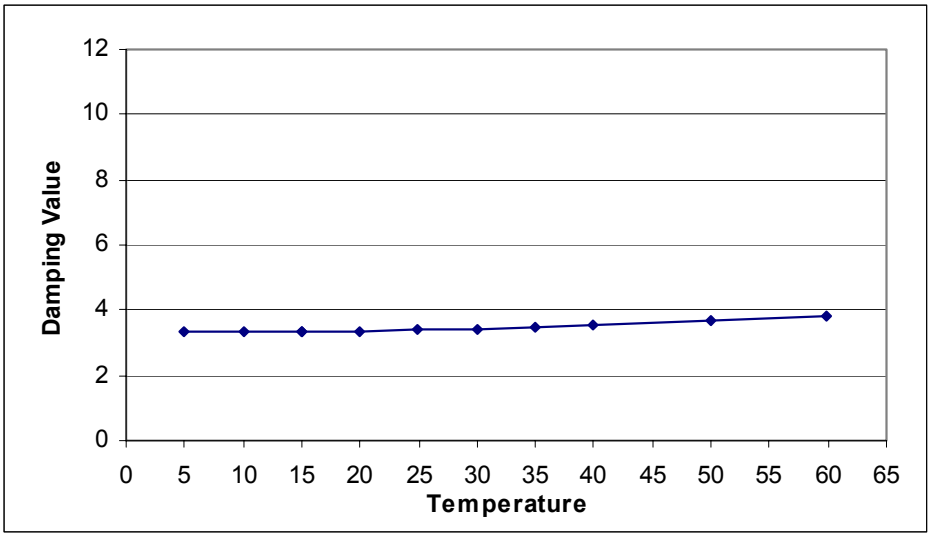
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.97	965.77	1532.7	5.51
2	40.00	39.94	955.09	1466.3	10.05
3	30.00	29.96	962.03	1508.2	7.13
4	50.00	49.91	948.28	1427.8	10.60
5	60.00	59.88	941.63	1391.9	9.72
6	35.00	34.94	958.37	1485.8	8.79
7	20.00	19.99	969.59	1560.4	4.29
8	15.00	15.00	973.50	1592.5	3.57
9	25.00	24.98	966.08	1534.5	5.24

Sample Details and Data

Sample Name:	Jet A1	**Sample Number:**	33
Sample Type:	Kerosine (Jet)	**Sample date :**	24/04/2001

Damping Curve



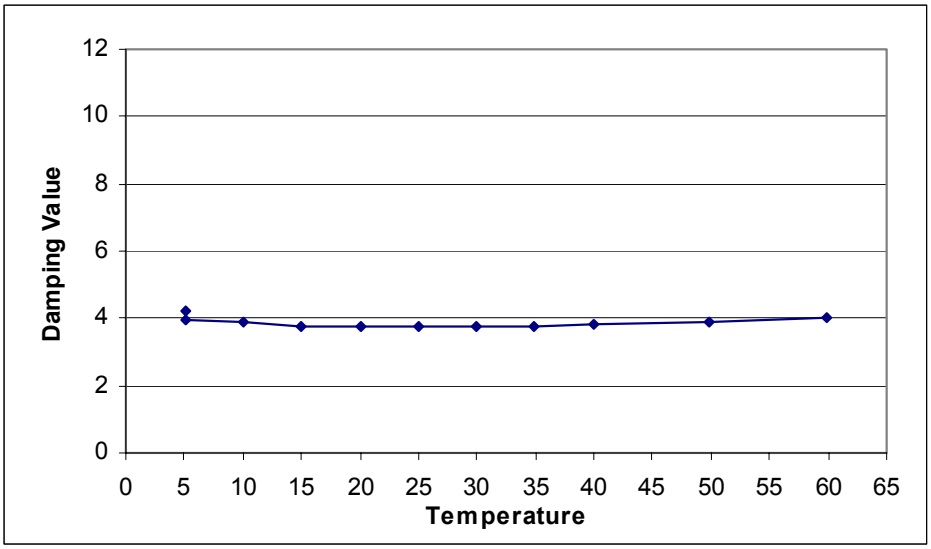
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	796.92	1323.7	3.36
2	30.00	29.97	785.73	1267.0	3.43
3	10.00	10.02	800.63	1342.5	3.35
4	40.00	39.94	778.24	1229.5	3.54
5	50.00	49.91	770.72	1192.5	3.66
6	25.00	24.97	789.46	1285.5	3.40
7	5.00	5.03	804.35	1361.2	3.35
8	20.00	19.99	793.19	1304.1	3.37
9	60.00	59.88	763.18	1155.6	3.82
10	35.00	34.95	781.99	1247.4	3.50
11	15.00	15.00	796.91	1322.8	3.36

Sample Details and Data

Sample Name:	Njord	**Sample Number:**	35
Sample Type:	Crude oil	**Sample date :**	22/05/2001

Damping Curve



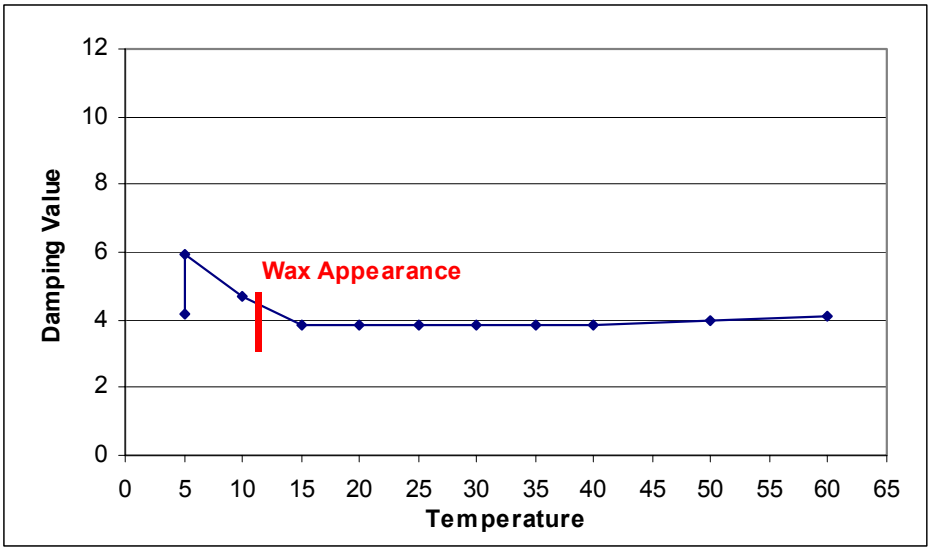
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	820.64	1379.2	4.22
2	20.00	19.99	808.74	1321.4	3.74
3	35.00	34.95	797.81	1265.7	3.76
4	15.00	15.00	812.38	1339.9	3.75
5	25.00	24.98	805.11	1302.7	3.73
6	30.00	29.97	801.48	1284.4	3.74
7	10.00	10.02	816.49	1359.4	3.89
8	60.00	59.89	779.50	1175.2	4.03
9	40.00	39.93	794.17	1247.0	3.80
10	50.00	49.91	786.86	1211.0	3.88
11	5.00	5.03	820.68	1379.2	3.97

Sample Details and Data

Sample Name:	Triton	**Sample Number:**	36
Sample Type:	Crude oil	**Sample date :**	13/06/2001

Damping Curve



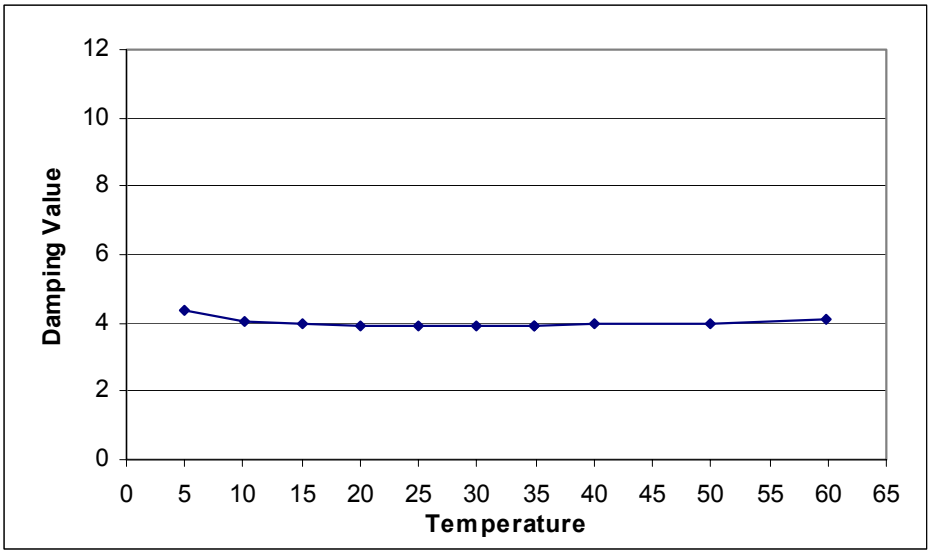
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	831.29	1390.0	5.93
2	10.00	10.02	827.05	1370.7	4.69
3	35.00	34.95	808.25	1277.4	3.87
4	50.00	49.91	797.36	1223.2	3.96
5	30.00	29.96	811.86	1295.3	3.86
6	40.00	39.94	804.63	1259.2	3.88
7	25.00	24.98	815.48	1313.7	3.83
8	20.00	19.99	819.10	1332.3	3.84
9	15.00	15.01	822.71	1350.9	3.87
10	60.00	59.88	790.07	1187.7	4.08
11	5.00	5.03	831.09	1390.1	4.19

Sample Details and Data

Sample Name:	Arab Extra Light	**Sample Number:**	37
Sample Type:	Crude oil	**Sample date :**	10/05/2001

Damping Curve



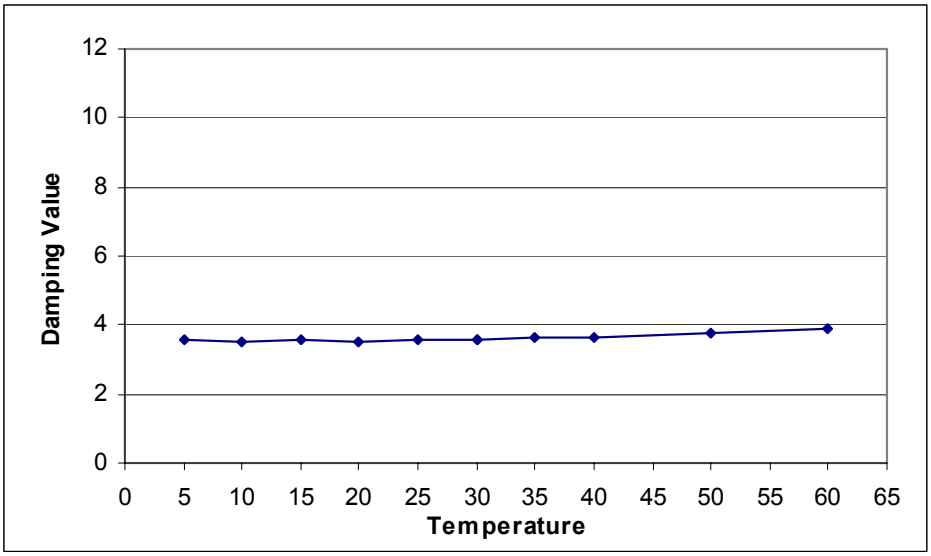
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	820.22	1281.3	3.92
2	5.00	5.03	842.68	1392.4	4.37
3	40.00	39.94	816.61	1263.5	3.95
4	20.00	19.99	831.09	1335.7	3.93
5	10.00	10.02	838.61	1373.1	4.05
6	30.00	29.97	823.87	1299.7	3.90
7	60.00	59.88	802.04	1192.5	4.10
8	25.00	24.97	827.47	1317.3	3.91
9	50.00	49.91	809.34	1227.8	3.98
10	15.00	15.00	834.71	1354.1	3.96
11	35.00	34.95	820.25	1281.6	3.90

Sample Details and Data

Sample Name:	Saharan Blend	**Sample Number:**	38
Sample Type:	Crude oil	**Sample date :**	05/06/2001

Damping Curve



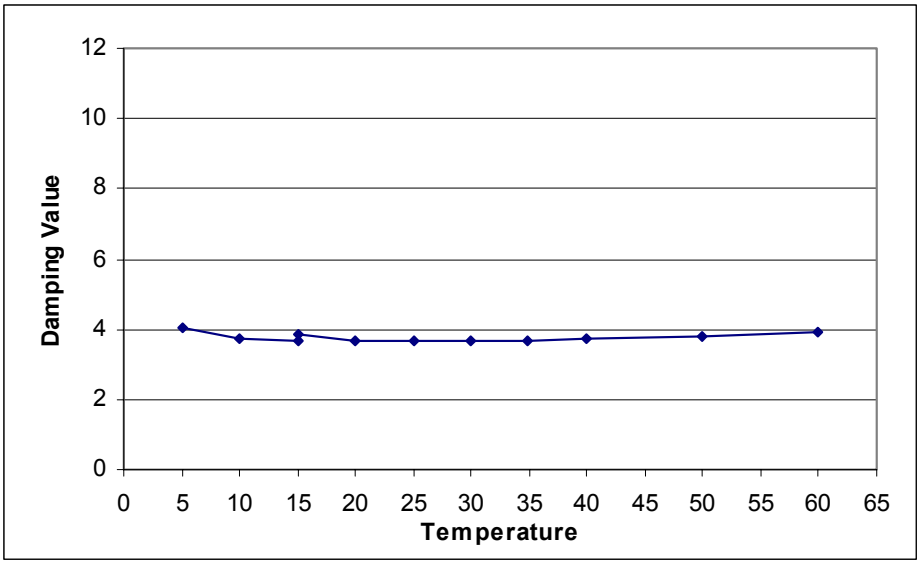
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	786.10	1246.6	3.60
2	35.00	34.95	782.31	1227.7	3.62
3	15.00	15.00	797.42	1303.9	3.55
4	5.00	5.03	805.11	1342.8	3.56
5	25.00	24.98	789.91	1266.2	3.55
6	40.00	39.94	778.55	1209.5	3.66
7	60.00	59.88	763.25	1135.2	3.91
8	50.00	49.91	770.90	1171.5	3.78
9	10.00	10.02	801.21	1323.3	3.54
10	20.00	19.99	793.70	1285.2	3.54
11	30.00	29.97	786.13	1247.2	3.57

Sample Details and Data

Sample Name:	Asgard	**Sample Number:**	39
Sample Type:	Crude oil	**Sample date :**	14/05/2001

Damping Curve



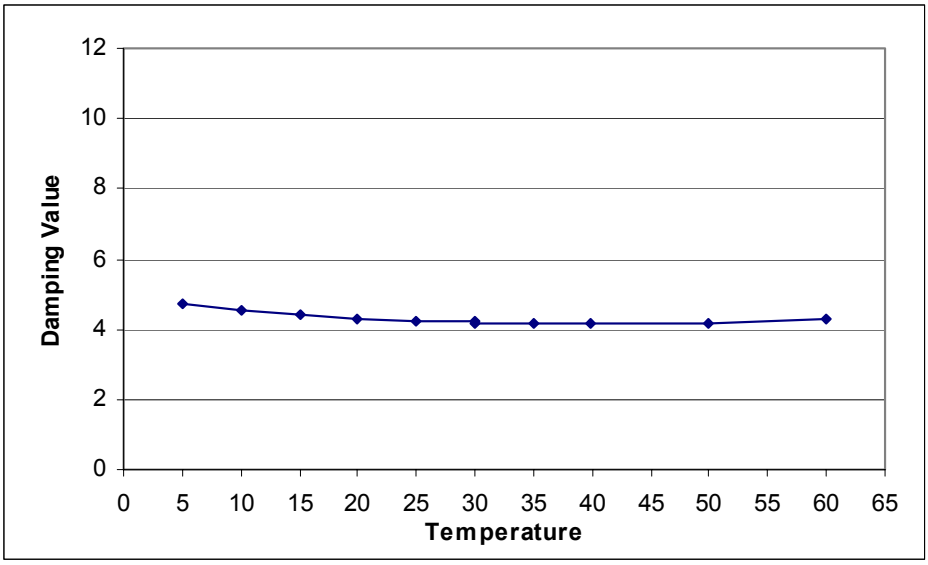
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	819.27	1339.3	3.64
2	10.00	10.02	823.45	1358.8	3.71
3	60.00	59.89	785.91	1174.3	3.95
4	30.00	29.96	808.19	1283.1	3.67
5	50.00	49.91	793.39	1210.5	3.81
6	25.00	24.97	811.89	1301.8	3.64
7	20.00	19.99	815.58	1320.5	3.65
8	40.00	39.94	800.82	1247.0	3.72
9	35.00	34.95	804.50	1264.7	3.69
10	5.00	5.03	827.71	1377.6	4.04
11	15.00	15.01	819.83	1338.8	3.88

Sample Details and Data

Sample Name:	Arab Light	**Sample Number:**	40
Sample Type:	Crude oil	**Sample date :**	09/05/2001

Damping Curve



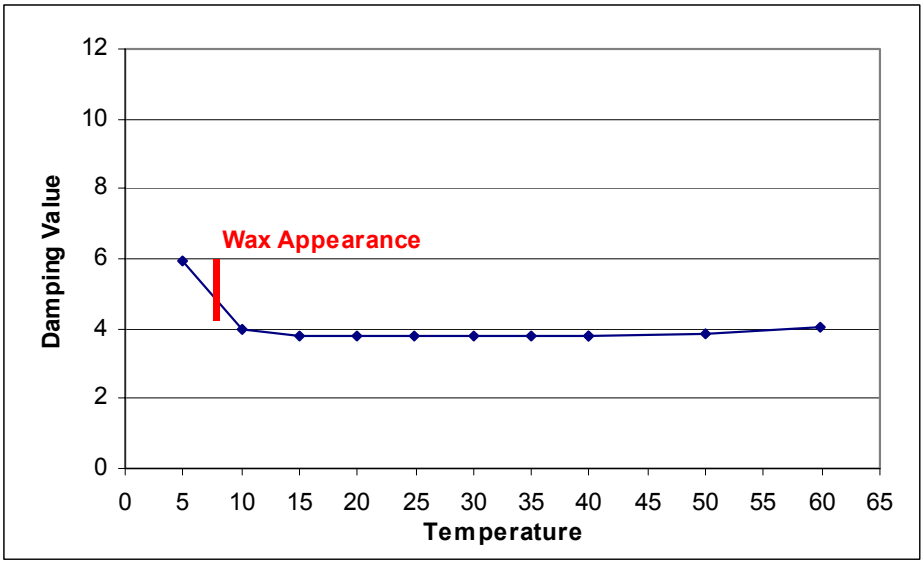
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	845.43	1321.1	4.20
2	60.00	59.88	824.05	1216.1	4.27
3	35.00	34.95	841.87	1303.2	4.18
4	15.00	15.00	856.11	1375.3	4.39
5	25.00	24.98	849.00	1339.6	4.25
6	40.00	39.94	838.33	1286.1	4.17
7	10.00	10.02	859.69	1393.7	4.51
8	20.00	19.99	852.59	1357.8	4.32
9	5.00	5.03	863.68	1412.9	4.70
10	50.00	49.91	831.20	1250.9	4.19
11	30.00	29.96	845.43	1321.1	4.21

Sample Details and Data

Sample Name:	Beryl	**Sample Number:**	41
Sample Type:	Crude oil	**Sample date :**	13/05/2001

Damping Curve



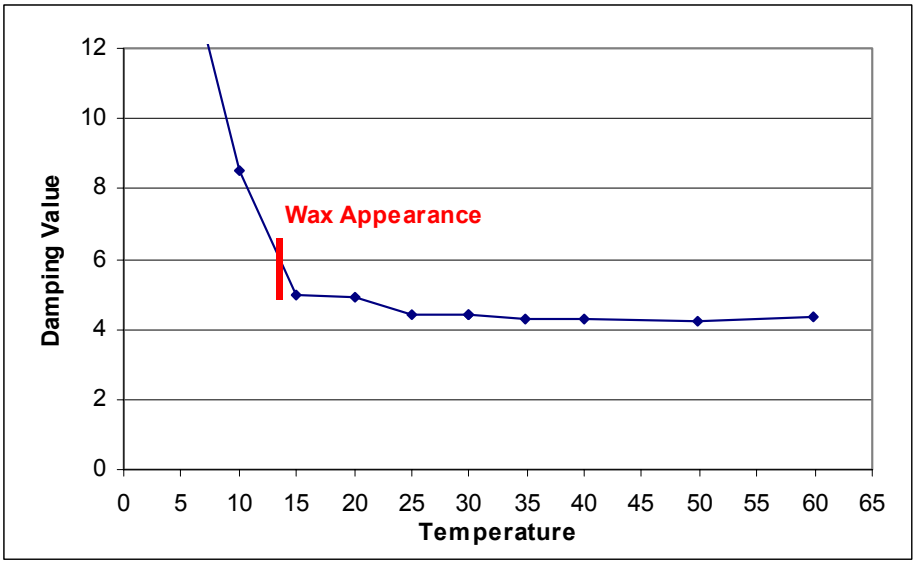
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	810.61	1254.6	3.80
2	50.00	49.91	803.23	1218.6	3.88
3	35.00	34.95	814.28	1272.4	3.78
4	30.00	29.96	817.96	1290.8	3.76
5	60.00	59.88	795.82	1182.8	4.02
6	5.00	5.03	837.70	1385.9	5.96
7	15.00	15.00	828.98	1346.6	3.78
8	10.00	10.02	833.10	1366.0	3.95
9	20.00	19.99	825.32	1328.5	3.78
10	25.00	24.98	821.66	1310.1	3.77
11	40.00	39.94	810.63	1255.1	3.81

Sample Details and Data

Sample Name:	Fife	**Sample Number:**	42
Sample Type:	Crude oil	**Sample date :**	07/08/2001

Damping Curve



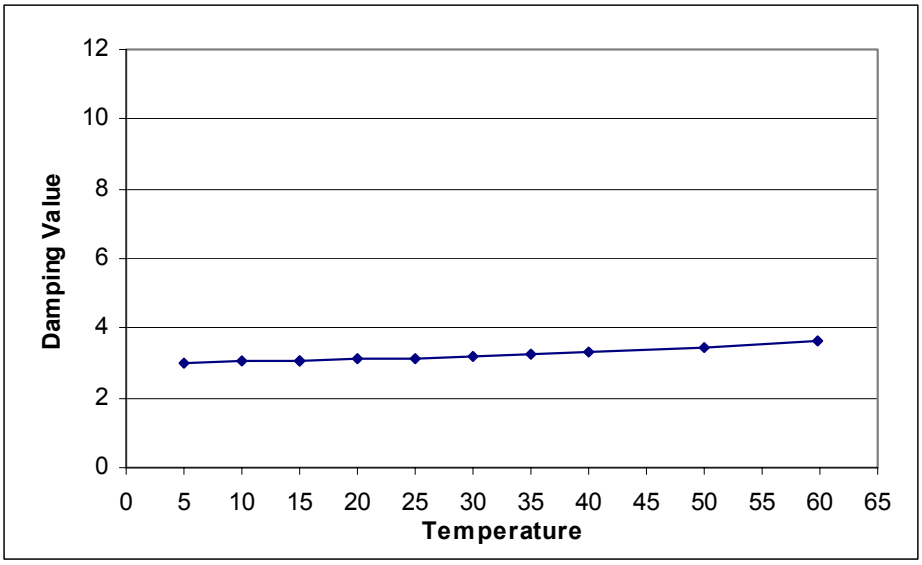
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	842.82	1328.1	4.40
2	50.00	49.91	828.43	1257.1	4.25
3	15.00	15.00	853.83	1382.9	4.99
4	60.00	59.89	821.34	1222.1	4.35
5	40.00	39.93	835.49	1291.5	4.26
6	25.00	24.97	846.36	1345.7	4.41
7	35.00	34.95	839.20	1310.0	4.29
8	5.00	5.03	861.22	1421.5	14.99
9	20.00	19.99	850.21	1365.1	4.91
10	10.00	10.02	857.92	1402.1	8.54
11	30.00	29.97	842.85	1328.6	4.41

Sample Details and Data

Sample Name:	Motor Spirit PU50	**Sample Number:**	43
Sample Type:	Gasoline	**Sample date :**	25/09/2001

Damping Curve



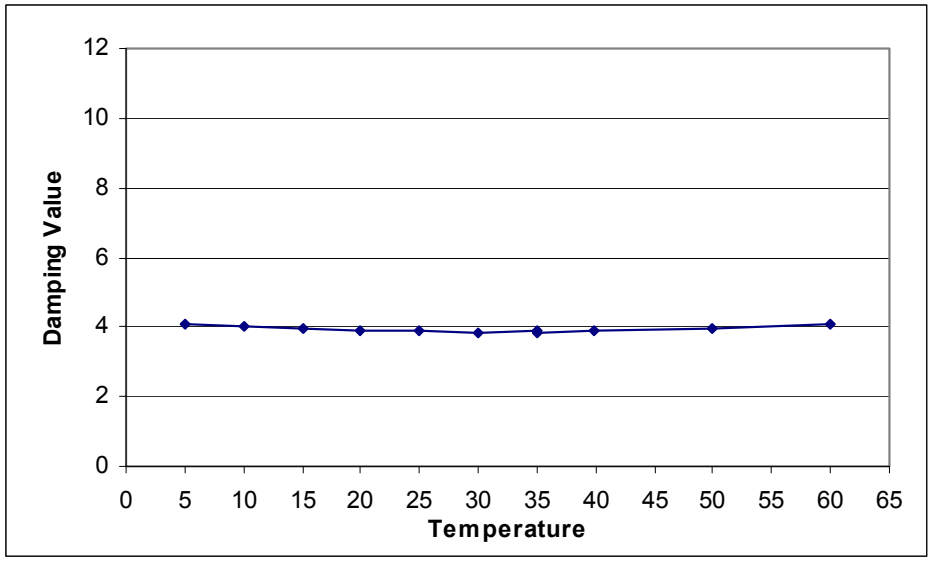
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	738.50	1180.4	3.06
2	50.00	49.91	706.47	1032.4	3.47
3	5.00	5.03	747.41	1223.5	3.00
4	35.00	34.95	720.42	1095.8	3.27
5	25.00	24.98	729.48	1137.5	3.16
6	10.00	10.02	742.96	1201.8	3.04
7	30.00	29.97	724.98	1116.9	3.19
8	20.00	19.99	734.00	1158.8	3.11
9	60.00	59.89	697.07	991.3	3.64
10	40.00	39.93	715.78	1074.0	3.35
11	15.00	15.00	738.50	1180.4	3.06

Sample Details and Data

Sample Name:	Gas Oil IGO dyed CIW	**Sample Number:**	44
Sample Type:	Gas oil	**Sample date :**	24/09/2001

Damping Curve



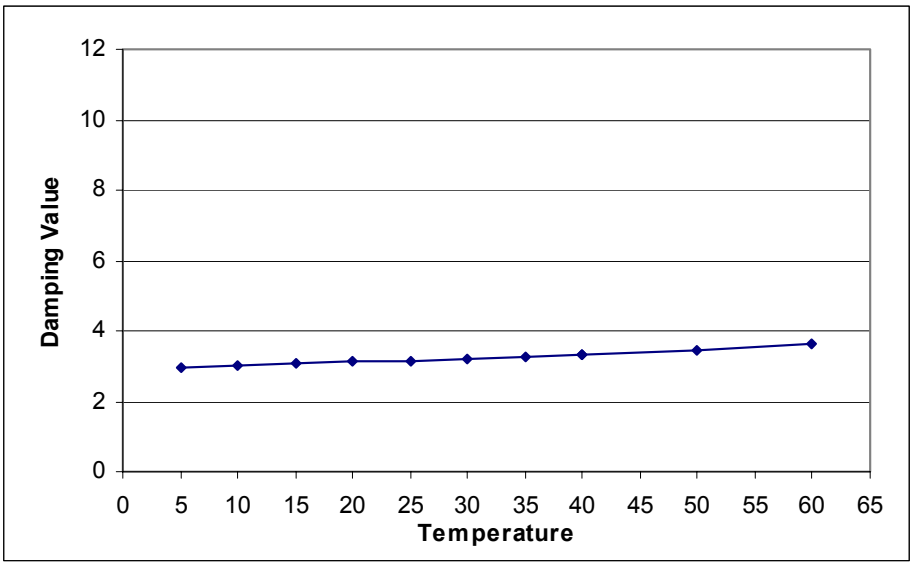
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	842.99	1335.5	3.85
2	50.00	49.91	832.45	1282.3	3.96
3	10.00	10.02	860.53	1425.0	4.00
4	40.00	39.94	839.48	1317.3	3.88
5	5.00	5.03	864.04	1443.1	4.07
6	60.00	59.89	825.42	1247.3	4.08
7	20.00	19.99	853.51	1388.2	3.90
8	15.00	15.01	857.01	1406.4	3.94
9	25.00	24.98	850.00	1370.4	3.88
10	30.00	29.97	846.49	1352.6	3.85
11	35.00	34.95	842.98	1334.8	3.88

Sample Details and Data

Sample Name:	Raffinate (Mogas comp)	**Sample Number:**	45
Sample Type:	Gasoline	**Sample date :**	25/09/2001

Damping Curve



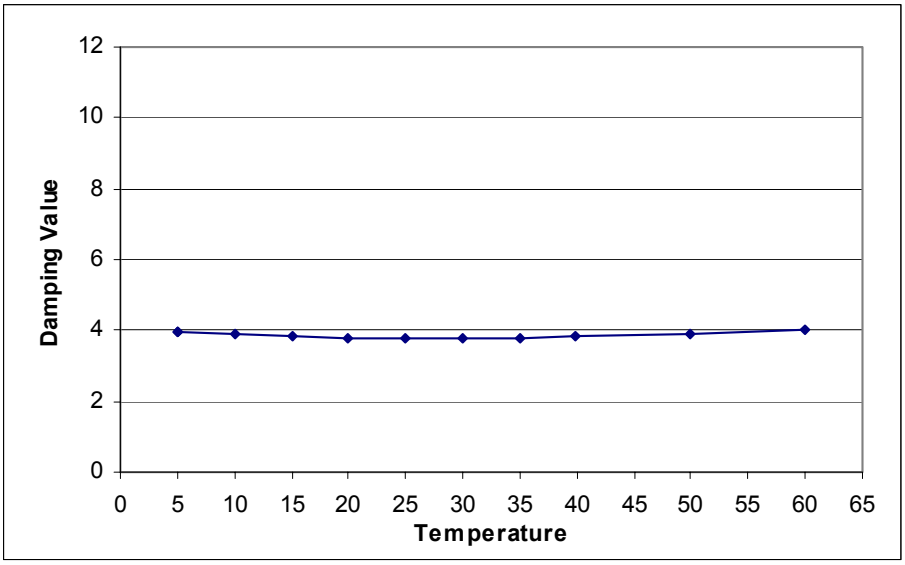
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	661.41	1019.8	3.29
2	20.00	19.99	679.93	1107.1	3.11
3	50.00	49.91	651.95	977.1	3.44
4	30.00	29.96	670.73	1063.1	3.21
5	60.00	59.88	642.22	933.8	3.60
6	15.00	15.00	684.48	1129.3	3.07
7	25.00	24.98	675.39	1085.9	3.14
8	10.00	10.02	688.99	1151.6	3.03
9	5.00	5.03	693.48	1173.8	2.96
10	35.00	34.95	666.16	1042.6	3.27
11	40.00	39.94	661.48	1020.7	3.30

Sample Details and Data

Sample Name:	GO Derv RVW	**Sample Number:**	46
Sample Type:	Diesel	**Sample date :**	24/09/2001

Damping Curve



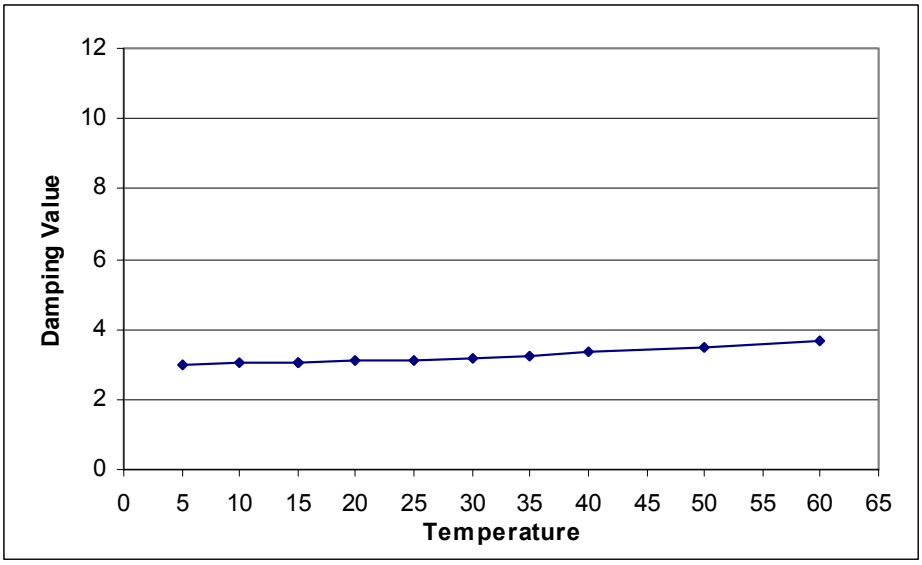
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	838.10	1422.8	3.94
2	40.00	39.94	813.66	1296.5	3.82
3	50.00	49.91	806.66	1261.1	3.89
4	35.00	34.95	817.14	1313.6	3.81
5	25.00	24.97	824.12	1349.6	3.80
6	20.00	19.99	827.61	1367.7	3.80
7	15.00	15.01	831.11	1386.0	3.83
8	10.00	10.02	834.60	1404.3	3.88
9	30.00	29.97	820.65	1332.3	3.79
10	60.00	59.88	799.65	1226.3	4.02
11	5.00	5.03	838.10	1422.7	3.94

Sample Details and Data

Sample Name:	Mogas LRP	**Sample Number:**	47
Sample Type:	Gasoline	**Sample date :**	25/09/2001

Damping Curve



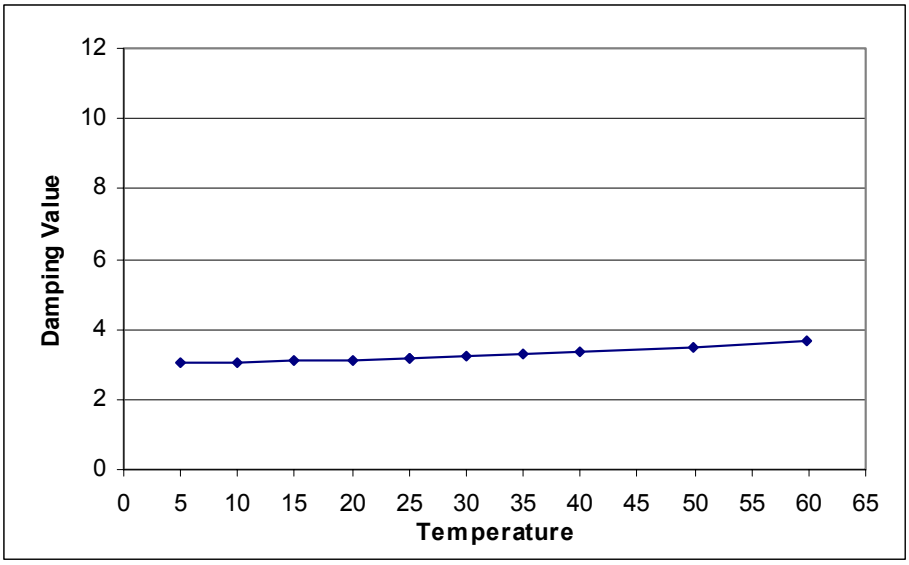
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	742.74	1182.3	3.05
2	25.00	24.98	733.65	1139.5	3.13
3	35.00	34.95	724.45	1097.0	3.25
4	20.00	19.99	738.21	1160.7	3.11
5	10.00	10.02	747.25	1203.8	3.02
6	50.00	49.91	710.43	1034.0	3.49
7	60.00	59.88	700.88	992.2	3.68
8	40.00	39.93	719.82	1075.6	3.35
9	5.00	5.03	751.84	1225.4	2.99
10	30.00	29.97	729.17	1118.4	3.20
11	15.00	15.00	742.82	1182.1	3.06

Sample Details and Data

Sample Name:	Naphtha	**Sample Number:**	48
Sample Type:	Distillate	**Sample date :**	27/09/2001

Damping Curve



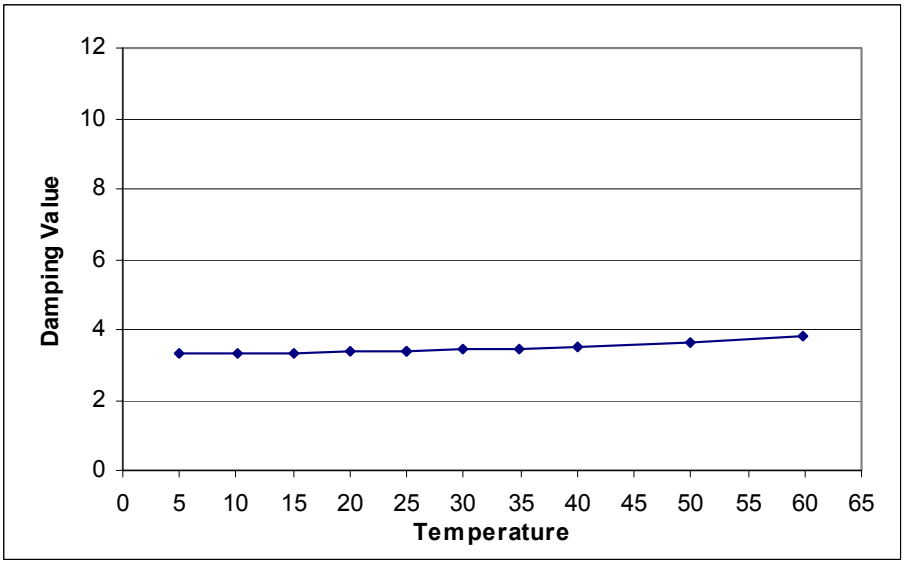
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	731.78	1171.0	3.15
2	50.00	49.91	709.89	1067.9	3.51
3	15.00	15.00	740.37	1212.8	3.10
4	10.00	10.02	744.63	1233.9	3.08
5	20.00	19.99	736.08	1192.0	3.13
6	5.00	5.03	748.85	1255.1	3.03
7	30.00	29.97	727.43	1150.3	3.22
8	60.00	59.88	700.96	1027.5	3.69
9	35.00	34.94	723.09	1129.3	3.31
10	40.00	39.94	718.74	1109.0	3.36
11	25.00	24.97	731.75	1170.8	3.19

Sample Details and Data

Sample Name:	Jet A1	**Sample Number:**	49
Sample Type:	Kerosine (Jet)	**Sample date :**	25/09/2001

Damping Curve



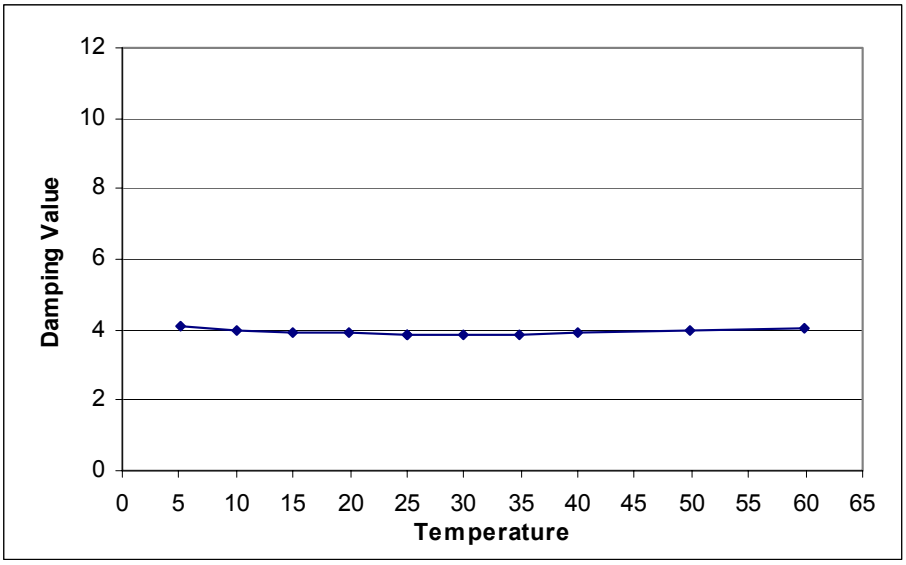
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	793.10	1286.4	3.40
2	30.00	29.97	789.35	1267.6	3.43
3	40.00	39.94	781.84	1230.3	3.51
4	60.00	59.88	766.71	1156.9	3.80
5	10.00	10.02	804.30	1343.2	3.35
6	15.00	15.01	800.57	1324.2	3.35
7	35.00	34.95	785.60	1248.8	3.47
8	20.00	19.99	796.83	1305.0	3.37
9	5.00	5.03	807.98	1362.4	3.35
10	50.00	49.91	774.27	1193.6	3.66
11	25.00	24.97	793.06	1286.1	3.40

Sample Details and Data

Sample Name:	Gas Oil IGO undyed	**Sample Number:**	50
Sample Type:	Gas oil	**Sample date :**	24/09/2001

Damping Curve



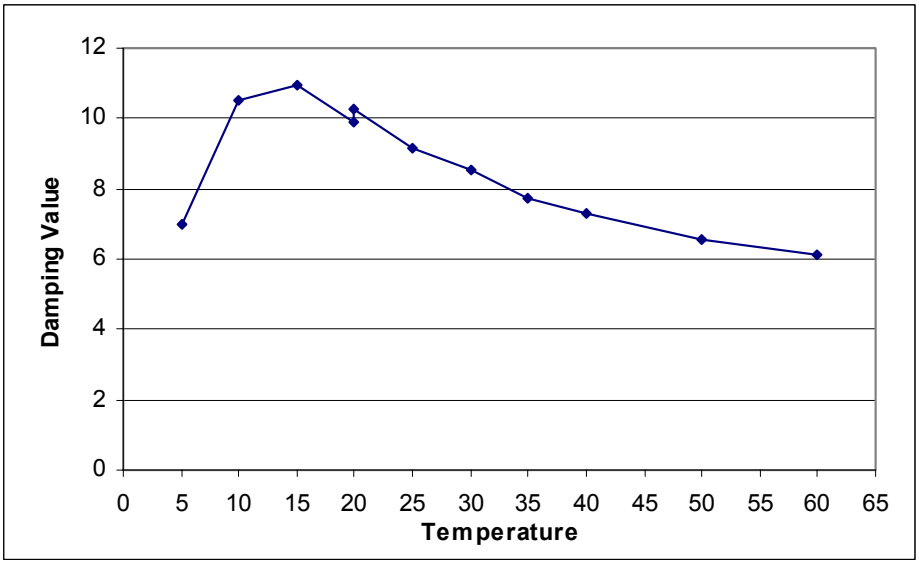
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	850.00	1370.6	3.86
2	35.00	34.95	842.98	1334.8	3.86
3	10.00	10.02	860.53	1424.5	3.99
4	40.00	39.94	839.48	1317.4	3.89
5	50.00	49.91	832.45	1282.2	3.95
6	5.00	5.03	864.04	1442.9	4.07
7	15.00	15.01	857.01	1406.5	3.94
8	20.00	19.99	853.50	1388.6	3.90
9	60.00	59.88	825.41	1247.5	4.06
10	30.00	29.96	846.48	1352.2	3.86
11	25.00	24.98	849.99	1370.1	3.87

Sample Details and Data

Sample Name:	Light Fuel Oil UKSG	**Sample Number:**	51
Sample Type:	Fuel oil	**Sample date :**	25/09/2001

Damping Curve



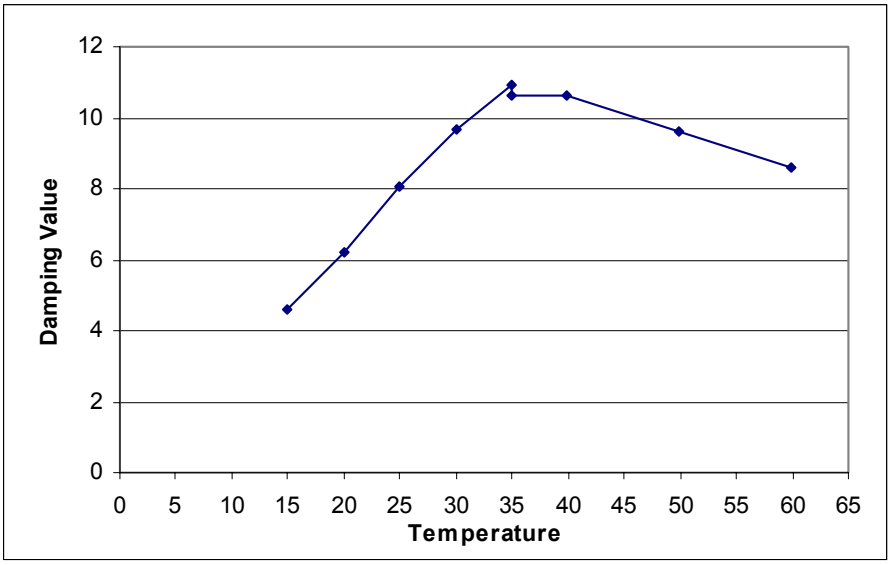
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	969.55	1516.6	9.90
2	30.00	29.97	962.56	1479.5	8.51
3	10.00	10.02	976.77	1556.3	10.49
4	25.00	24.98	965.99	1497.3	9.14
5	50.00	49.91	948.50	1409.0	6.58
6	60.00	59.88	941.65	1375.3	6.13
7	35.00	34.95	958.69	1460.0	7.72
8	40.00	39.94	955.33	1442.9	7.29
9	5.00	5.03	981.04	1579.3	7.00
10	15.00	15.01	973.14	1535.9	10.95
11	20.00	19.99	969.47	1515.8	10.27

Sample Details and Data

Sample Name:	Heavy Fuel Oil UKSG	**Sample Number:**	52
Sample Type:	Fuel oil	**Sample date :**	25/09/2001

Damping Curve



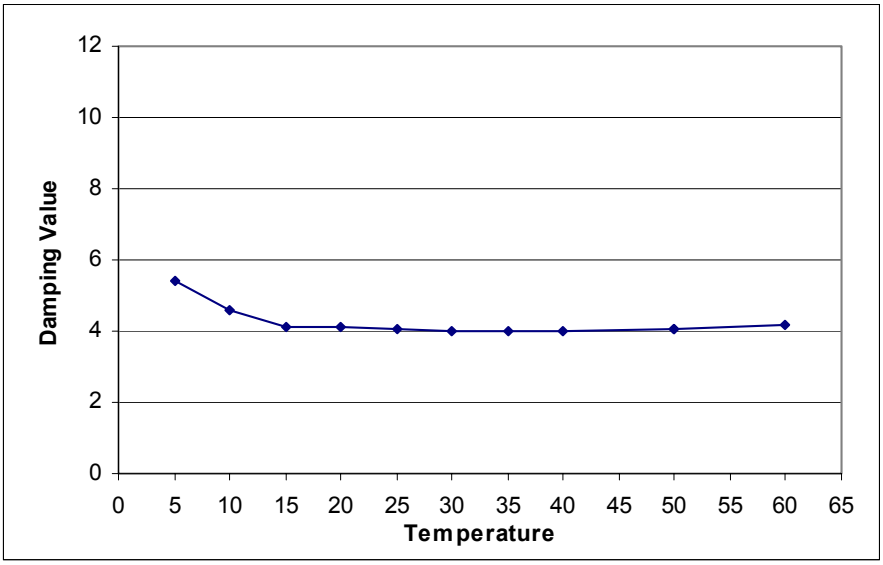
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	979.18	1498.4	10.95
2	20.00	19.99	990.12	1569.3	6.24
3	60.00	59.89	962.76	1407.3	8.58
4	40.00	39.93	975.87	1477.2	10.65
5	50.00	49.91	969.38	1441.5	9.61
6	25.00	24.97	986.38	1540.9	8.07
7	30.00	29.96	982.93	1519.0	9.66
8	15.00	15.00	994.12	1599.2	4.57
9	35.00	34.95	979.44	1498.0	10.65

Sample Details and Data

Sample Name:	Ekofisk	**Sample Number:**	53
Sample Type:	Crude oil	**Sample date :**	23/10/2001

Damping Curve



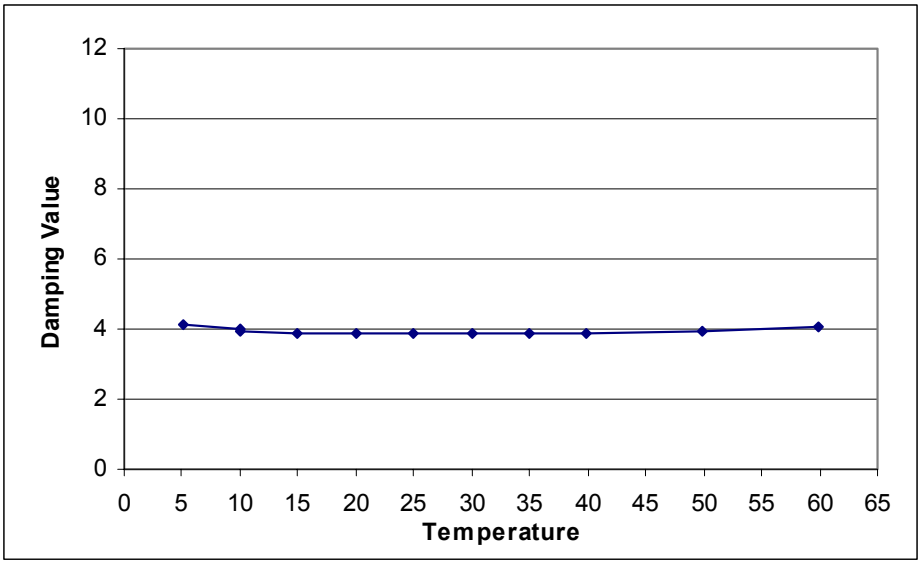
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	810.84	1235.9	4.05
2	15.00	15.00	836.19	1363.2	4.14
3	5.00	5.03	844.08	1401.6	5.44
4	20.00	19.99	832.58	1345.1	4.10
5	25.00	24.98	828.92	1326.7	4.04
6	10.00	10.02	840.07	1382.2	4.58
7	30.00	29.97	825.30	1308.4	3.99
8	35.00	34.95	821.69	1290.3	4.00
9	40.00	39.94	818.08	1272.1	3.99
10	60.00	59.88	803.63	1200.8	4.15
11	50.00	49.91	810.83	1235.5	4.07

Sample Details and Data

Sample Name:	Statfjord	**Sample Number:**	54
Sample Type:	Crude oil	**Sample date :**	20/10/2001

Damping Curve



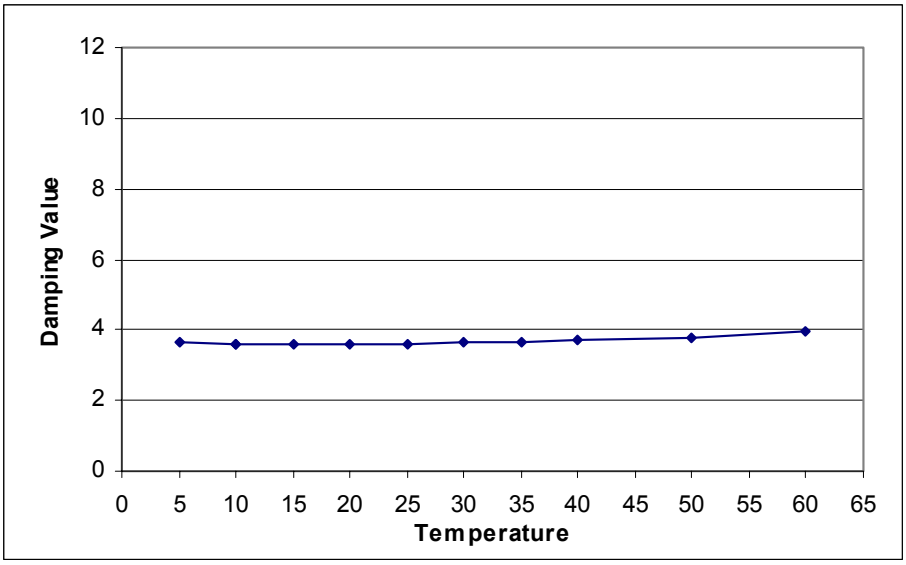
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	833.39	1368.8	4.00
2	40.00	39.94	811.43	1258.1	3.89
3	5.00	5.03	837.43	1388.3	4.15
4	20.00	19.99	826.01	1331.7	3.89
5	25.00	24.98	822.37	1313.2	3.85
6	35.00	34.95	815.08	1276.4	3.87
7	50.00	49.91	804.12	1222.0	3.96
8	30.00	29.96	818.71	1294.2	3.85
9	60.00	59.89	796.77	1186.3	4.07
10	15.00	15.00	829.63	1349.9	3.89
11	10.00	10.02	833.33	1368.8	3.95

Sample Details and Data

Sample Name:	Asgard	**Sample Number:**	55
Sample Type:	Crude oil	**Sample date :**	18/10/2001

Damping Curve



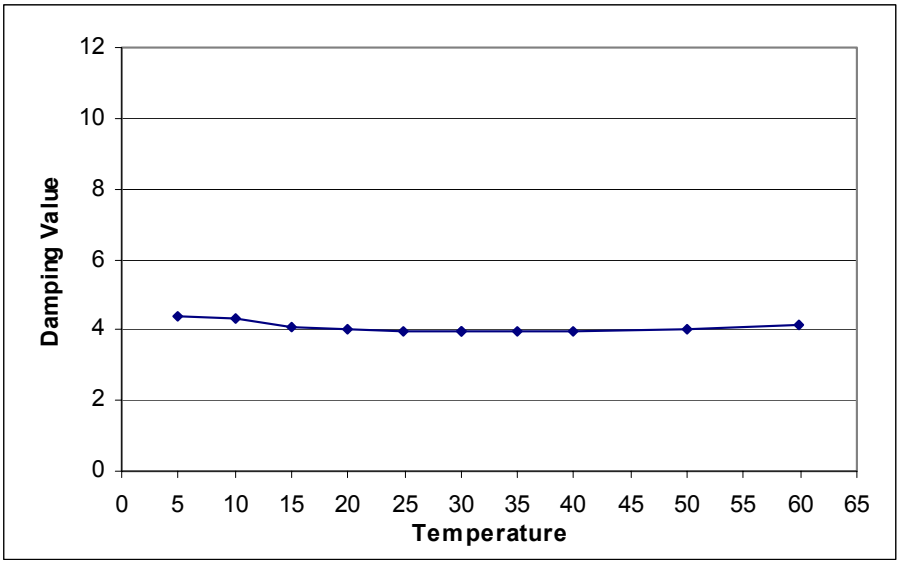
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	817.79	1348.4	3.62
2	35.00	34.95	799.17	1254.6	3.66
3	20.00	19.99	810.35	1310.4	3.60
4	15.00	15.01	814.07	1329.4	3.61
5	50.00	49.91	787.95	1199.7	3.80
6	30.00	29.96	802.90	1272.8	3.64
7	60.00	59.88	780.42	1163.4	3.93
8	40.00	39.93	795.43	1235.7	3.71
9	5.00	5.03	821.51	1367.6	3.65
10	25.00	24.98	806.65	1292.4	3.61
11	10.00	10.02	817.79	1348.5	3.61

Sample Details and Data

Sample Name:	Jotun	**Sample Number:**	56
Sample Type:	Crude oil	**Sample date :**	06/11/2001

Damping Curve



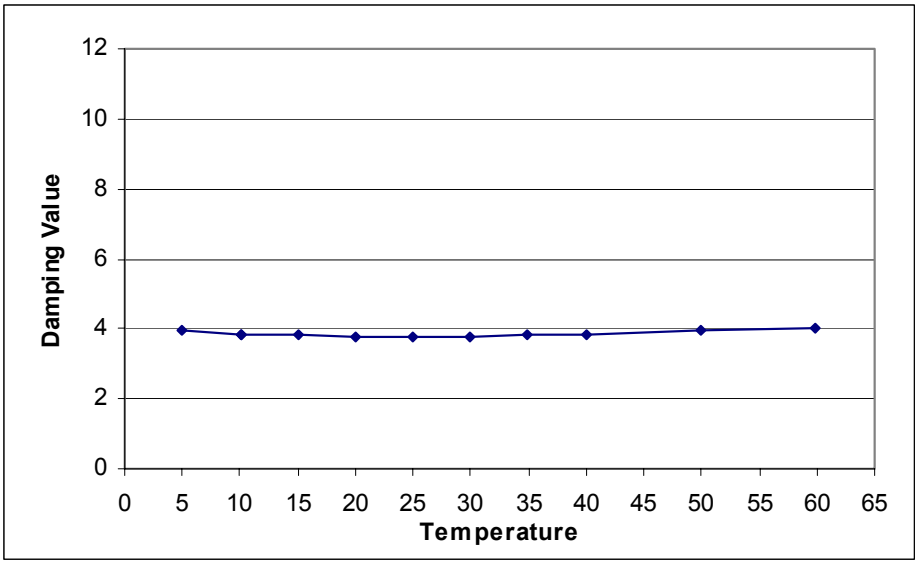
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	824.22	1314.6	3.97
2	25.00	24.98	827.79	1332.7	3.99
3	15.00	15.00	834.91	1369.4	4.07
4	10.00	10.02	838.87	1388.5	4.33
5	60.00	59.89	802.80	1207.9	4.13
6	20.00	19.99	831.36	1350.9	4.01
7	50.00	49.91	809.96	1243.0	4.03
8	35.00	34.95	820.67	1296.3	3.97
9	5.00	5.03	843.23	1408.4	4.39
10	40.00	39.94	817.12	1279.0	3.98
11	30.00	29.96	824.23	1314.5	3.98

Sample Details and Data

Sample Name:	Statfjord	**Sample Number:**	57
Sample Type:	Crude oil	**Sample date :**	29/10/2001

Damping Curve



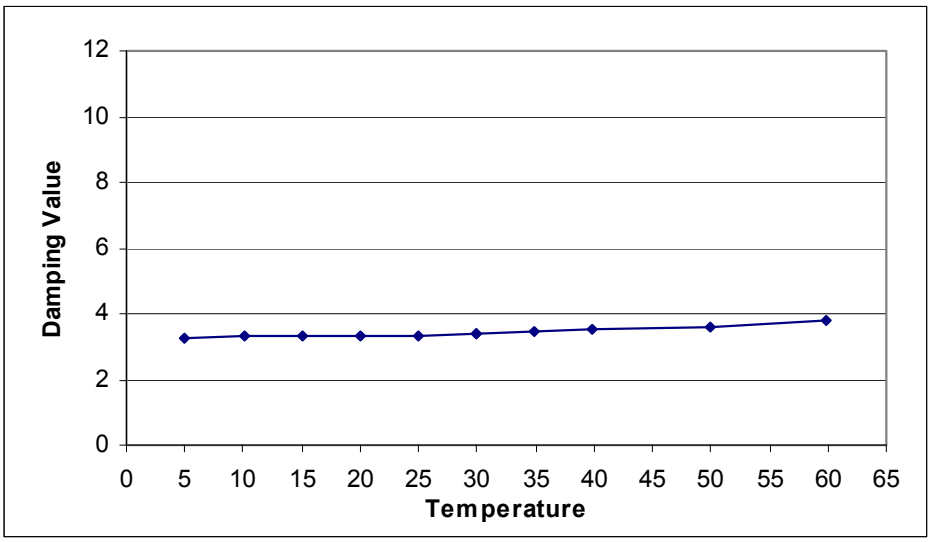
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	827.69	1358.1	3.86
2	60.00	59.89	790.85	1174.2	4.04
3	35.00	34.95	809.34	1264.6	3.82
4	40.00	39.94	805.66	1246.4	3.84
5	25.00	24.97	816.69	1301.7	3.80
6	30.00	29.96	813.02	1283.5	3.79
7	20.00	19.99	820.36	1320.4	3.79
8	50.00	49.91	798.28	1210.3	3.93
9	5.00	5.03	831.71	1377.7	3.97
10	15.00	15.01	824.03	1339.6	3.84
11	10.00	10.02	827.70	1358.3	3.86

Sample Details and Data

Sample Name:	White Spirit de aromatised	**Sample Number:**	58
Sample Type:	Kerosine	**Sample date :**	11/10/2001

Damping Curve



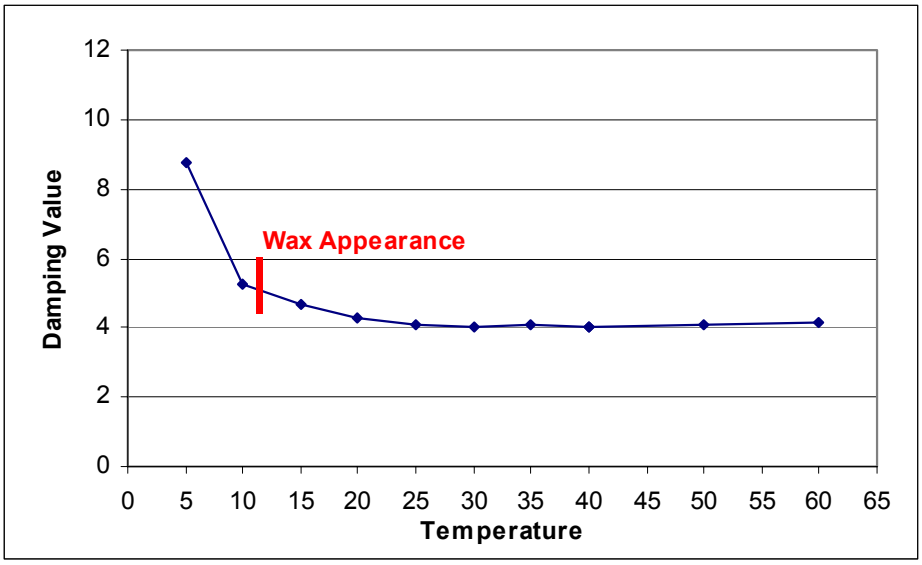
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	763.38	1236.4	3.41
2	25.00	24.98	767.17	1255.5	3.35
3	15.00	15.00	774.72	1294.2	3.32
4	50.00	49.91	748.14	1160.3	3.61
5	60.00	59.88	740.44	1123.0	3.77
6	40.00	39.93	755.78	1197.6	3.50
7	10.00	10.02	778.50	1313.7	3.30
8	35.00	34.95	759.58	1217.2	3.45
9	5.00	5.03	782.25	1333.0	3.29
10	20.00	19.99	770.94	1274.7	3.33
11	30.00	29.97	763.40	1236.8	3.41

Sample Details and Data

Sample Name:	Ekofisk	**Sample Number:**	59
Sample Type:	Crude oil	**Sample date :**	06/10/2001

Damping Curve



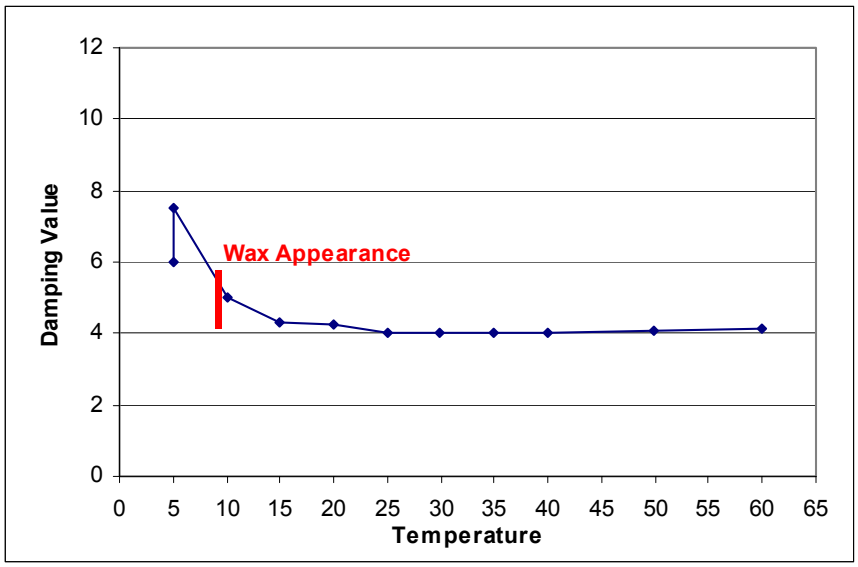
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	818.10	1272.4	4.05
2	30.00	29.97	825.28	1308.3	4.05
3	10.00	10.02	840.48	1385.1	5.28
4	15.00	15.00	836.64	1365.6	4.65
5	20.00	19.99	832.80	1346.2	4.27
6	5.00	5.03	844.65	1405.6	8.78
7	60.00	59.88	803.65	1203.8	4.18
8	50.00	49.91	810.84	1236.9	4.09
9	25.00	24.98	828.95	1326.9	4.10
10	35.00	34.95	821.72	1290.5	4.06
11	40.00	39.94	818.10	1272.8	4.05

Sample Details and Data

Sample Name:	Ekofisk	**Sample Number:**	60
Sample Type:	Crude oil	**Sample date :**	10/10/2001

Damping Curve



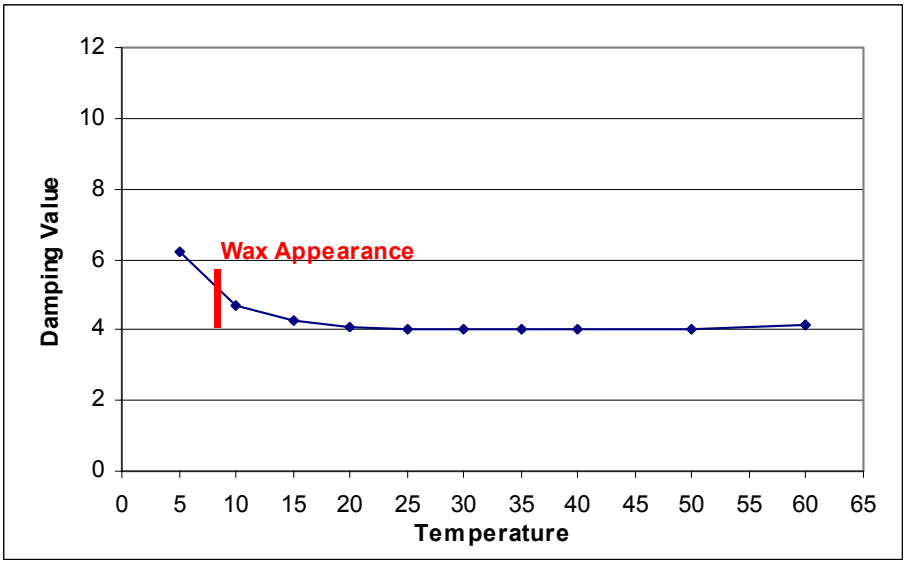
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	844.24	1401.8	6.03
2	35.00	34.95	821.47	1289.4	4.01
3	50.00	49.91	810.59	1235.3	4.06
4	30.00	29.96	825.00	1307.3	4.01
5	40.00	39.94	817.80	1271.2	4.00
6	25.00	24.97	828.67	1325.7	4.05
7	15.00	15.00	836.17	1363.0	4.31
8	60.00	59.88	803.36	1199.9	4.14
9	10.00	10.02	840.11	1381.9	5.01
10	20.00	19.99	832.49	1344.3	4.26
11	5.00	5.03	844.37	1401.5	7.54

Sample Details and Data

Sample Name:	Ekofisk	**Sample Number:**	61
Sample Type:	Crude oil	**Sample date :**	13/10/2001

Damping Curve



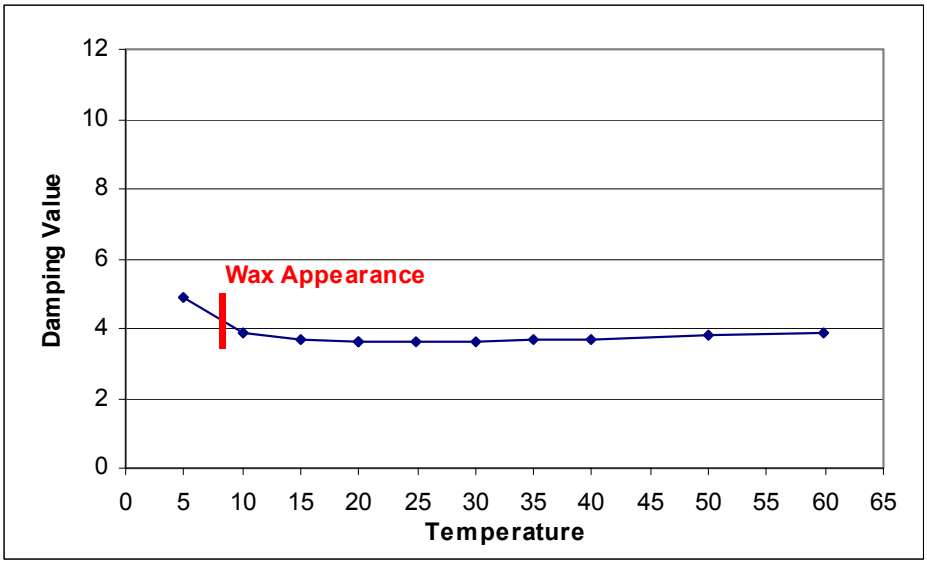
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.89	803.17	1199.9	4.12
2	20.00	19.99	832.17	1343.8	4.11
3	40.00	39.94	817.64	1270.8	4.00
4	25.00	24.97	828.49	1325.2	4.03
5	30.00	29.97	824.89	1307.0	4.02
6	10.00	10.02	839.90	1381.6	4.68
7	50.00	49.91	810.41	1234.8	4.05
8	5.00	5.03	844.06	1400.9	6.24
9	35.00	34.95	821.28	1288.8	4.01
10	15.00	15.00	835.95	1362.2	4.28
11	60.00	59.88	803.18	1199.4	4.15

Sample Details and Data

Sample Name:	Forties Blend	**Sample Number:**	62
Sample Type:	Crude oil	**Sample date :**	25/10/2001

Damping Curve



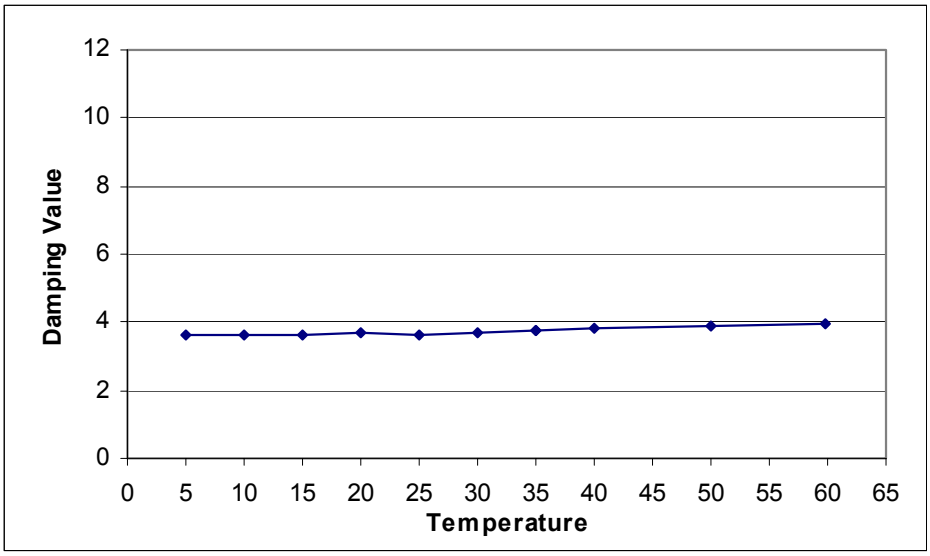
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	805.78	1300.1	3.64
2	10.00	10.02	813.61	1338.2	3.87
3	25.00	24.98	802.00	1281.2	3.64
4	30.00	29.96	798.17	1262.3	3.65
5	15.00	15.00	809.59	1318.9	3.66
6	35.00	34.95	794.34	1243.5	3.67
7	5.00	5.03	817.66	1357.9	4.91
8	50.00	49.91	782.97	1188.1	3.79
9	40.00	39.93	790.54	1224.9	3.69
10	60.00	59.88	775.36	1151.7	3.90
11	20.00	19.99	805.69	1299.8	3.64

Sample Details and Data

Sample Name:	Kerosene K5	**Sample Number:**	63
Sample Type:	Kerosine	**Sample date :**	13/10/2001

Damping Curve



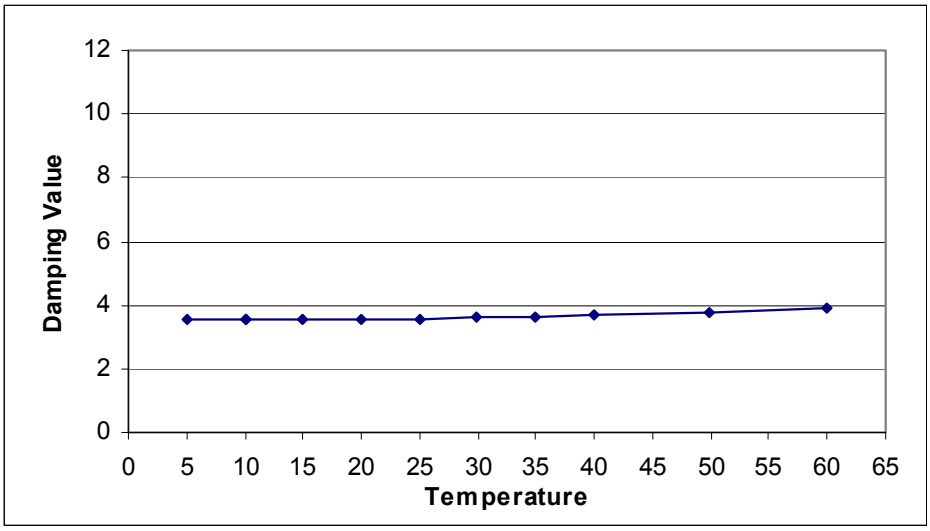
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
	99.00				
1	35.00	34.95	809.81	1290.4	3.75
2	15.00	15.00	824.17	1365.7	3.63
3	5.00	5.03	831.32	1404.0	3.65
4	25.00	24.98	817.00	1327.3	3.66
5	40.00	39.94	806.20	1272.4	3.79
6	30.00	29.96	813.40	1308.2	3.73
7	60.00	59.88	791.70	1202.6	3.98
8	10.00	10.02	827.75	1385.0	3.65
9	50.00	49.91	798.96	1237.0	3.86
10	20.00	19.99	820.59	1346.0	3.68
11	35.00	34.95	809.81	1290.3	3.75

Sample Details and Data

Sample Name:	Kerosene SPK-05	**Sample Number:**	64
Sample Type:	Kerosine	**Sample date :**	27/10/2001

Damping Curve



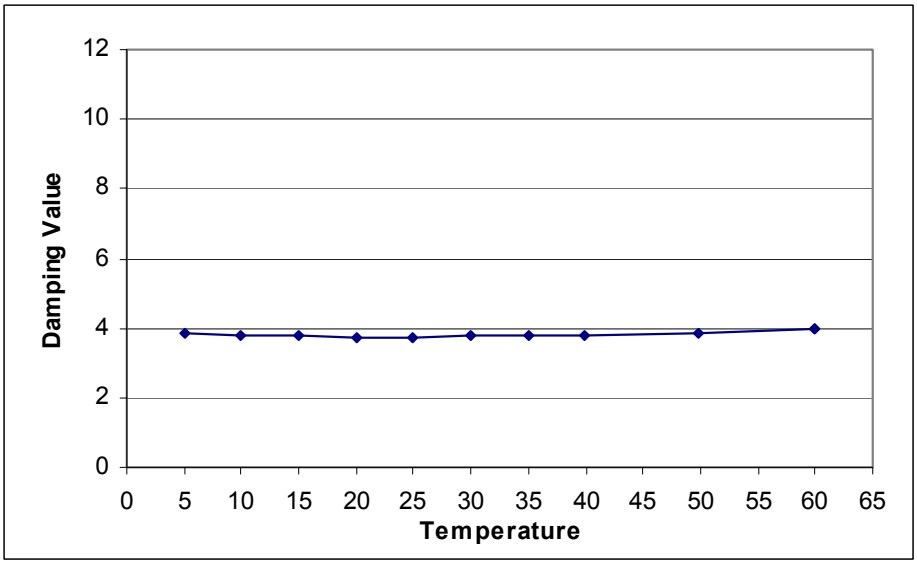
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	808.25	1367.7	3.55
2	60.00	59.89	772.36	1183.8	3.89
3	50.00	49.91	779.58	1219.6	3.77
4	30.00	29.96	793.94	1292.7	3.60
5	40.00	39.94	786.77	1256.0	3.66
6	15.00	15.00	804.67	1348.6	3.56
7	20.00	19.99	801.10	1329.9	3.56
8	5.00	5.03	811.82	1386.0	3.57
9	35.00	34.95	790.35	1273.6	3.64
10	25.00	24.98	797.51	1310.3	3.58
11	10.00	10.02	808.24	1364.9	3.57

Sample Details and Data

Sample Name:	Light Cycle Oil	**Sample Number:**	65
Sample Type:	Distillate	**Sample date :**	29/10/2001

Damping Curve



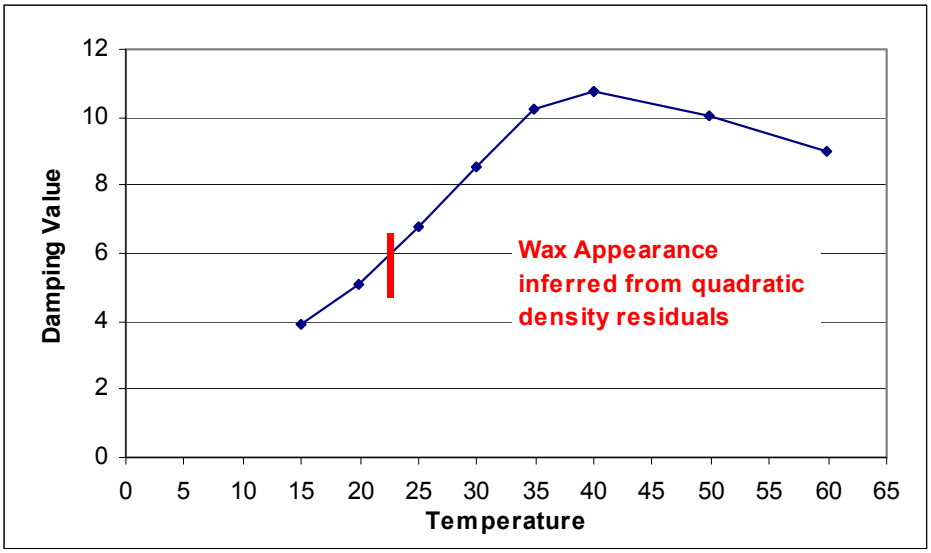
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	889.37	1286.4	3.97
2	40.00	39.93	904.28	1356.6	3.79
3	50.00	49.91	896.83	1321.3	3.85
4	10.00	10.02	926.63	1465.3	3.81
5	25.00	24.98	915.45	1411.0	3.74
6	15.00	15.00	922.90	1447.1	3.76
7	20.00	19.99	919.17	1429.1	3.74
8	5.00	5.03	930.37	1483.5	3.83
9	35.00	34.95	908.01	1374.8	3.77
10	30.00	29.96	911.73	1392.6	3.76
11	60.00	59.88	889.37	1286.4	3.96

Sample Details and Data

Sample Name:	Fuel Oil LS	**Sample Number:**	66
Sample Type:	Fuel oil	**Sample date :**	07/10/2001

Damping Curve



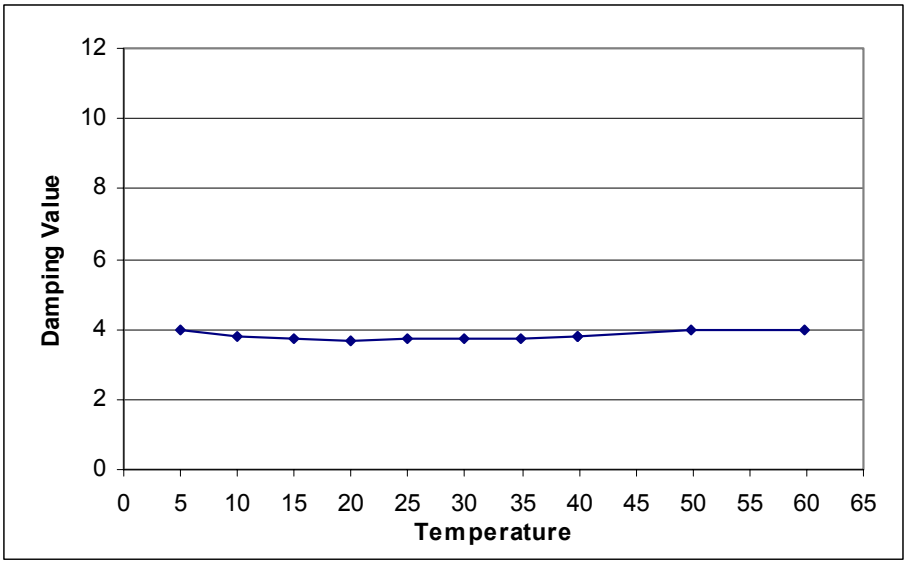
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	976.02	1470.2	10.75
2	25.00	24.97	987.13	1536.7	6.80
3	50.00	49.91	969.63	1433.5	10.05
4	20.00	19.99	991.17	1564.5	5.07
5	30.00	29.97	983.61	1514.0	8.51
6	15.00	15.00	995.36	1597.3	3.93
7	60.00	59.88	963.01	1398.2	8.99
8	35.00	34.95	979.59	1490.6	10.21
9	40.00	39.94	976.29	1471.0	10.76

Sample Details and Data

Sample Name:	Mexican	**Sample Number:**	67
Sample Type:	Crude oil	**Sample date :**	28/10/2001

Damping Curve



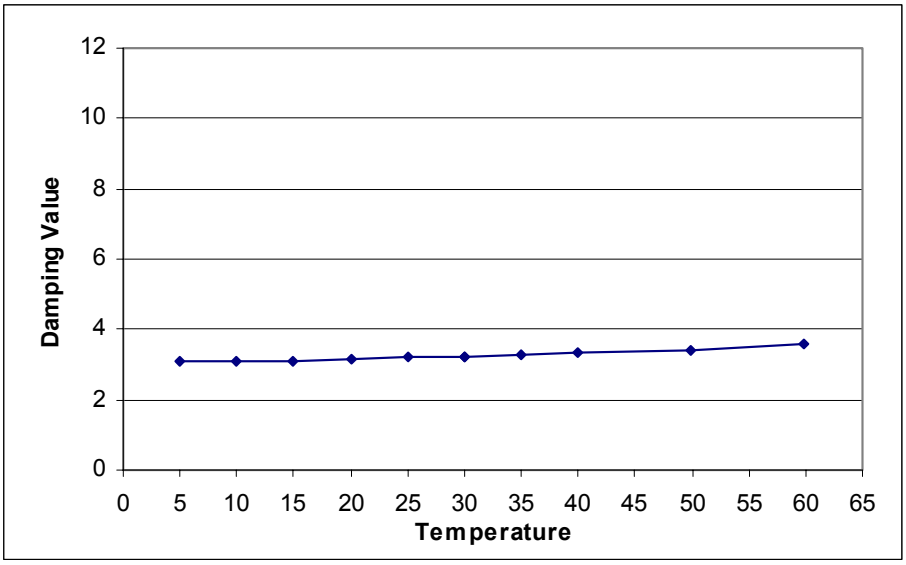
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	794.53	1230.9	3.80
2	50.00	49.91	787.02	1195.1	2.88
3	25.00	24.98	805.77	1286.9	3.72
4	5.00	5.03	821.41	1366.3	3.99
5	35.00	34.95	798.31	1249.8	3.75
6	60.00	59.88	779.45	1160.1	3.96
7	15.00	15.01	813.33	1325.7	3.70
8	20.00	19.99	809.61	1306.5	3.68
9	10.00	10.02	817.31	1345.9	3.77
10	30.00	29.97	802.07	1268.5	3.73
11	40.00	39.94	794.54	1231.3	3.80

Sample Details and Data

Sample Name:	Naphtha MSR	**Sample Number:**	68
Sample Type:	Distillate	**Sample date :**	09/10/2001

Damping Curve



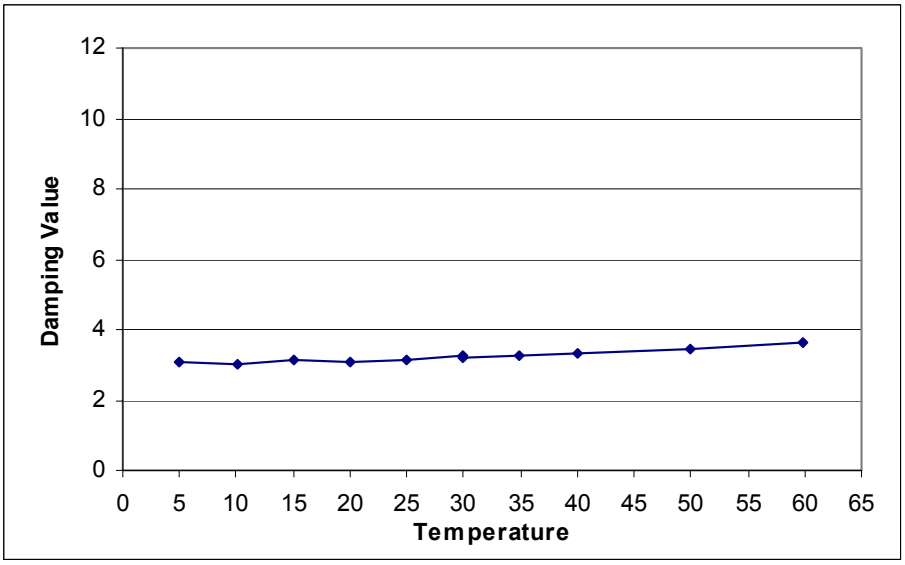
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	732.18	1159.5	3.24
2	30.00	29.97	732.17	1159.6	3.24
3	15.00	15.00	744.88	1221.5	3.10
4	50.00	49.91	714.94	1078.3	3.43
5	20.00	19.99	740.66	1200.7	3.15
6	60.00	59.88	706.16	1038.2	3.58
7	5.00	5.03	753.27	1263.3	3.07
8	10.00	10.02	749.08	1242.5	3.07
9	25.00	24.98	736.43	1180.2	3.19
10	35.00	34.95	727.90	1139.1	3.26
11	40.00	39.94	723.61	1118.8	3.32

Sample Details and Data

Sample Name:	Naphtha LSR	**Sample Number:**	69
Sample Type:	Distillate	**Sample date :**	28/10/2001

Damping Curve



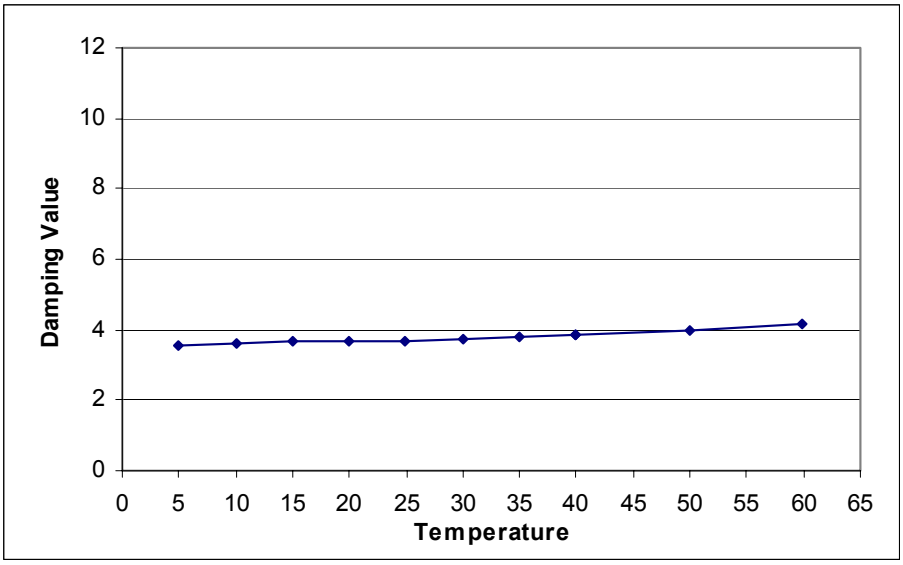
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	656.99	1037.5	3.19
2	10.00	10.02	676.00	1133.2	3.04
3	20.00	19.99	666.55	1087.2	3.11
4	40.00	39.94	647.21	996.8	3.32
5	35.00	34.95	652.12	1018.8	3.24
6	5.00	5.03	680.63	1155.1	3.07
7	50.00	49.91	637.21	951.2	3.45
8	15.00	15.00	671.27	1108.5	3.14
9	60.00	59.89	626.98	906.2	3.64
10	25.00	24.97	661.78	1062.9	3.15
11	30.00	29.97	656.95	1040.5	3.24

Sample Details and Data

Sample Name:	Naphtha N&A	**Sample Number:**	70
Sample Type:	Distillate	**Sample date :**	13/10/2001

Damping Curve



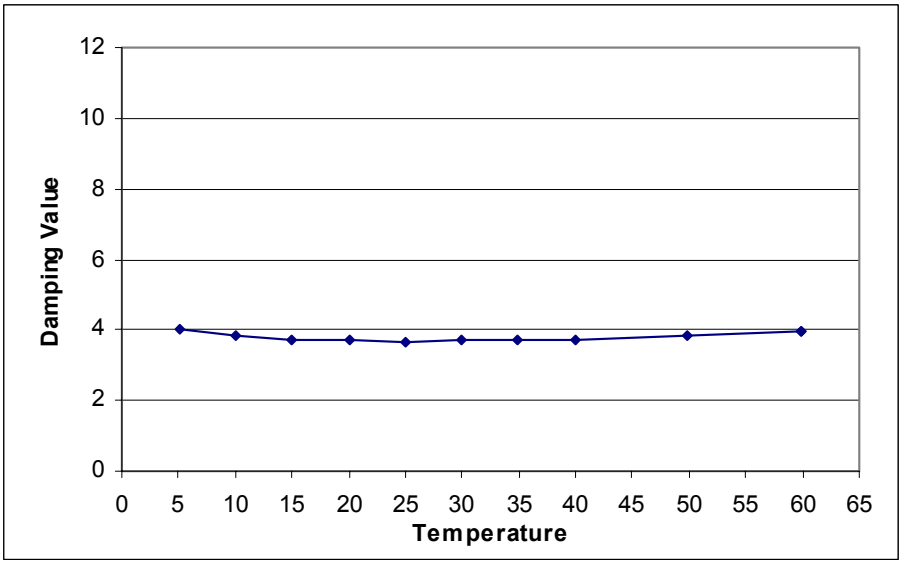
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	713.06	1089.1	3.88
2	35.00	34.95	717.54	1110.1	3.82
3	5.00	5.03	743.75	1238.3	3.55
4	30.00	29.97	721.96	1131.0	3.76
5	20.00	19.99	730.75	1173.4	3.67
6	60.00	59.89	694.74	1005.1	4.13
7	15.00	15.00	735.12	1194.7	3.67
8	10.00	10.02	739.46	1216.5	3.62
9	50.00	49.91	704.02	1046.8	3.95
10	25.00	24.98	726.40	1151.9	3.69
11	40.00	39.94	713.08	1088.5	3.84

Sample Details and Data

Sample Name:	Njord	**Sample Number:**	71
Sample Type:	Crude oil	**Sample date :**	24/10/2001

Damping Curve



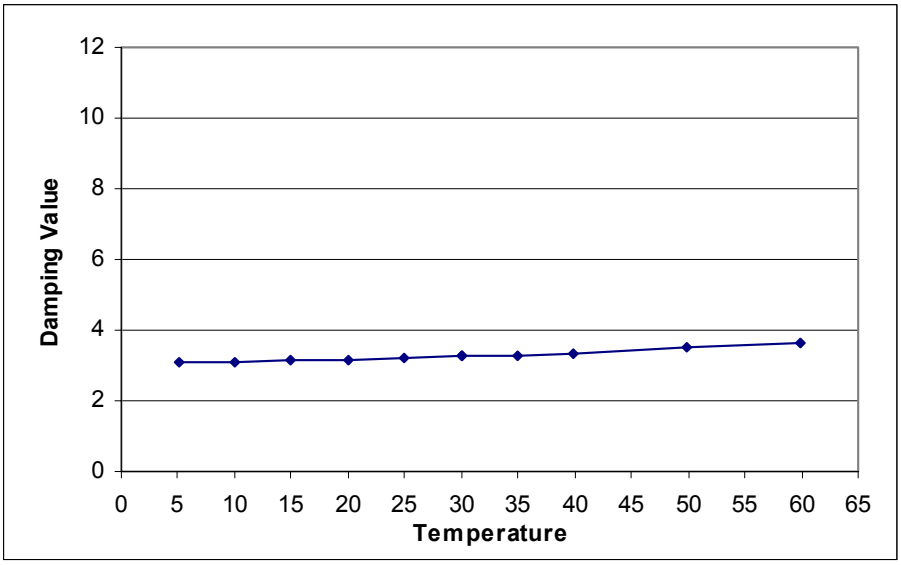
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	772.83	1163.9	3.95
2	40.00	39.93	787.69	1236.4	3.74
3	10.00	10.02	810.29	1348.6	3.84
4	30.00	29.97	795.10	1272.8	3.70
5	35.00	34.95	791.41	1254.2	3.71
6	25.00	24.98	798.78	1291.4	3.68
7	15.00	15.00	806.24	1329.1	3.71
8	5.00	5.03	814.42	1368.2	4.05
9	20.00	20.00	802.51	1310.3	3.70
10	50.00	49.91	780.31	1199.2	3.82
11	60.00	59.88	772.86	1163.3	3.95

Sample Details and Data

Sample Name:	Naphtha LSR	**Sample Number:**	72
Sample Type:	Distillate	**Sample date :**	29/10/2001

Damping Curve



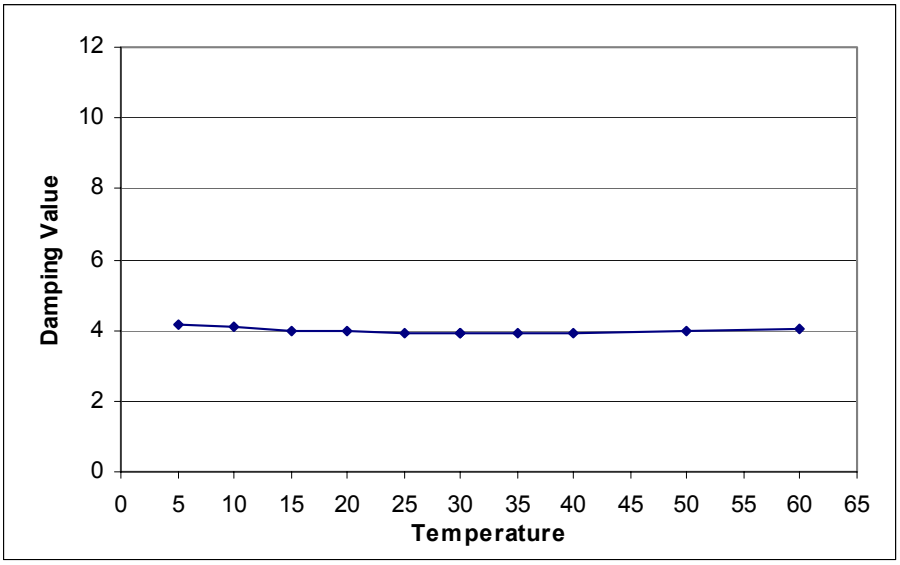
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	728.05	1150.8	3.25
2	35.00	34.95	723.72	1130.2	3.28
3	10.00	10.02	745.14	1234.6	3.09
4	40.00	39.94	719.34	1109.9	3.36
5	5.00	5.03	749.34	1255.6	3.09
6	60.00	59.89	701.67	1029.0	3.65
7	25.00	24.97	732.31	1171.9	3.20
8	15.00	15.00	740.86	1213.6	3.15
9	20.00	19.99	736.59	1192.8	3.17
10	50.00	49.91	710.56	1069.4	3.49
11	30.00	29.96	728.01	1151.2	3.26

Sample Details and Data

Sample Name:	Fuel Oil Domestic	**Sample Number:**	73
Sample Type:	Gas oil	**Sample date :**	17/11/2001

Damping Curve



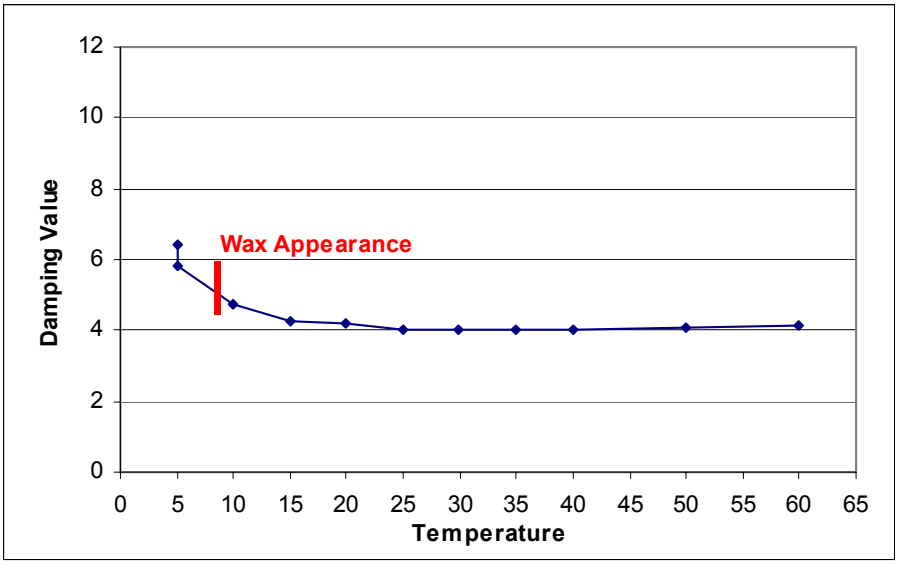
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	843.28	1353.2	3.92
2	10.00	10.02	857.28	1425.1	4.07
3	35.00	34.95	839.79	1335.2	3.91
4	50.00	49.91	829.29	1282.3	3.98
5	25.00	24.97	846.78	1370.8	3.95
6	40.00	39.94	836.29	1317.5	3.91
7	5.00	5.03	860.78	1443.2	4.17
8	20.00	19.99	850.28	1388.7	3.96
9	15.00	15.00	853.78	1406.7	4.00
10	60.00	59.88	822.29	1247.3	4.07
11	30.00	29.96	843.29	1352.5	3.92

Sample Details and Data

Sample Name:	Welton	**Sample Number:**	75
Sample Type:	Crude oil	**Sample date :**	08/12/2001

Damping Curve



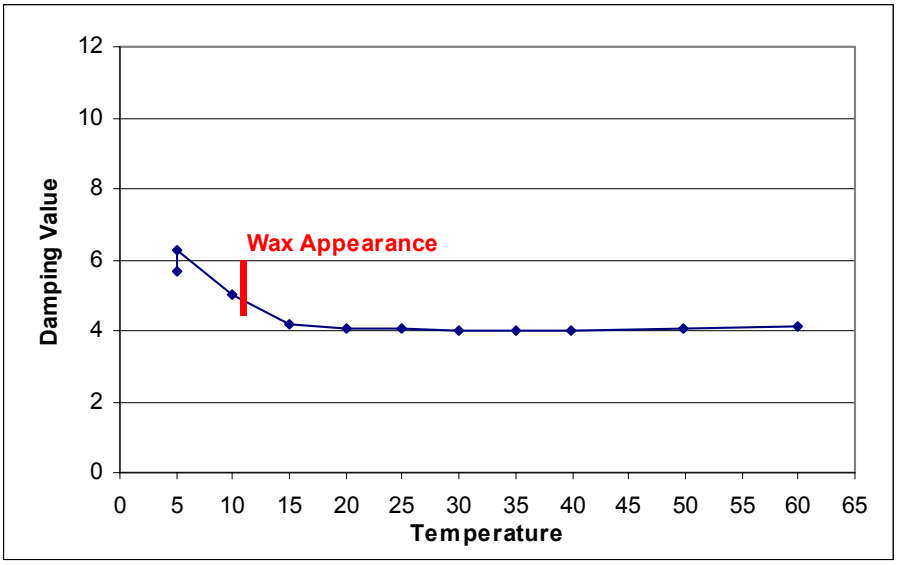
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	847.03	1403.6	6.43
2	40.00	39.94	820.81	1273.5	4.02
3	50.00	49.91	813.64	1237.7	4.07
4	25.00	24.97	831.52	1327.8	4.03
5	60.00	59.89	806.44	1202.5	4.16
6	30.00	29.96	827.92	1309.7	4.01
7	10.00	10.02	842.73	1384.0	4.76
8	20.00	19.99	835.21	1346.5	4.20
9	35.00	34.95	824.38	1291.5	4.02
10	15.00	15.00	838.81	1364.7	4.27
11	5.00	5.03	846.82	1403.4	5.83

Sample Details and Data

Sample Name:	Ekofisk	**Sample Number:**	76
Sample Type:	Crude oil	**Sample date :**	01/11/2001

Damping Curve



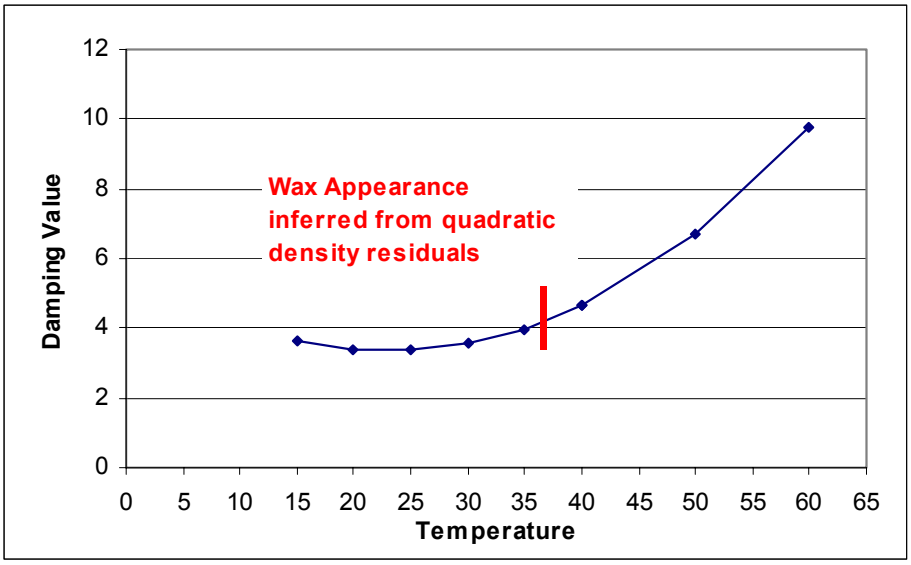
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	845.68	1404.7	6.27
2	30.00	29.97	826.63	1310.9	4.03
3	10.00	10.02	841.51	1385.0	4.99
4	40.00	39.94	819.39	1274.5	4.01
5	35.00	34.95	822.98	1292.4	4.02
6	60.00	59.88	804.95	1203.3	4.14
7	15.00	15.00	837.51	1365.8	4.20
8	50.00	49.91	812.17	1238.6	4.06
9	20.00	19.99	833.80	1347.1	4.08
10	25.00	24.98	830.22	1328.9	4.04
11	5.00	5.03	845.58	1404.3	5.67

Sample Details and Data

Sample Name:	Fuel Oil HS	**Sample Number:**	77
Sample Type:	Fuel oil	**Sample date :**	06/04/2001

Damping Curve



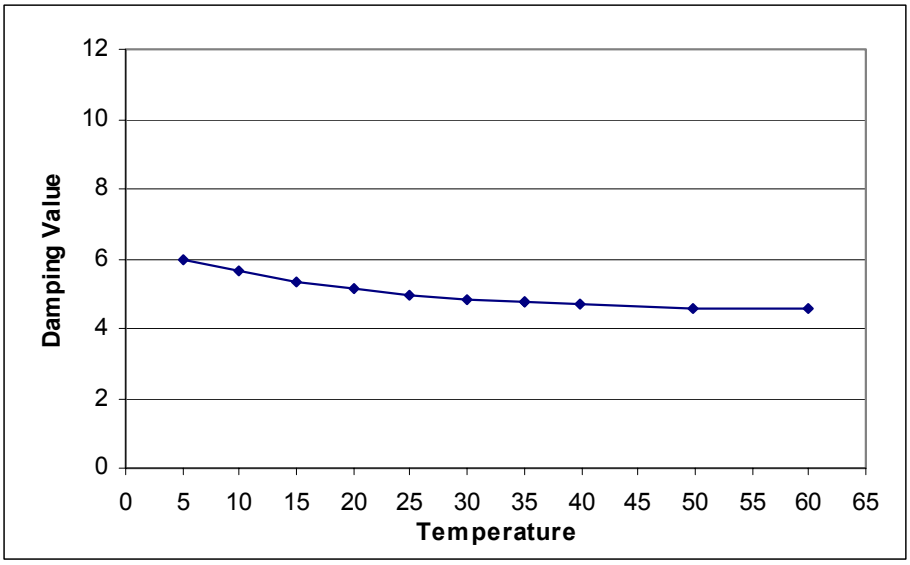
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.93	985.26	1512.1	4.66
2	50.00	49.91	978.74	1465.6	6.72
3	20.00	19.99	999.46	1645.8	3.41
4	15.00	15.00	1003.10	1691.0	3.65
5	35.00	34.95	989.09	1541.7	3.98
6	25.00	24.98	995.75	1605.2	3.41
7	30.00	29.96	992.53	1572.5	3.57
8	60.00	59.88	971.87	1424.0	9.76
9	40.00	39.93	985.33	1512.1	4.64

Sample Details and Data

Sample Name:	Heidrun	**Sample Number:**	78
Sample Type:	Crude oil	**Sample date :**	20/10/2001

Damping Curve



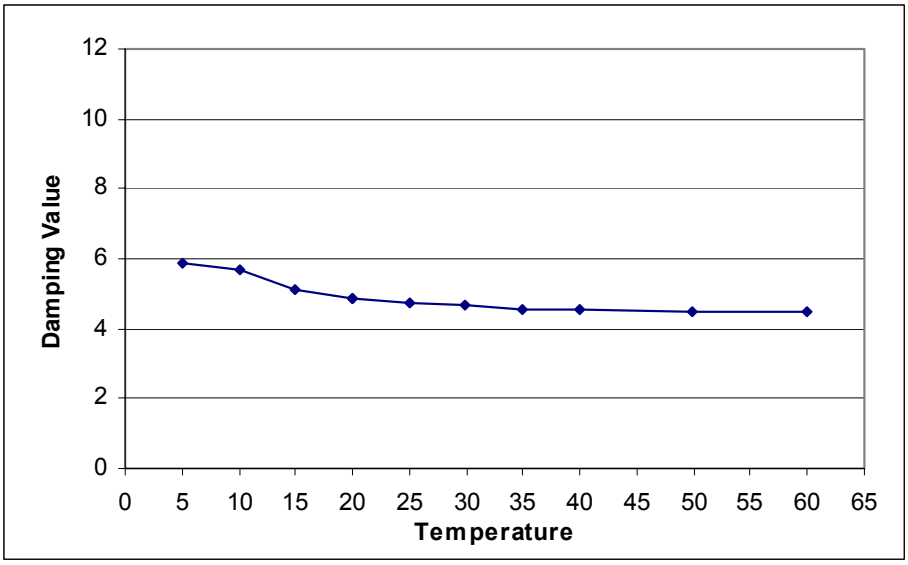
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	876.62	1357.1	4.73
2	10.00	10.02	893.78	1446.2	5.62
3	15.00	15.01	890.35	1428.2	5.36
4	40.00	39.94	873.19	1339.4	4.67
5	60.00	59.88	859.48	1270.3	4.59
6	50.00	49.91	866.33	1304.3	4.59
7	30.00	29.96	880.04	1374.2	4.82
8	20.00	19.99	886.90	1409.8	5.15
9	25.00	24.98	883.47	1392.0	4.97
10	5.00	5.03	897.26	1464.1	5.96
11	35.00	34.95	876.62	1356.8	4.75

Sample Details and Data

Sample Name:	Glitne	**Sample Number:**	79
Sample Type:	Crude oil	**Sample date :**	07/10/2001

Damping Curve



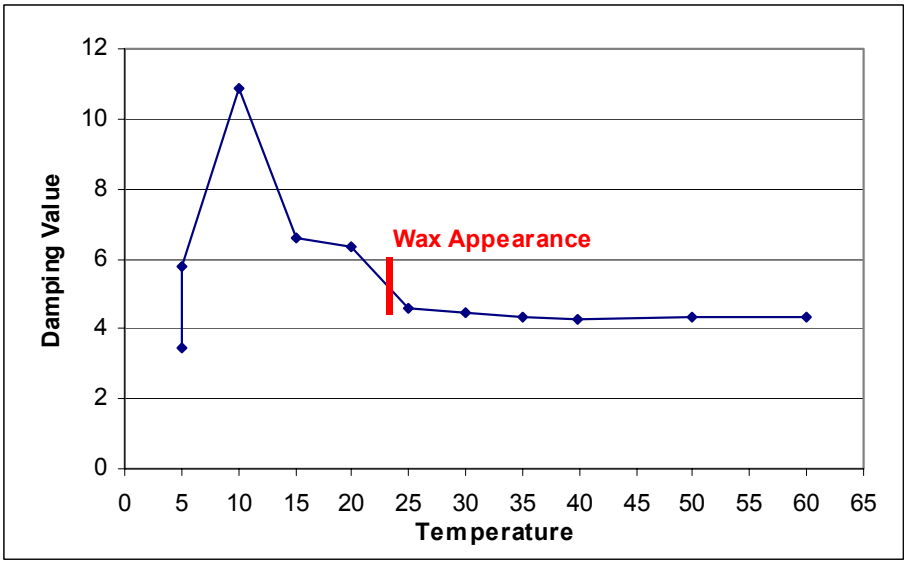
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	860.39	1383.7	4.86
2	40.00	39.94	846.44	1312.4	4.53
3	35.00	34.95	849.91	1330.0	4.56
4	15.00	15.00	863.93	1401.7	5.09
5	10.00	10.02	867.88	1420.8	5.66
6	60.00	59.88	832.58	1242.8	4.49
7	50.00	49.91	839.52	1277.0	4.48
8	30.00	29.96	853.37	1347.3	4.65
9	5.00	5.03	871.96	1440.2	5.85
10	25.00	24.98	856.88	1365.3	4.77
11	20.00	19.99	860.35	1383.1	4.88

Sample Details and Data

Sample Name:	Norne	**Sample Number:**	80
Sample Type:	Crude oil	**Sample date :**	30/09/2001

Damping Curve



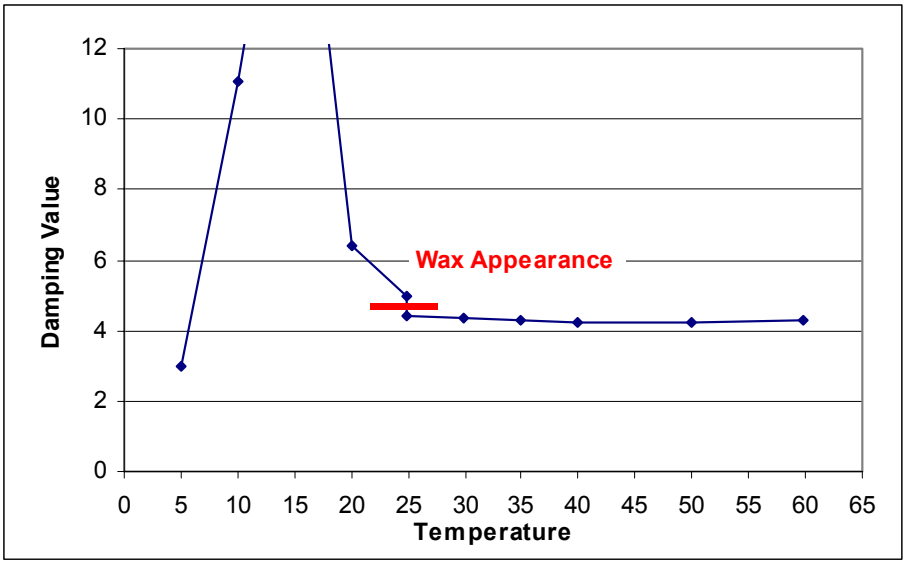
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	873.01	1457.1	3.45
2	35.00	34.96	847.38	1360.6	4.32
3	25.00	24.98	854.40	1386.8	4.58
4	30.00	29.97	850.87	1373.6	4.43
5	40.00	39.94	843.87	1347.2	4.30
6	20.00	19.99	858.55	1402.1	6.36
7	60.00	59.88	830.00	1319.6	4.35
8	10.00	10.02	867.56	1438.4	10.90
9	50.00	49.91	836.94	1344.1	4.31
10	15.00	15.00	863.00	1421.6	6.58
11	5.00	5.03	872.73	1457.8	5.78

Sample Details and Data

Sample Name:	Norne	**Sample Number:**	81
Sample Type:	Crude oil	**Sample date :**	13/10/2001

Damping Curve



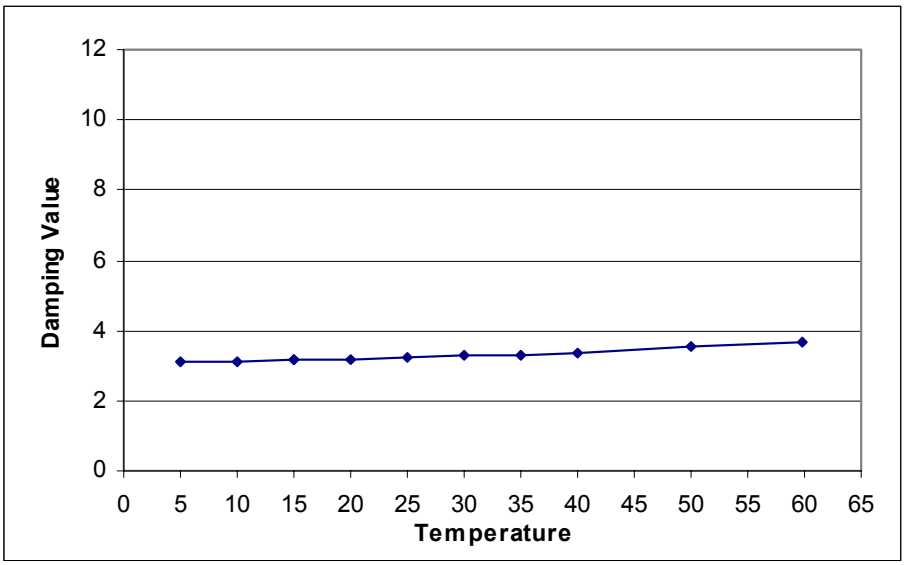
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	853.30	1378.2	4.97
2	15.00	15.00	860.53	1417.1	20.56
3	40.00	39.94	841.90	1322.1	4.23
4	50.00	49.91	834.96	1286.6	4.25
5	10.00	10.02	866.17	1436.0	11.06
6	30.00	29.97	849.08	1357.4	4.38
7	5.00	5.03	871.69	1468.3	2.97
8	35.00	34.96	845.46	1341.8	4.27
9	20.00	19.99	857.02	1400.4	6.39
10	60.00	59.88	828.05	1253.8	4.31
11	25.00	24.97	852.61	1377.9	4.42

Sample Details and Data

Sample Name:	High Cat Cracked Spirit	**Sample Number:**	82
Sample Type:	Distillate	**Sample date :**	25/12/2001

Damping Curve



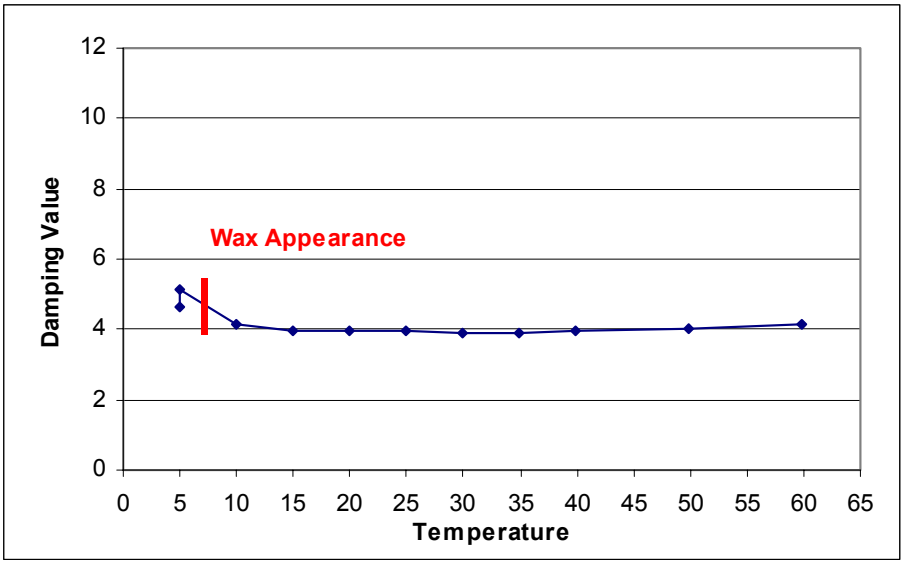
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	778.20	1252.0	3.16
2	10.00	10.02	782.45	1272.8	3.13
3	5.00	5.03	786.68	1293.5	3.10
4	50.00	49.91	747.96	1110.3	3.53
5	60.00	59.88	739.13	1070.6	3.68
6	25.00	24.97	769.63	1211.2	3.24
7	40.00	39.94	756.68	1150.4	3.36
8	35.00	34.95	761.02	1170.6	3.32
9	20.00	19.99	773.91	1231.7	3.20
10	30.00	29.97	765.33	1190.9	3.27
11	15.00	15.00	778.18	1252.3	3.15

Sample Details and Data

Sample Name:	Welton	**Sample Number:**	83
Sample Type:	Crude oil	**Sample date :**	07/09/2001

Damping Curve



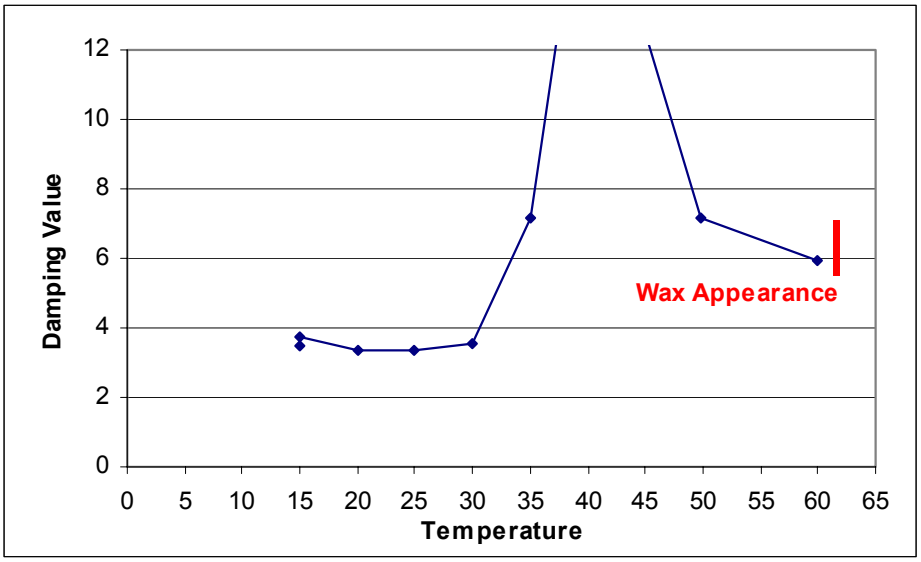
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	834.01	1375.8	5.13
2	40.00	39.94	807.51	1243.7	3.93
3	60.00	59.88	792.67	1171.5	4.14
4	15.00	15.00	825.91	1336.7	3.98
5	25.00	24.98	818.57	1299.2	3.93
6	35.00	34.95	811.19	1262.1	3.93
7	10.00	10.02	829.87	1355.7	4.16
8	20.00	19.99	822.30	1317.9	3.97
9	50.00	49.91	800.12	1207.2	4.02
10	30.00	29.96	814.83	1280.5	3.92
11	5.00	5.03	833.95	1375.5	4.62

Sample Details and Data

Sample Name:	Vacuum Gas Oil	**Sample Number:**	84
Sample Type:	Gas oil	**Sample date :**	29/01/2002

Damping Curve



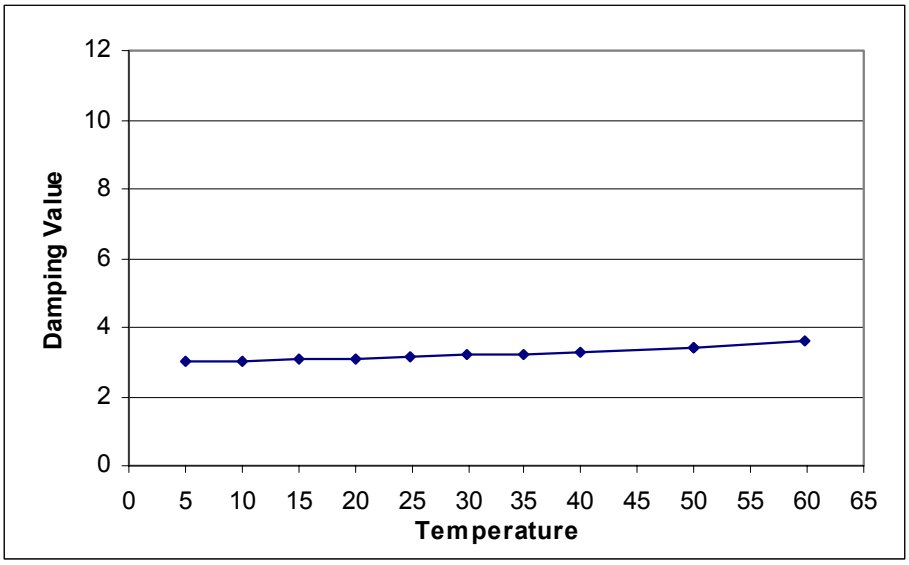
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	900.83	1542.7	3.49
2	40.00	39.94	890.33	1419.2	18.15
3	25.00	24.97	903.20	1486.5	3.35
4	50.00	49.91	885.03	1383.3	7.14
5	60.00	59.88	879.10	1350.2	5.97
6	20.00	19.99	910.13	1513.4	3.34
7	35.00	34.95	896.45	1438.6	7.19
8	30.00	29.96	901.10	1460.6	3.53
9	15.00	15.00	914.39	1543.1	3.72

Sample Details and Data

Sample Name:	Motor Spirit Premium	**Sample Number:**	85
Sample Type:	Gasoline	**Sample date :**	13/10/2001

Damping Curve



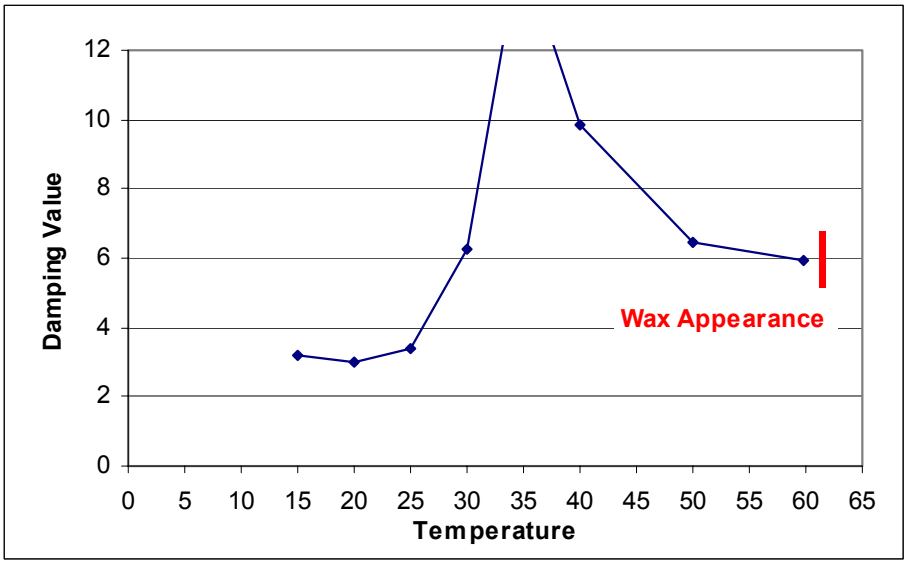
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	693.62	1007.6	3.43
2	60.00	59.88	683.80	964.9	3.60
3	10.00	10.02	731.27	1180.9	3.02
4	30.00	29.97	712.73	1094.1	3.18
5	5.00	5.03	735.84	1202.7	3.00
6	20.00	19.99	722.04	1137.2	3.07
7	15.00	15.00	726.66	1158.8	3.06
8	35.00	34.95	707.98	1072.1	3.23
9	40.00	39.94	703.22	1050.6	3.31
10	25.00	24.98	717.38	1115.1	3.14
11	50.00	49.91	693.59	1007.9	3.44

Sample Details and Data

Sample Name:	Vacuum Gas Oil LS	**Sample Number:**	86
Sample Type:	Gas oil	**Sample date :**	28/10/2001

Damping Curve



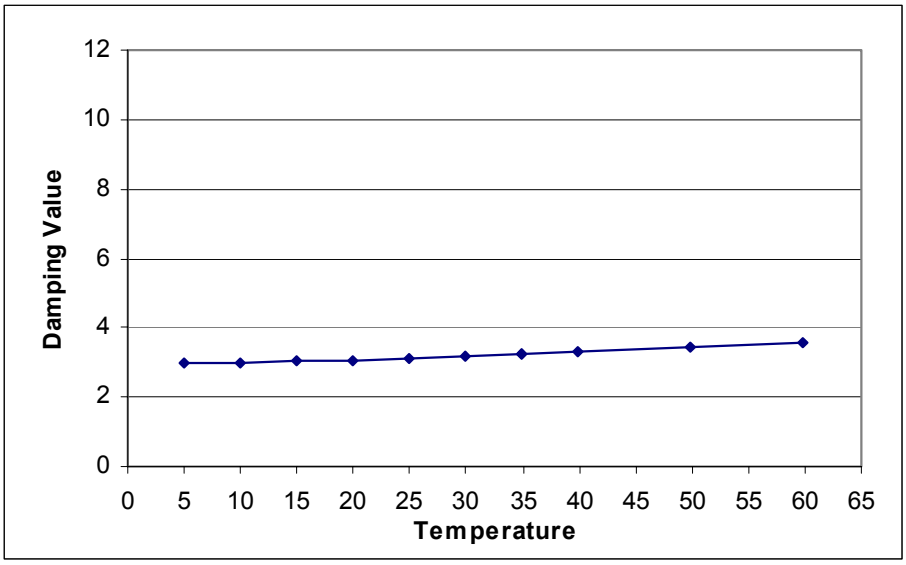
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	897.95	1438.1	15.61
2	50.00	49.91	888.15	1384.0	6.44
3	15.00	15.00	917.03	1541.6	3.21
4	25.00	24.98	908.42	1485.6	3.39
5	30.00	29.96	903.58	1461.1	6.27
6	40.00	39.94	895.08	1419.8	9.88
7	60.00	59.88	881.79	1350.8	5.93
8	20.00	19.99	912.70	1511.2	3.00
9	35.00	34.95	898.44	1438.7	14.72

Sample Details and Data

Sample Name:	Naphtha LSR	**Sample Number:**	87
Sample Type:	Distillate	**Sample date :**	22/10/2001

Damping Curve



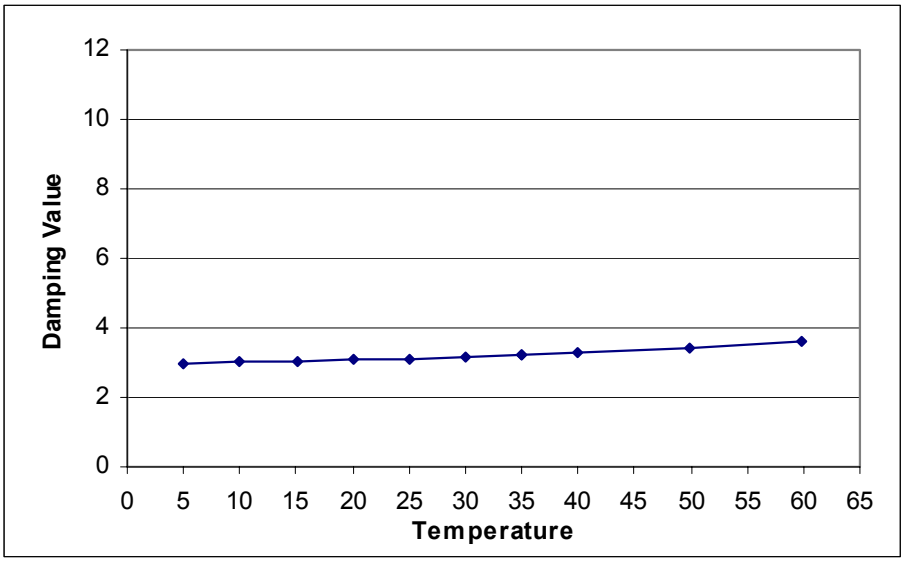
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	654.62	1019.4	3.22
2	60.00	59.88	629.54	907.1	3.59
3	5.00	5.03	683.04	1154.8	2.99
4	50.00	49.91	639.75	951.7	3.44
5	40.00	39.93	649.72	996.6	3.30
6	15.00	15.00	673.72	1109.2	3.03
7	25.00	24.98	664.23	1063.9	3.12
8	10.00	10.02	678.39	1132.0	3.00
9	20.00	19.99	668.99	1086.6	3.07
10	30.00	29.97	659.43	1041.4	3.18
11	35.00	34.95	654.58	1018.8	3.24

Sample Details and Data

Sample Name:	Naphtha	**Sample Number:**	88
Sample Type:	Distillate	**Sample date :**	18/10/2001

Damping Curve



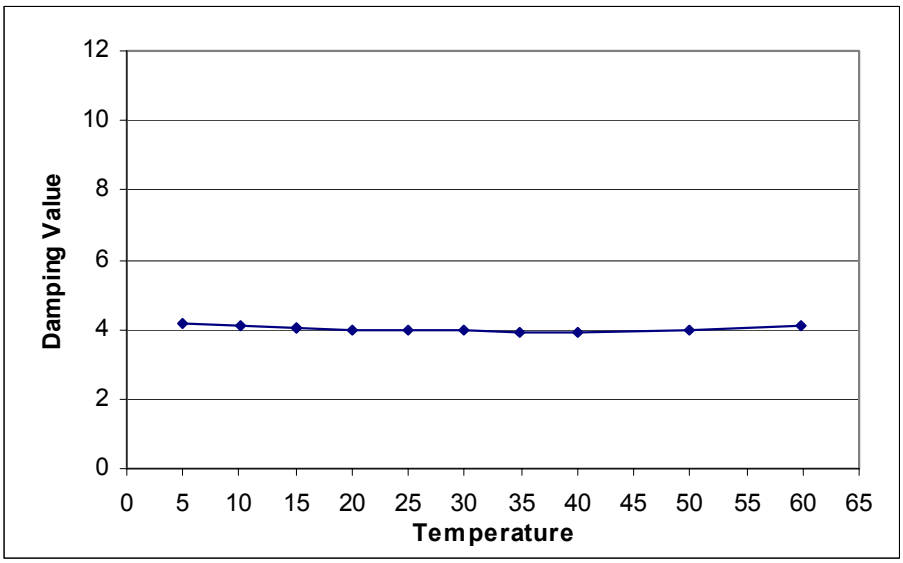
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	657.65	1023.3	3.23
2	20.00	19.99	672.01	1091.1	3.08
3	10.00	10.02	681.40	1136.9	3.01
4	25.00	24.98	667.27	1068.9	3.10
5	5.00	5.03	686.00	1159.3	2.97
6	15.00	15.01	676.69	1113.8	3.03
7	60.00	59.89	632.65	911.7	3.60
8	50.00	49.91	642.74	955.4	3.45
9	40.00	39.93	652.71	1000.6	3.30
10	30.00	29.96	662.44	1045.6	3.17
11	35.00	34.95	657.60	1023.1	3.23

Sample Details and Data

Sample Name:	Fuel Oil Domestic (Base)	**Sample Number:**	89
Sample Type:	Gas oil	**Sample date :**	18/01/2002

Damping Curve



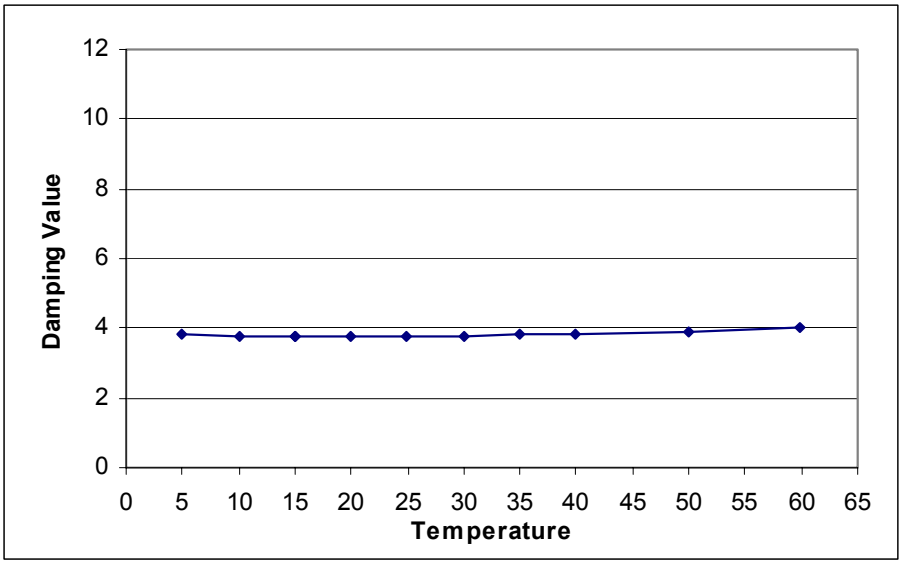
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	873.39	1417.7	4.03
2	25.00	24.98	866.37	1381.6	3.95
3	35.00	34.95	859.34	1345.5	3.93
4	10.00	10.02	876.91	1435.5	4.08
5	40.00	39.94	855.82	1327.8	3.94
6	60.00	59.88	841.70	1257.8	4.08
7	50.00	49.91	848.76	1292.9	4.00
8	5.00	5.03	880.42	1453.5	4.18
9	30.00	29.97	862.86	1363.2	3.95
10	20.00	19.99	869.89	1398.9	3.99
11	15.00	15.01	873.41	1417.0	4.02

Sample Details and Data

Sample Name:	Aktobinsk	**Sample Number:**	90
Sample Type:	Crude oil	**Sample date :**	28/01/2002

Damping Curve



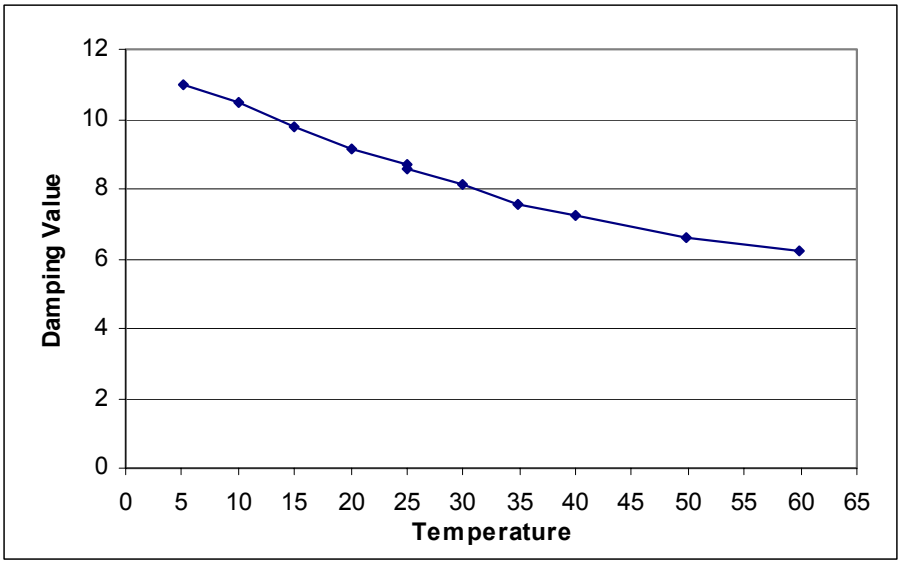
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.01	816.11	1324.8	3.79
2	5.00	5.03	823.49	1364.7	3.83
3	25.00	24.98	808.69	1286.4	3.78
4	10.00	10.02	819.72	1344.7	3.79
5	30.00	29.97	804.96	1267.6	3.77
6	20.00	19.99	812.34	1305.5	3.76
7	35.00	34.95	801.26	1248.8	3.83
8	50.00	49.91	790.09	1194.3	3.92
9	40.00	39.93	797.54	1230.1	3.86
10	60.00	59.88	782.59	1159.2	4.01
11	15.00	15.01	816.00	1324.9	3.79

Sample Details and Data

Sample Name:	Maya	**Sample Number:**	91
Sample Type:	Crude oil	**Sample date :**	28/12/2001

Damping Curve



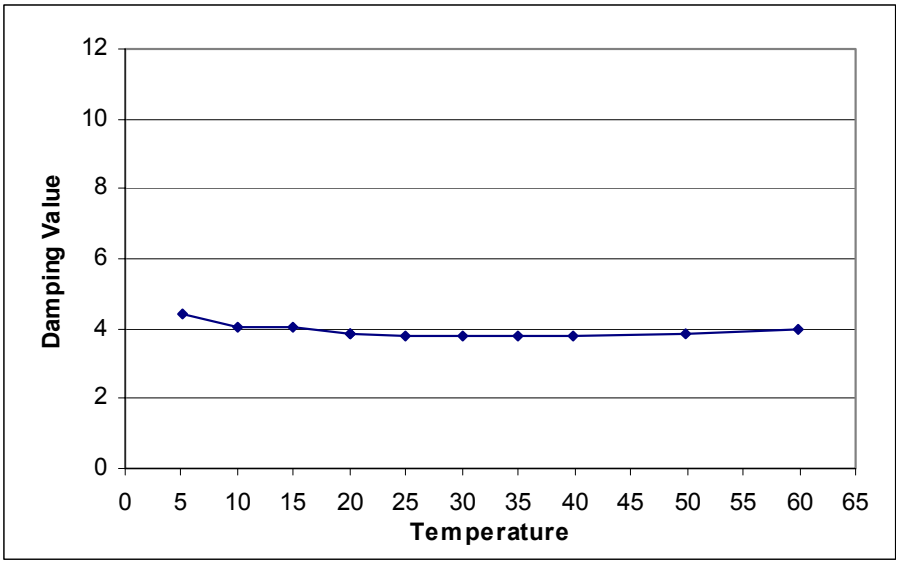
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	919.16	1404.1	8.69
2	30.00	29.96	915.63	1385.6	8.11
3	40.00	39.94	908.67	1350.0	7.25
4	60.00	59.88	894.82	1281.0	6.21
5	35.00	34.95	911.97	1366.6	7.58
6	50.00	49.91	901.69	1314.8	6.61
7	10.00	10.02	929.58	1458.3	10.46
8	5.00	5.03	933.24	1478.0	10.97
9	20.00	19.99	922.63	1421.4	9.17
10	15.00	15.00	926.03	1439.3	9.79
11	25.00	24.98	919.09	1402.9	8.56

Sample Details and Data

Sample Name:	Galeota blend	**Sample Number:**	92
Sample Type:	Crude oil	**Sample date :**	06/12/2001

Damping Curve



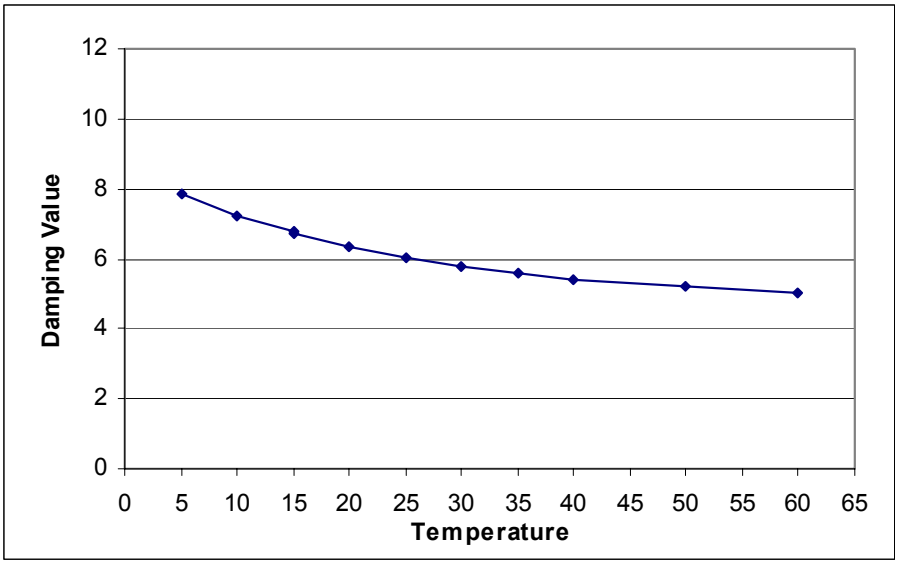
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	835.28	1349.3	3.84
2	40.00	39.94	820.82	1276.6	3.80
3	35.00	34.95	824.43	1294.3	3.80
4	10.00	10.02	843.32	1387.7	4.04
5	50.00	49.91	813.59	1240.9	3.87
6	60.00	59.88	806.33	1205.4	3.98
7	5.00	5.03	847.54	1407.5	4.42
8	25.00	24.98	831.69	1331.4	3.80
9	30.00	29.96	828.08	1313.2	3.80
10	15.00	15.00	839.20	1368.3	4.06
11	20.00	19.99	835.35	1349.7	3.86

Sample Details and Data

Sample Name:	D/SLTD	**Sample Number:**	93
Sample Type:	Fuel oil	**Sample date :**	30/12/2001

Damping Curve



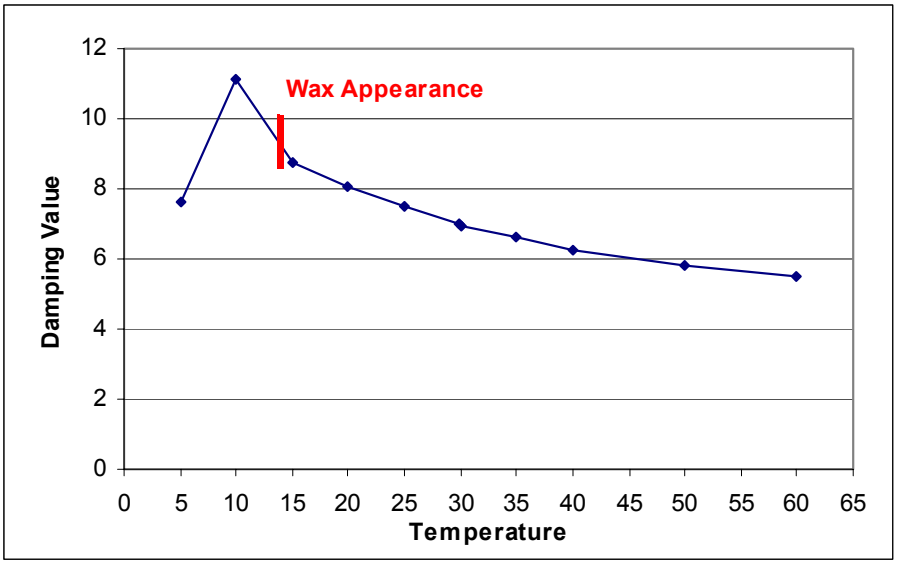
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	927.62	1448.9	6.76
2	50.00	49.91	903.60	1327.3	5.19
3	5.00	5.03	934.51	1485.4	7.83
4	40.00	39.94	910.47	1361.7	5.39
5	20.00	19.99	924.18	1431.1	6.37
6	60.00	59.88	896.73	1293.4	5.03
7	30.00	29.96	917.31	1395.7	5.80
8	35.00	34.95	913.89	1378.5	5.58
9	25.00	24.98	920.74	1413.3	6.05
10	10.00	10.02	931.06	1467.0	7.23
11	15.00	15.01	927.62	1449.2	6.74

Sample Details and Data

Sample Name:	Vacuum Gas Oil	**Sample Number:**	94
Sample Type:	Gas oil	**Sample date :**	13/12/2001

Damping Curve



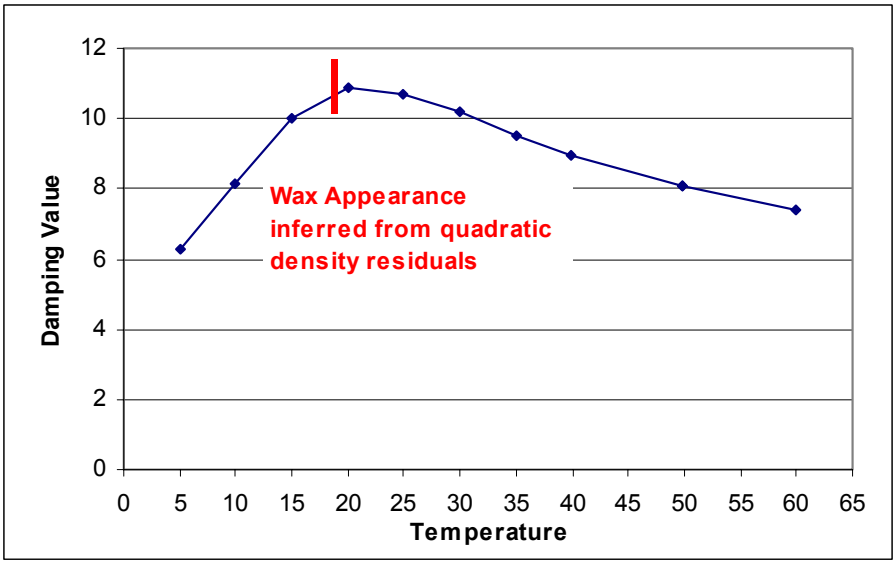
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	935.01	1442.1	7.00
2	20.00	19.99	941.68	1477.0	8.09
3	40.00	39.94	928.37	1407.9	6.26
4	5.00	5.03	952.23	1534.8	7.62
5	50.00	49.91	921.75	1374.1	5.80
6	25.00	24.97	938.35	1458.5	7.50
7	15.00	15.00	945.01	1494.2	8.77
8	60.00	59.89	915.16	1341.0	5.52
9	35.00	34.95	931.69	1424.1	6.61
10	10.00	10.02	948.29	1513.5	11.11
11	30.00	29.97	935.02	1441.4	6.96

Sample Details and Data

Sample Name:	Coban	**Sample Number:**	95
Sample Type:	Crude oil	**Sample date :**	26/12/2001

Damping Curve



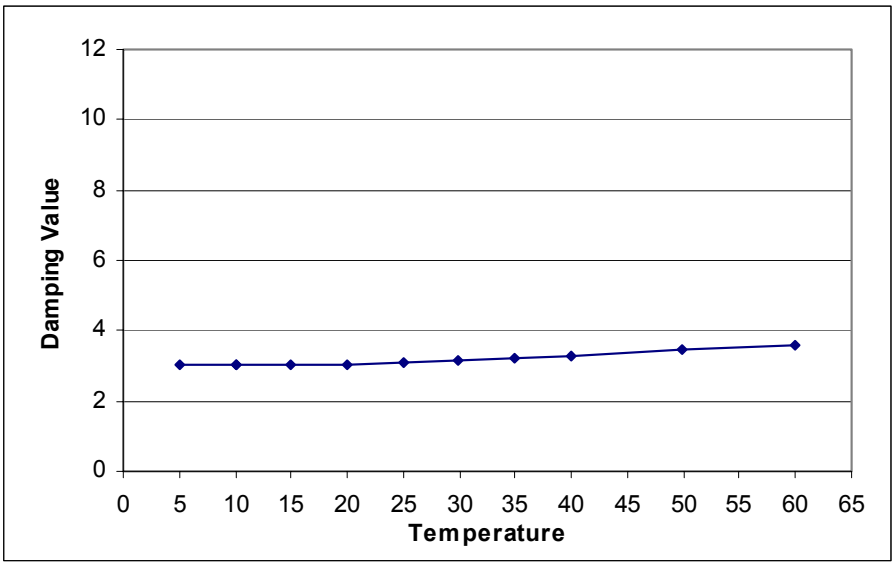
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	936.14	1342.6	8.11
2	15.00	15.00	960.59	1469.6	10.02
3	10.00	10.02	964.53	1490.7	8.16
4	60.00	59.89	929.28	1308.3	7.42
5	35.00	34.95	946.19	1393.2	9.52
6	40.00	39.94	942.85	1376.3	8.98
7	20.00	19.99	956.74	1448.9	10.85
8	25.00	24.98	953.38	1430.9	10.70
9	30.00	29.96	949.91	1412.4	10.23
10	5.00	5.03	968.61	1512.6	6.28
11	50.00	49.91	936.10	1341.8	8.09

Sample Details and Data

Sample Name:	Gasoline M1-315 (blend 025060)	**Sample Number:**	96
Sample Type:	Gasoline	**Sample date :**	02/02/2002

Damping Curve



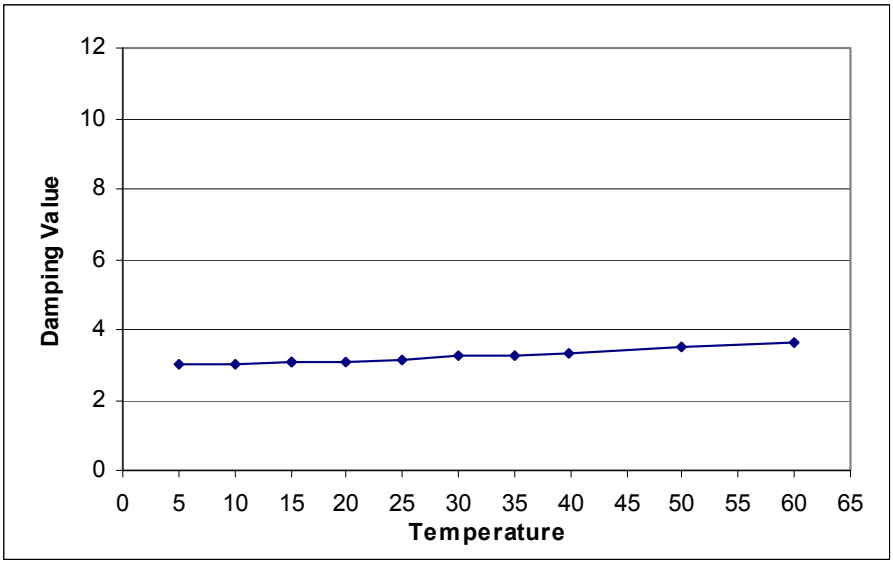
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	745.32	1215.5	3.03
2	25.00	24.98	732.23	1152.2	3.12
3	60.00	59.88	700.81	1007.9	3.59
4	50.00	49.91	709.94	1048.5	3.44
5	35.00	34.95	723.40	1110.3	3.24
6	5.00	5.03	749.63	1236.6	3.03
7	15.00	15.01	740.98	1194.4	3.02
8	20.00	19.99	736.62	1173.4	3.05
9	30.00	29.97	727.84	1131.6	3.15
10	40.00	39.94	718.96	1090.1	3.29
11	10.00	10.02	745.31	1215.5	3.02

Sample Details and Data

Sample Name:	Gasoline #2 Coker	**Sample Number:**	97
Sample Type:	Gasoline	**Sample date :**	30/12/2001

Damping Curve



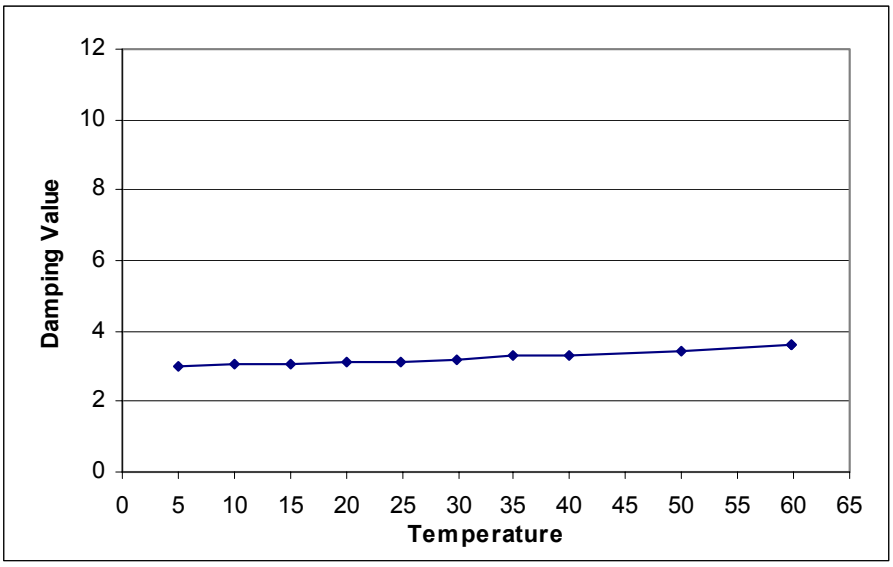
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	735.35	1197.0	3.06
2	10.00	10.02	739.69	1218.0	3.02
3	20.00	19.99	731.00	1176.2	3.10
4	50.00	49.91	704.37	1052.4	3.49
5	30.00	29.96	722.24	1134.4	3.24
6	40.00	39.94	713.36	1093.3	3.33
7	5.00	5.03	743.98	1238.7	3.02
8	35.00	34.95	717.77	1113.4	3.27
9	60.00	59.88	695.20	1011.2	3.61
10	25.00	24.97	726.60	1154.6	3.16
11	15.00	15.00	735.33	1196.4	3.07

Sample Details and Data

Sample Name:	Gasoline M3-351 (blend 02N180)	**Sample Number:**	98
Sample Type:	Gasoline	**Sample date :**	28/02/2002

Damping Curve



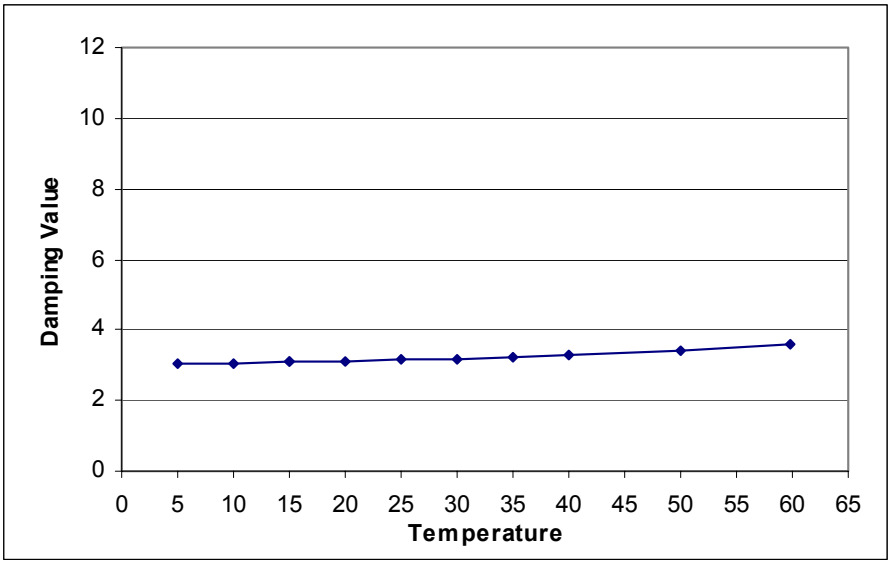
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	700.88	1005.0	3.64
2	35.00	34.95	723.66	1108.2	3.28
3	40.00	39.94	719.16	1087.4	3.33
4	25.00	24.97	732.56	1150.1	3.15
5	30.00	29.96	728.12	1129.2	3.18
6	50.00	49.91	710.07	1046.0	3.45
7	15.00	15.00	741.40	1192.3	3.09
8	20.00	19.99	737.03	1171.3	3.11
9	5.00	5.03	750.09	1234.6	3.03
10	10.00	10.02	745.73	1213.4	3.04
11	60.00	59.89	700.74	1004.5	3.61

Sample Details and Data

Sample Name:	Gasoline	**Sample Number:**	99
Sample Type:	Gasoline	**Sample date :**	25/02/2002

Damping Curve



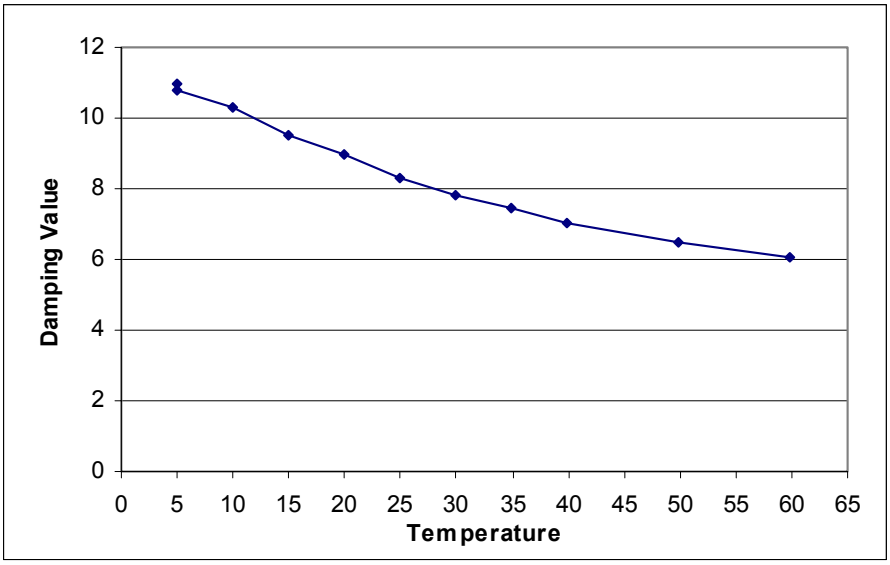
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	747.92	1190.6	3.09
2	25.00	24.98	739.07	1148.5	3.17
3	60.00	59.88	707.24	1003.5	3.58
4	50.00	49.91	716.50	1044.4	3.43
5	40.00	39.93	725.63	1085.7	3.29
6	10.00	10.02	752.33	1211.8	3.06
7	5.00	5.03	756.70	1233.1	3.03
8	20.00	19.99	743.51	1169.6	3.13
9	30.00	29.97	734.62	1127.5	3.19
10	35.00	34.95	730.14	1106.6	3.24
11	15.00	15.00	747.93	1190.6	3.10

Sample Details and Data

Sample Name:	Maya	**Sample Number:**	101
Sample Type:	Crude oil	**Sample date :**	24/10/2001

Damping Curve



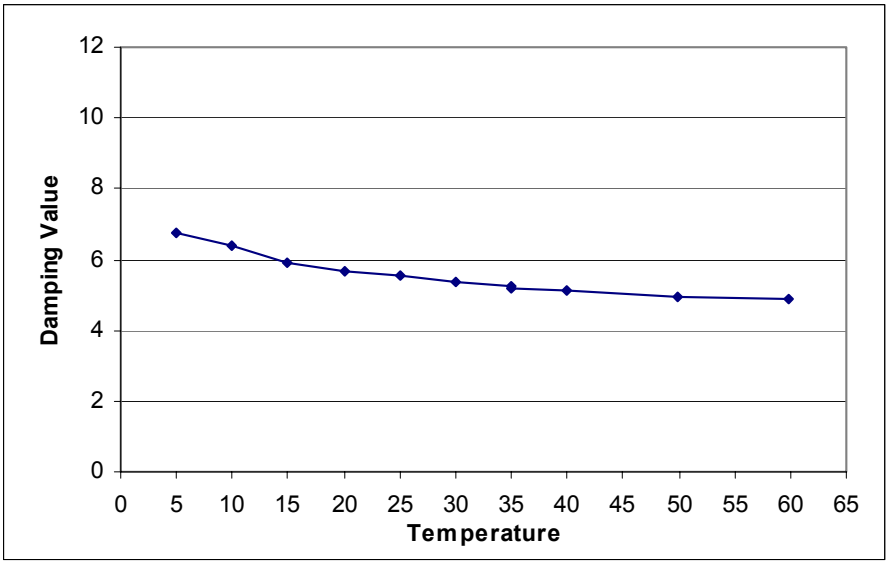
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	931.82	1477.4	10.97
2	35.00	34.95	910.71	1366.1	7.43
3	15.00	15.00	924.43	1437.4	9.52
4	10.00	10.02	928.09	1456.7	10.30
5	20.00	19.99	921.15	1419.8	8.96
6	60.00	59.89	893.36	1279.1	6.09
7	40.00	39.93	907.09	1347.2	7.06
8	30.00	29.96	913.97	1382.4	7.81
9	50.00	49.91	900.24	1312.9	6.49
10	25.00	24.97	917.46	1400.2	8.30
11	5.00	5.03	931.80	1475.9	10.78

Sample Details and Data

Sample Name:	Arab Medium	**Sample Number:**	102
Sample Type:	Crude oil	**Sample date :**	29/10/2001

Damping Curve



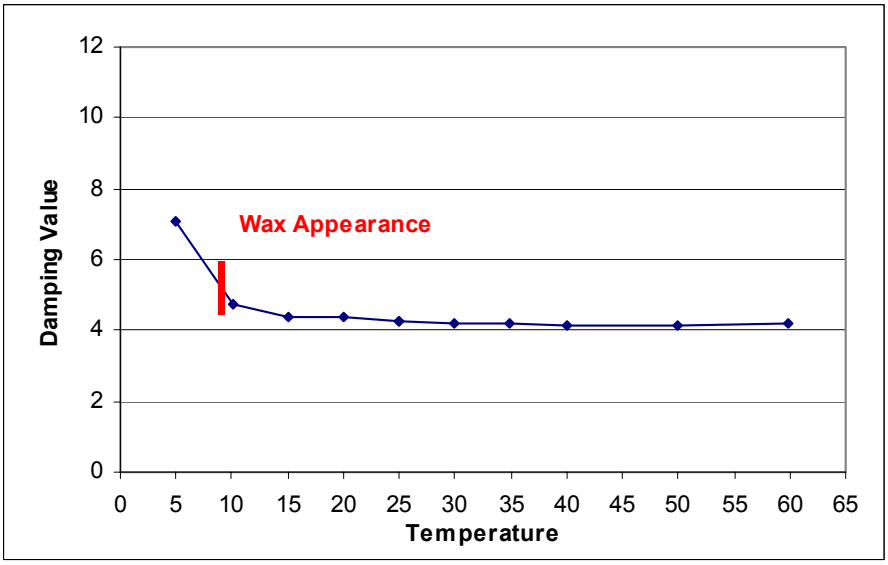
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	873.67	1329.0	5.23
2	50.00	49.91	863.18	1276.7	4.95
3	60.00	59.88	856.18	1242.4	4.88
4	30.00	29.96	877.15	1346.1	5.37
5	40.00	39.94	870.16	1311.1	5.13
6	25.00	24.98	880.64	1363.9	5.52
7	15.00	15.00	887.64	1399.8	5.93
8	5.00	5.03	895.31	1436.8	6.74
9	10.00	10.02	891.75	1418.4	6.38
10	20.00	19.99	884.28	1381.1	5.70
11	35.00	34.95	873.65	1327.5	5.21

Sample Details and Data

Sample Name:	Forcados	**Sample Number:**	103
Sample Type:	Crude oil	**Sample date :**	01/12/2001

Damping Curve



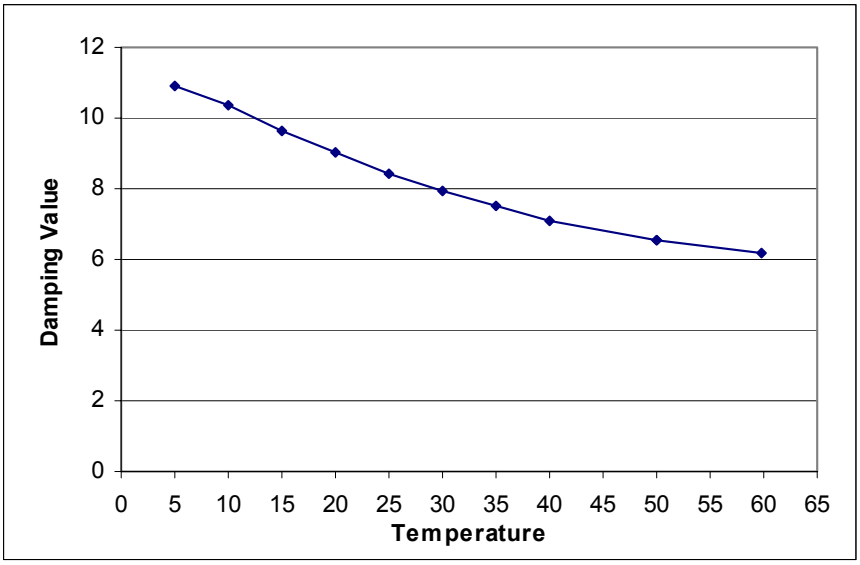
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	864.65	1364.7	4.27
2	35.00	34.95	857.63	1329.3	4.18
3	5.00	5.03	880.28	1440.4	7.08
4	60.00	59.88	840.08	1241.4	4.21
5	50.00	49.91	847.10	1275.5	4.15
6	15.00	15.00	871.67	1400.9	4.39
7	40.00	39.94	854.13	1311.4	4.15
8	10.00	10.02	875.85	1420.6	4.71
9	20.00	19.99	868.30	1383.3	4.35
10	30.00	29.97	861.15	1347.1	4.22
11	25.00	24.98	864.65	1364.6	4.26

Sample Details and Data

Sample Name:	Gas Oil HV (lubes)	**Sample Number:**	104
Sample Type:	Gas oil	**Sample date :**	10/12/2001

Damping Curve



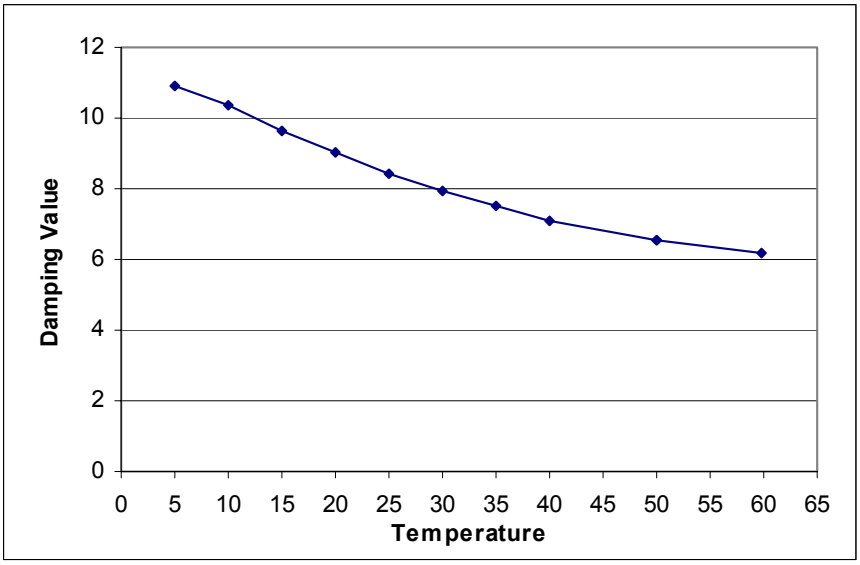
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	947.42	1500.0	3.63
2	40.00	39.94	943.91	1476.2	4.67
3	25.00	24.97	954.64	1559.8	3.22
4	30.00	29.97	951.14	1528.1	3.48
5	50.00	49.91	936.05	1433.1	11.59
6	20.00	19.99	958.28	1597.9	3.21
7	60.00	59.88	928.75	1393.4	9.29
8	15.00	15.00	961.82		3.56
9	35.00	34.95	947.63	1501.3	3.44

Sample Details and Data

Sample Name:	Maya	**Sample Number:**	105
Sample Type:	Crude oil	**Sample date :**	11/12/2001

Damping Curve



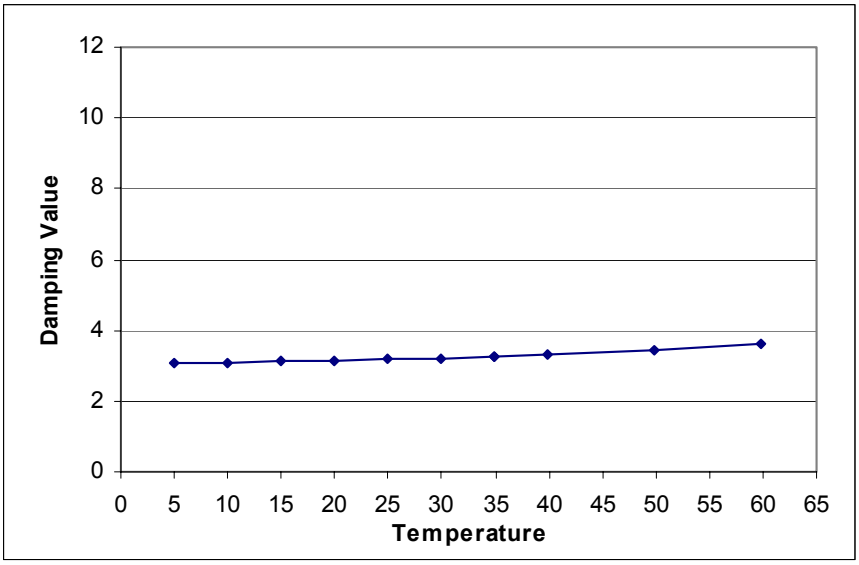
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	900.48	1312.9	6.57
2	35.00	34.95	910.78	1364.8	7.51
3	15.00	15.00	924.66	1437.2	9.62
4	10.00	10.02	928.28	1456.5	10.35
5	20.00	19.99	921.35	1419.6	9.05
6	30.00	29.97	914.34	1383.3	7.94
7	60.00	59.88	893.61	1279.1	6.15
8	25.00	24.97	917.63	1400.3	8.42
9	5.00	5.03	931.97	1476.2	10.90
10	40.00	39.94	907.38	1347.8	7.11
11	50.00	49.91	900.48	1313.1	6.56

Sample Details and Data

Sample Name:	Reformate	**Sample Number:**	106
Sample Type:	Distillate	**Sample date :**	09/02/2002

Damping Curve



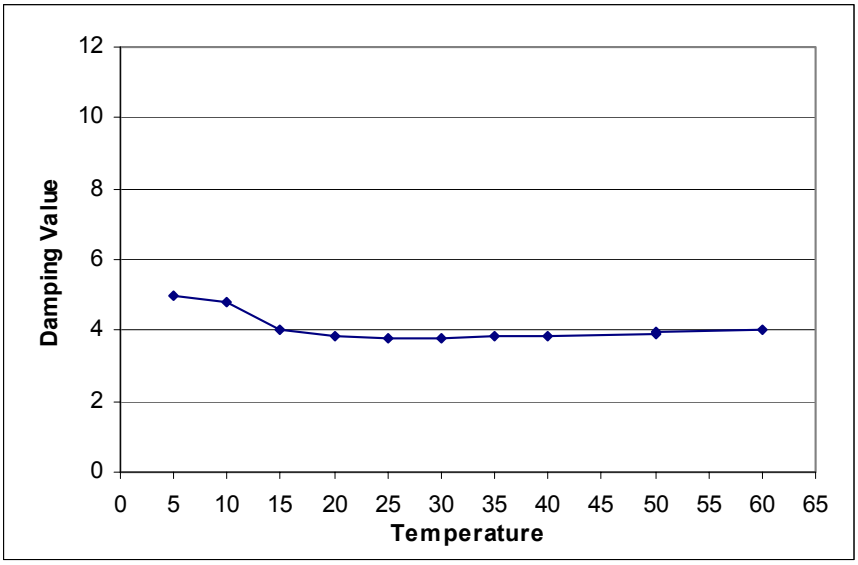
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	770.52	1166.1	3.26
2	50.00	49.91	756.84	1104.4	3.44
3	60.00	59.88	747.58	1063.6	3.59
4	25.00	24.97	779.73	1207.4	3.18
5	5.00	5.03	797.65	1291.1	3.06
6	40.00	39.94	766.28	1144.8	3.31
7	20.00	19.99	784.31	1227.8	3.12
8	10.00	10.02	793.07	1270.2	3.09
9	15.00	15.01	788.62	1249.1	3.11
10	30.00	29.97	775.18	1186.4	3.19
11	35.00	34.95	770.66	1165.7	3.25

Sample Details and Data

Sample Name:	Galeota blend	**Sample Number:**	107
Sample Type:	Crude oil	**Sample date :**	06/12/2001

Damping Curve



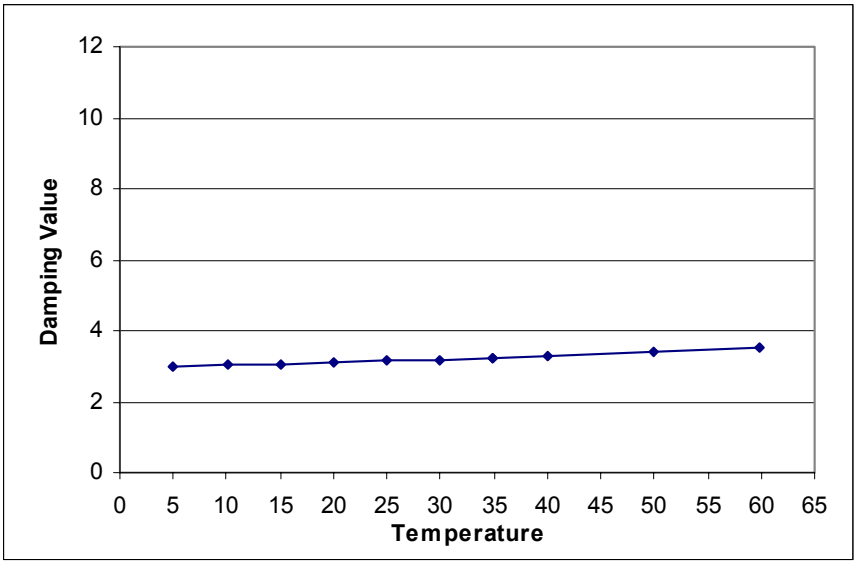
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	50.01	813.76	1241.7	3.93
2	40.00	40.00	821.02	1276.8	3.86
3	20.00	20.00	835.46	1350.4	3.83
4	10.00	10.00	843.46	1390.8	4.78
5	30.00	30.00	828.25	1313.2	3.81
6	60.00	60.00	806.51	1207.5	4.03
7	15.00	15.00	839.32	1369.9	4.05
8	5.00	5.00	847.72	1411.1	4.99
9	25.00	25.00	831.87	1331.7	3.80
10	35.00	35.00	824.65	1294.9	3.83
11	50.00	50.00	813.79	1241.6	3.93

Sample Details and Data

Sample Name:	Gasoline 83CB	**Sample Number:**	108
Sample Type:	Gasoline	**Sample date :**	16/08/2001

Damping Curve



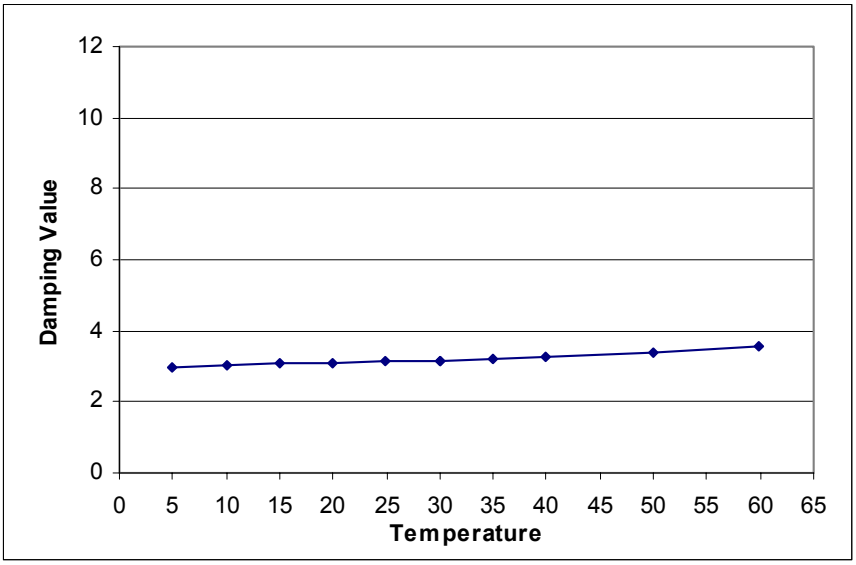
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	713.30	1097.4	3.21
2	15.00	15.00	731.11	1182.1	3.07
3	30.00	29.97	717.80	1118.6	3.16
4	60.00	59.88	690.38	993.7	3.55
5	40.00	39.93	708.79	1076.4	3.29
6	50.00	49.91	699.65	1034.9	3.41
7	20.00	19.99	726.70	1160.8	3.11
8	5.00	5.03	739.88	1225.1	3.00
9	25.00	24.98	722.27	1139.8	3.15
10	10.00	10.02	735.52	1203.7	3.04
11	35.00	34.95	713.33	1097.8	3.20

Sample Details and Data

Sample Name:	Gasoline 87 RFG	**Sample Number:**	109
Sample Type:	Gasoline	**Sample date :**	19/08/2001

Damping Curve



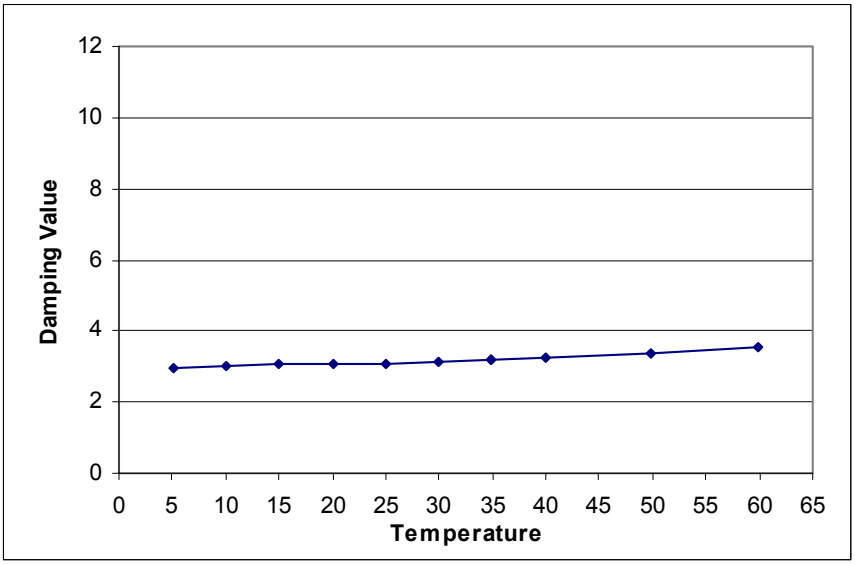
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	726.11	1117.6	3.17
2	60.00	59.89	698.28	992.9	3.56
3	40.00	39.93	716.96	1075.4	3.29
4	20.00	19.99	735.15	1160.0	3.12
5	35.00	34.95	721.57	1096.8	3.22
6	50.00	49.91	707.72	1034.3	3.41
7	25.00	24.97	730.66	1138.7	3.13
8	10.00	10.02	744.10	1202.8	3.03
9	15.00	15.01	739.64	1181.5	3.07
10	5.00	5.03	748.54	1224.4	3.00
11	30.00	29.97	726.14	1118.0	3.17

Sample Details and Data

Sample Name:	Gasoline 87 CONV	**Sample Number:**	110
Sample Type:	Gasoline	**Sample date :**	31/01/2002

Damping Curve



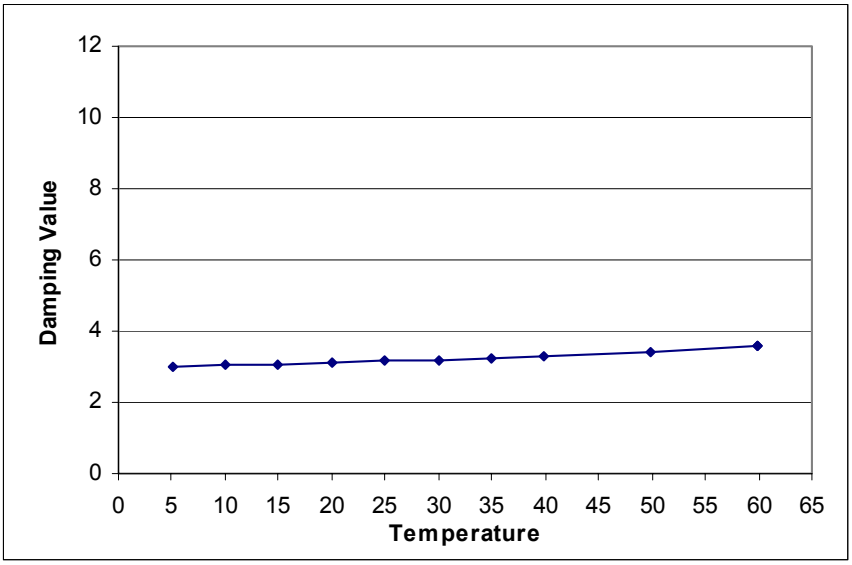
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	709.99	1084.4	3.21
2	60.00	59.88	686.56	980.2	3.54
3	25.00	24.97	719.14	1127.8	3.10
4	40.00	39.94	705.39	1064.7	3.27
5	15.00	15.00	728.21	1172.0	3.07
6	5.00	5.04	737.15	1215.2	2.98
7	50.00	49.91	696.11	1023.5	3.40
8	10.00	10.02	732.71	1193.4	3.02
9	20.00	19.99	723.72	1150.3	3.09
10	30.00	29.97	714.64	1107.5	3.15
11	35.00	34.95	710.06	1086.2	3.20

Sample Details and Data

Sample Name:	Gasoline 93 RFG	**Sample Number:**	111
Sample Type:	Gasoline	**Sample date :**	03/08/2001

Damping Curve



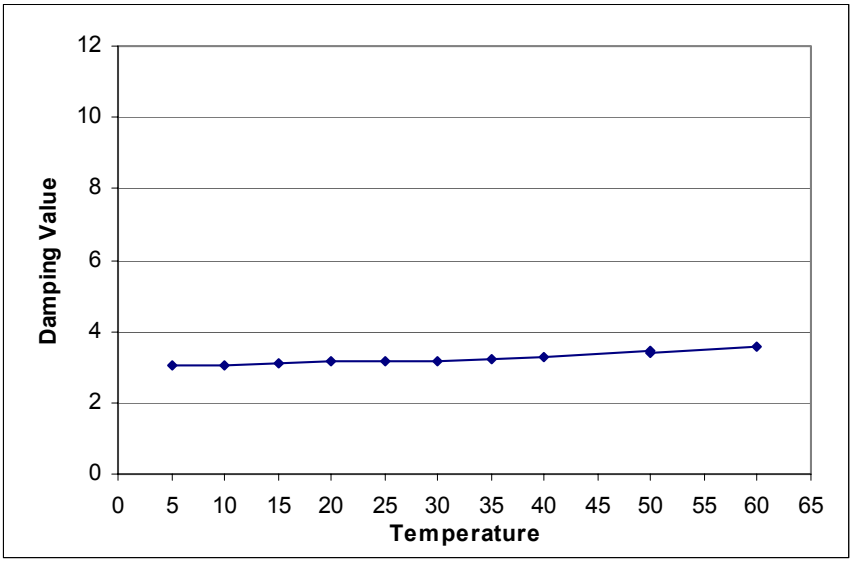
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	703.17	989.6	3.56
2	30.00	29.96	730.94	1114.0	3.18
3	35.00	34.95	726.39	1093.1	3.21
4	5.00	5.03	753.27	1220.2	3.01
5	15.00	15.01	744.41	1177.6	3.07
6	10.00	10.02	748.85	1198.8	3.04
7	25.00	24.98	735.45	1135.3	3.16
8	40.00	39.94	721.82	1072.4	3.28
9	50.00	49.91	712.58	1030.8	3.41
10	20.00	19.99	739.95	1156.2	3.11
11	60.00	59.89	703.19	989.7	3.57

Sample Details and Data

Sample Name:	Gasoline 94 RFG	**Sample Number:**	112
Sample Type:	Gasoline	**Sample date :**	25/11/2001

Damping Curve



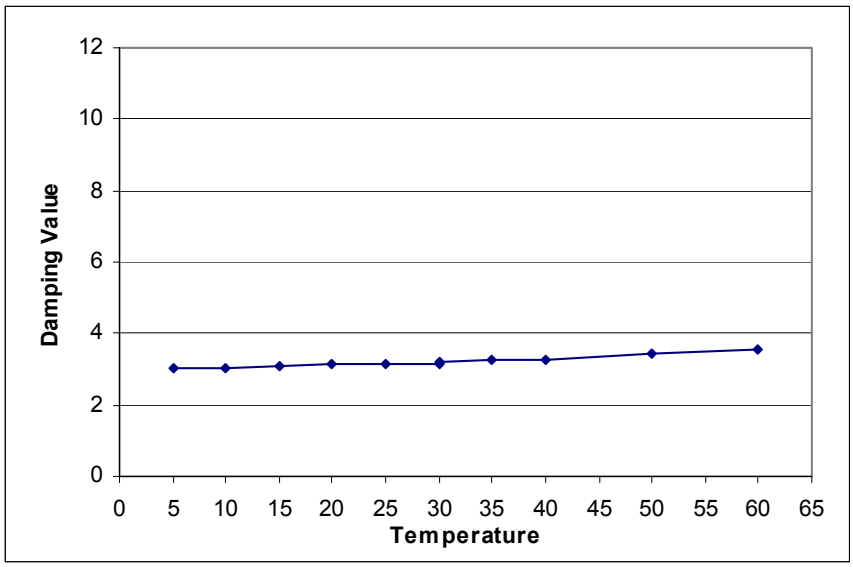
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	738.82	1059.4	3.41
2	20.00	19.99	766.81	1185.2	3.13
3	40.00	39.94	748.28	1101.1	3.28
4	30.00	29.96	757.60	1143.0	3.19
5	15.00	15.00	771.38	1206.6	3.09
6	35.00	34.95	752.95	1122.1	3.23
7	25.00	24.98	762.22	1164.1	3.15
8	5.00	5.03	780.46	1249.3	3.02
9	10.00	10.02	775.93	1228.0	3.03
10	60.00	59.88	729.24	1018.1	3.56
11	50.00	49.91	738.84	1059.4	3.43

Sample Details and Data

Sample Name:	Gasoline GT unleaded	**Sample Number:**	113
Sample Type:	Gasoline	**Sample date :**	07/03/2002

Damping Curve



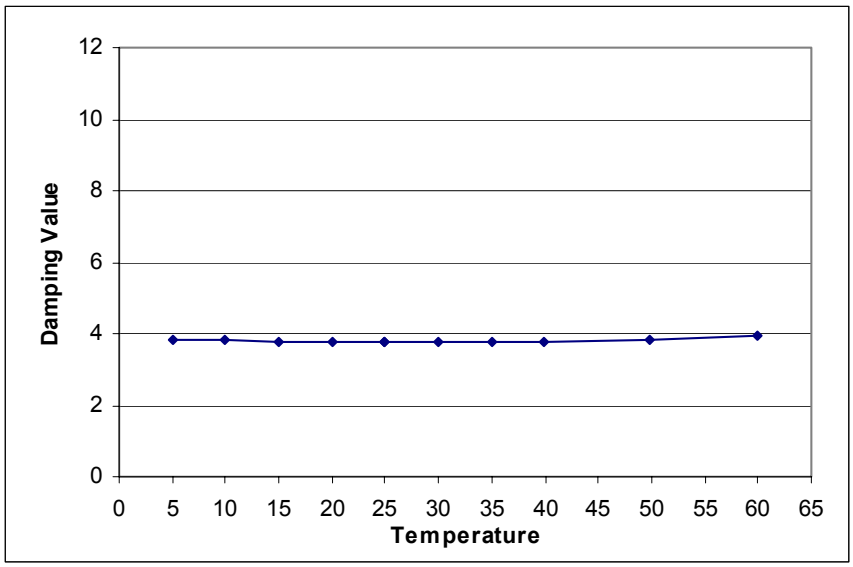
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	748.42	1128.0	3.18
2	15.00	15.00	762.07	1191.7	3.10
3	5.00	5.03	771.06	1234.5	3.02
4	20.00	19.99	757.54	1170.6	3.12
5	40.00	39.94	739.21	1086.4	3.27
6	25.00	24.97	753.00	1149.2	3.14
7	10.00	10.02	766.57	1213.0	3.05
8	50.00	49.91	729.86	1044.9	3.42
9	60.00	59.88	720.37	1003.7	3.57
10	35.00	34.95	743.84	1107.1	3.25
11	30.00	29.96	748.43	1128.0	3.16

Sample Details and Data

Sample Name:	LS diesel	**Sample Number:**	114
Sample Type:	Diesel	**Sample date :**	26/02/2002

Damping Curve



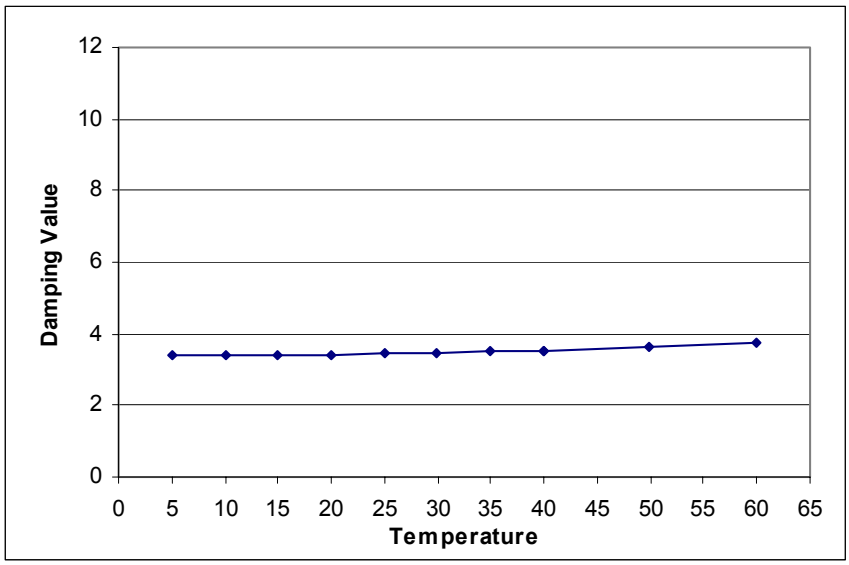
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	843.26	1352.8	3.75
2	15.00	15.00	850.38	1389.2	3.77
3	30.00	29.97	839.69	1334.7	3.76
4	20.00	19.99	846.82	1370.9	3.76
5	35.00	34.95	836.13	1316.7	3.76
6	5.00	5.03	857.52	1426.1	3.85
7	50.00	49.91	825.43	1263.3	3.84
8	40.00	39.94	832.57	1298.6	3.78
9	60.00	59.88	818.26	1228.1	3.93
10	10.00	10.02	853.95	1407.5	3.81
11	25.00	24.98	843.26	1352.7	3.75

Sample Details and Data

Sample Name:	Jet A	**Sample Number:**	115
Sample Type:	Kerosine (Jet)	**Sample date :**	12/03/2002

Damping Curve



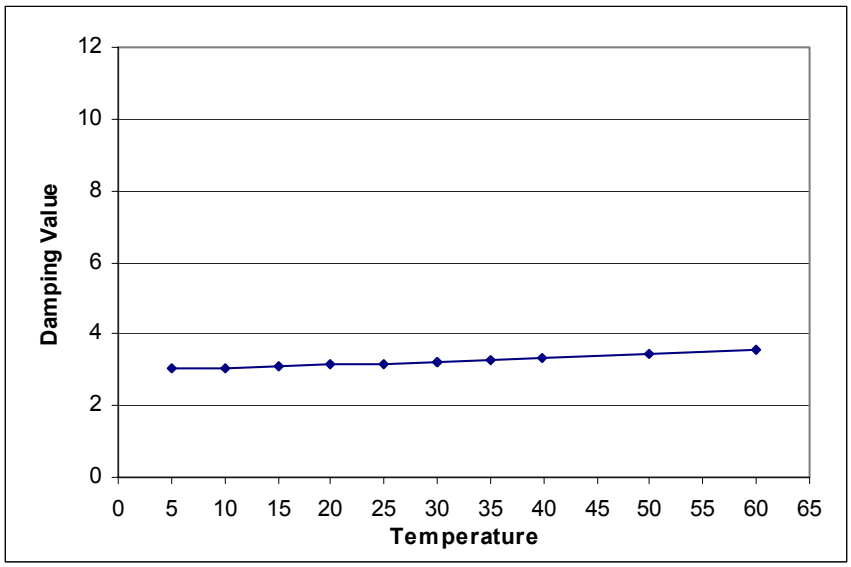
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	785.23	1234.2	3.53
2	60.00	59.88	770.20	1160.9	3.76
3	20.00	19.99	800.14	1308.9	3.42
4	50.00	49.91	777.73	1197.3	3.64
5	15.00	15.00	803.85	1327.9	3.40
6	25.00	24.98	796.42	1290.2	3.44
7	30.00	29.96	792.69	1271.4	3.49
8	35.00	34.95	788.97	1252.7	3.49
9	10.00	10.02	807.55	1347.0	3.39
10	5.00	5.03	811.26	1366.2	3.39
11	40.00	39.94	785.23	1234.2	3.52

Sample Details and Data

Sample Name:	Chemical Naphtha	**Sample Number:**	116
Sample Type:	Distillate	**Sample date :**	23/01/2002

Damping Curve



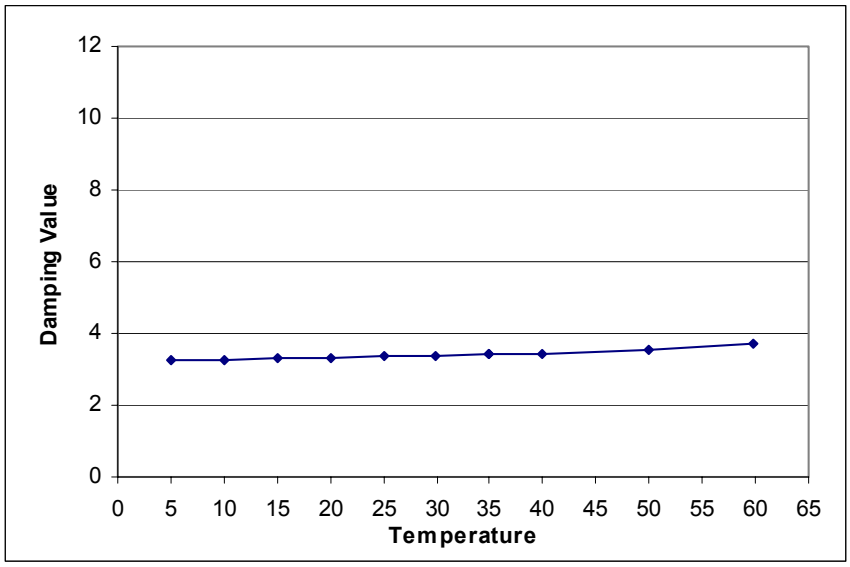
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	719.49	1134.3	3.20
2	5.00	5.03	740.98	1239.9	3.03
3	15.00	15.01	732.44	1197.5	3.10
4	20.00	19.99	728.15	1176.4	3.14
5	25.00	24.98	723.83	1155.3	3.17
6	50.00	49.91	701.88	1051.5	3.44
7	35.00	34.95	715.13	1113.4	3.27
8	40.00	39.94	710.74	1092.6	3.31
9	10.00	10.02	736.72	1218.5	3.06
10	60.00	59.89	692.89	1010.6	3.59
11	30.00	29.96	719.50	1134.1	3.21

Sample Details and Data

Sample Name:	Chemical mineral spirits	**Sample Number:**	117
Sample Type:	Distillate	**Sample date :**	30/09/2001

Damping Curve



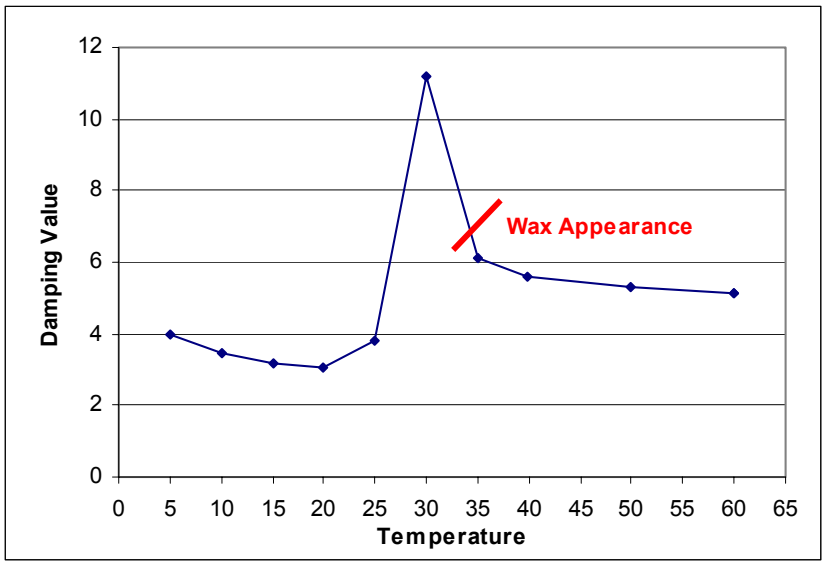
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	773.53	1223.6	3.41
2	10.00	10.02	792.70	1319.8	3.27
3	25.00	24.98	781.22	1261.9	3.34
4	40.00	39.94	769.67	1204.7	3.46
5	15.00	15.00	788.88	1300.3	3.30
6	50.00	49.91	761.92	1167.2	3.57
7	30.00	29.96	777.38	1242.6	3.39
8	60.00	59.88	754.11	1129.9	3.70
9	5.00	5.03	796.51	1339.3	3.26
10	20.00	19.99	785.05	1281.1	3.32
11	35.00	34.95	773.53	1223.6	3.42

Sample Details and Data

Sample Name:	Vacuum Gas Oil	**Sample Number:**	118
Sample Type:	Gas oil	**Sample date :**	09/12/2001

Damping Curve



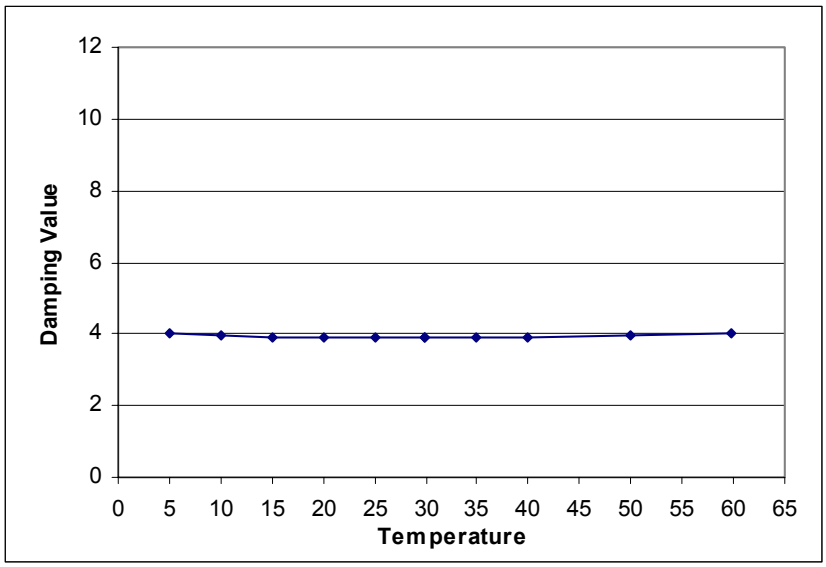
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	883.33	1335.3	5.16
2	50.00	49.91	889.82	1366.3	5.30
3	15.00	15.00	919.87	1515.4	3.20
4	35.00	34.95	899.77	1417.6	6.09
5	25.00	24.98	909.93	1461.3	3.78
6	30.00	29.97	904.21	1438.2	11.19
7	20.00	19.99	915.18	1486.0	3.05
8	10.00	10.02	924.54	1543.5	3.47
9	40.00	39.94	896.44	1400.9	5.62
10	5.00	5.03	928.20	1576.4	3.96
11	60.00	59.88	883.41	1336.2	5.15

Sample Details and Data

Sample Name:	Fuel Oil #2	**Sample Number:**	119
Sample Type:	Fuel oil	**Sample date :**	17/10/2001

Damping Curve



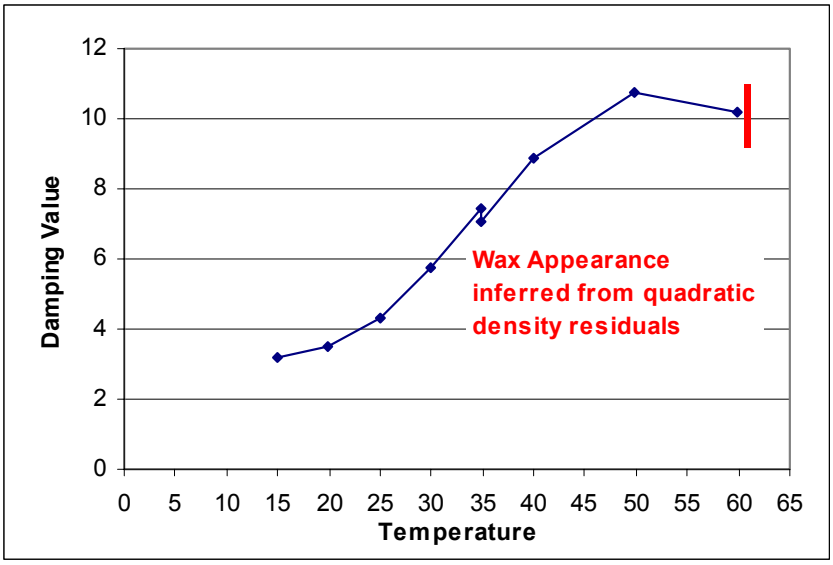
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	846.81	1346.5	3.90
2	50.00	49.91	832.65	1275.4	3.94
3	5.00	5.03	864.52	1437.1	4.01
4	15.00	15.01	857.44	1400.6	3.90
5	35.00	34.95	843.27	1328.5	3.90
6	40.00	39.94	839.74	1310.8	3.90
7	10.00	10.02	860.98	1418.7	3.96
8	25.00	24.98	850.35	1364.3	3.89
9	60.00	59.88	825.55	1240.7	4.05
10	20.00	19.99	853.90	1382.2	3.92
11	30.00	29.97	846.82	1346.3	3.89

Sample Details and Data

Sample Name:	Fuel Oil #6	**Sample Number:**	120
Sample Type:	Fuel oil	**Sample date :**	17/04/2002

Damping Curve



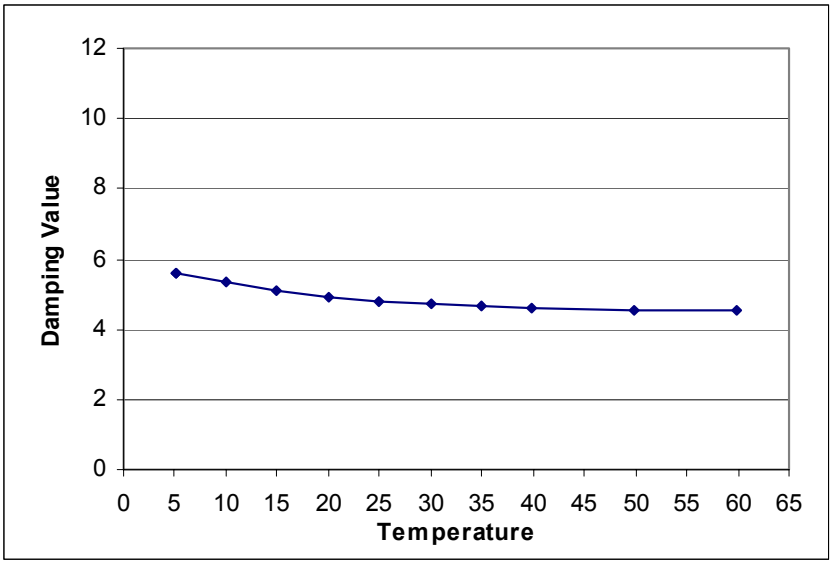
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	939.34	1490.0	7.42
2	25.00	24.98	947.48	1544.2	4.31
3	60.00	59.89	922.23	1391.7	10.19
4	15.00	15.00	956.28	1619.7	3.21
5	40.00	39.94	936.03	1469.2	8.85
6	30.00	29.96	943.22	1514.7	5.73
7	50.00	49.91	928.98	1428.8	10.75
8	20.00	19.99	951.84	1578.7	3.53
9	35.00	34.95	939.81	1491.9	7.07

Sample Details and Data

Sample Name:	Troll	**Sample Number:**	121
Sample Type:	Crude oil	**Sample date :**	30/01/2002

Damping Curve



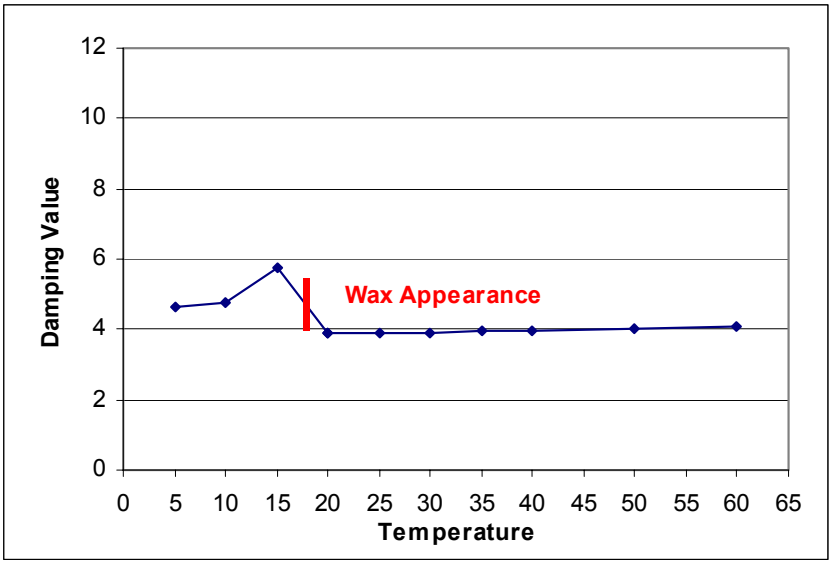
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	892.13	1462.7	5.62
2	20.00	19.99	881.77	1408.3	4.94
3	30.00	29.97	874.88	1372.7	4.73
4	35.00	34.95	871.45	1355.0	4.66
5	10.00	10.02	888.66	1444.3	5.33
6	25.00	24.98	878.32	1390.3	4.81
7	15.00	15.00	885.22	1426.2	5.11
8	60.00	59.88	854.27	1268.2	4.54
9	50.00	49.91	861.14	1302.3	4.53
10	40.00	39.93	868.02	1337.1	4.60
11	5.00	5.03	892.14	1462.4	5.61

Sample Details and Data

Sample Name:	Qua Iboe	**Sample Number:**	122
Sample Type:	Crude oil	**Sample date :**	20/04/2002

Damping Curve



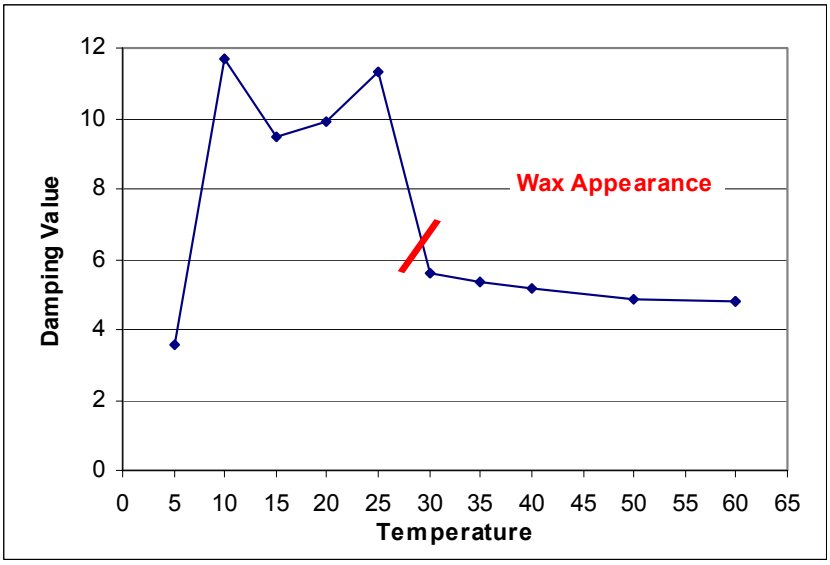
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	840.12	1347.7	3.92
2	15.00	15.01	844.63	1367.7	5.77
3	30.00	29.97	832.86	1310.7	3.90
4	40.00	39.94	825.64	1274.6	3.94
5	5.00	5.03	853.24	1409.6	4.64
6	50.00	49.91	818.41	1239.4	4.01
7	60.00	59.88	811.14	1205.1	4.11
8	35.00	34.95	829.25	1291.9	3.94
9	10.00	10.02	848.80	1388.5	4.76
10	25.00	24.98	836.50	1329.5	3.90
11	20.00	19.99	840.10	1347.8	3.92

Sample Details and Data

Sample Name:	Rabi Light	**Sample Number:**	123
Sample Type:	Crude oil	**Sample date :**	22/01/2002

Damping Curve



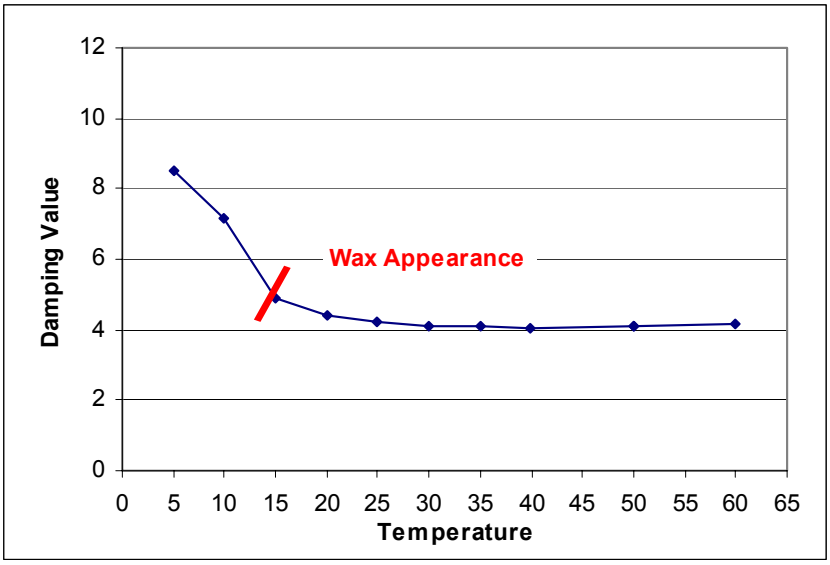
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	828.32	1270.0	4.80
2	10.00	10.02	869.91	1463.0	11.66
3	35.00	34.95	845.84	1357.0	5.36
4	5.00	5.03	875.47	1492.5	3.59
5	25.00	24.98	855.07	1397.1	11.31
6	20.00	19.99	860.21	1418.4	9.89
7	40.00	39.94	842.09	1339.0	5.17
8	50.00	49.91	834.98	1303.8	4.84
9	30.00	29.96	849.48	1374.2	5.58
10	60.00	59.88	828.33	1269.7	4.79
11	15.00	15.00	863.78	1440.1	9.46

Sample Details and Data

Sample Name:	Palanca	**Sample Number:**	124
Sample Type:	Crude oil	**Sample date :**	02/02/2002

Damping Curve



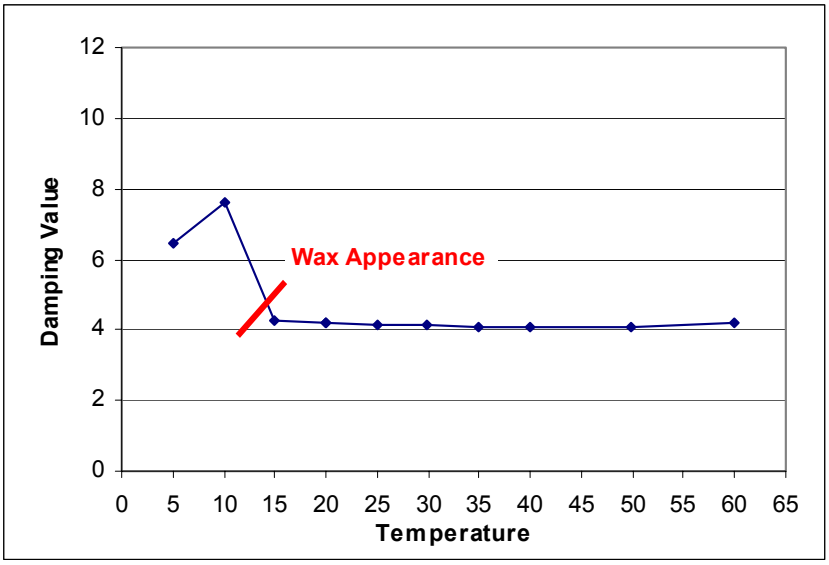
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	817.10	1253.0	4.09
2	60.00	59.88	809.98	1217.8	4.16
3	35.00	34.95	827.65	1305.7	4.08
4	5.00	5.03	851.62	1419.9	8.52
5	30.00	29.97	831.36	1324.6	4.12
6	40.00	39.94	824.21	1288.5	4.07
7	10.00	10.02	847.41	1399.7	7.13
8	20.00	19.99	838.87	1361.5	4.42
9	25.00	24.98	835.03	1342.9	4.20
10	15.00	15.00	842.70	1379.9	4.91
11	50.00	49.91	817.09	1253.0	4.09

Sample Details and Data

Sample Name:	Escravos	**Sample Number:**	125
Sample Type:	Crude oil	**Sample date :**	12/11/2001

Damping Curve



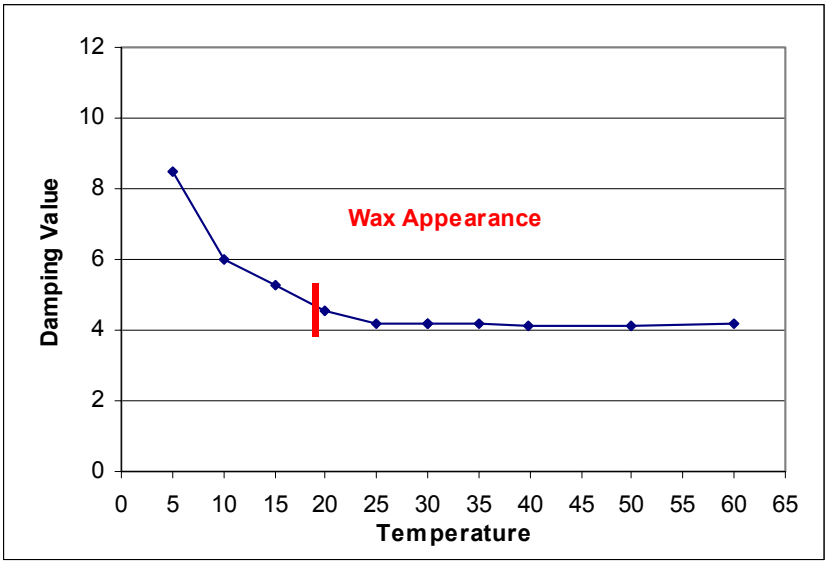
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	854.04	1368.2	4.23
2	15.00	15.01	857.62	1386.5	4.27
3	50.00	49.91	832.51	1260.5	4.09
4	5.00	5.03	866.63	1427.0	6.48
5	30.00	29.97	846.84	1331.7	4.12
6	10.00	10.02	862.46	1406.8	7.62
7	35.00	34.95	843.23	1313.9	4.09
8	60.00	59.88	825.39	1225.2	4.17
9	40.00	39.93	839.63	1295.4	4.09
10	25.00	24.97	850.29	1349.5	4.15
11	20.00	19.99	853.83	1367.7	4.18

Sample Details and Data

Sample Name:	Hibernia	**Sample Number:**	126
Sample Type:	Crude oil	**Sample date :**	21/02/2002

Damping Curve



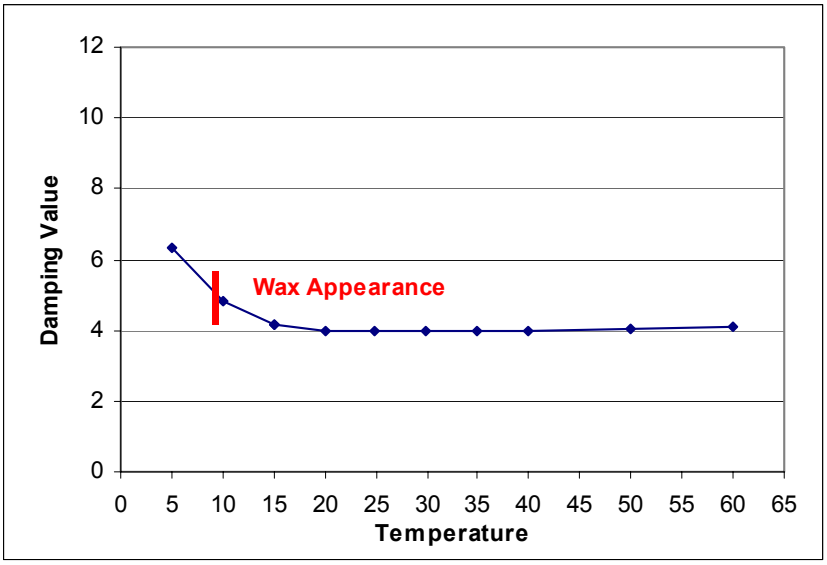
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	836.26	1324.2	4.17
2	25.00	24.98	839.81	1342.3	4.20
3	60.00	59.88	814.87	1218.4	4.18
4	40.00	39.93	829.09	1288.2	4.12
5	5.00	5.03	856.72	1420.4	8.50
6	10.00	10.02	852.48	1401.2	6.01
7	35.00	34.95	832.74	1307.0	4.16
8	50.00	49.91	822.01	1253.5	4.14
9	15.00	15.00	847.79	1380.3	5.29
10	20.00	19.99	843.84	1361.8	4.55
11	30.00	29.97	836.33	1325.0	4.19

Sample Details and Data

Sample Name:	Nemba	**Sample Number:**	127
Sample Type:	Crude oil	**Sample date :**	23/10/2001

Damping Curve



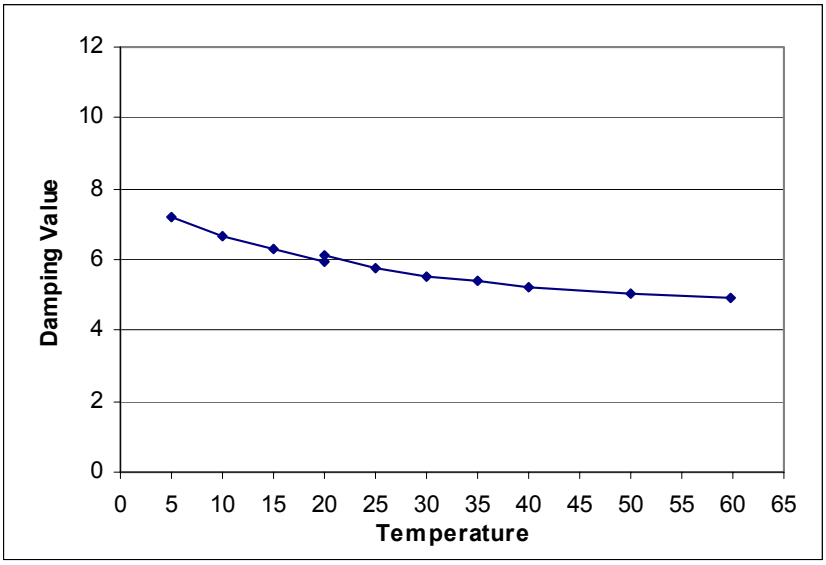
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	832.70	1355.7	4.17
2	60.00	59.88	799.66	1192.5	4.10
3	10.00	10.02	836.79	1374.9	4.84
4	40.00	39.94	814.22	1264.1	3.96
5	30.00	29.96	821.42	1299.7	3.95
6	50.00	49.91	806.94	1228.1	4.02
7	25.00	24.97	825.06	1318.1	3.96
8	20.00	19.99	828.72	1336.6	3.99
9	5.00	5.03	841.41	1394.8	6.32
10	35.00	34.95	817.85	1282.4	3.96
11	15.00	15.00	832.63	1355.6	4.15

Sample Details and Data

Sample Name:	Arab Heavy	**Sample Number:**	128
Sample Type:	Crude oil	**Sample date :**	21/12/2001

Damping Curve



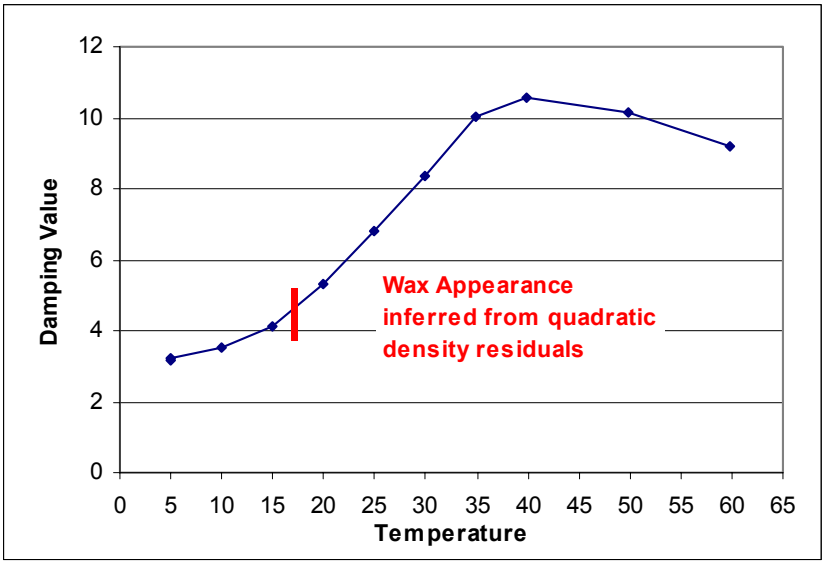
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	887.98	1386.3	6.09
2	40.00	39.94	873.81	1315.5	5.25
3	50.00	49.91	866.80	1280.7	5.05
4	15.00	15.00	891.41	1404.3	6.29
5	25.00	24.98	884.39	1368.7	5.74
6	35.00	34.95	877.31	1333.1	5.39
7	60.00	59.88	859.79	1246.4	4.95
8	10.00	10.02	895.17	1423.1	6.69
9	5.00	5.03	898.98	1442.2	7.18
10	30.00	29.97	880.83	1350.8	5.54
11	20.00	19.99	887.80	1386.1	5.96

Sample Details and Data

Sample Name:	Qing Huang Dao	**Sample Number:**	129
Sample Type:	Crude oil	**Sample date :**	03/11/2001

Damping Curve



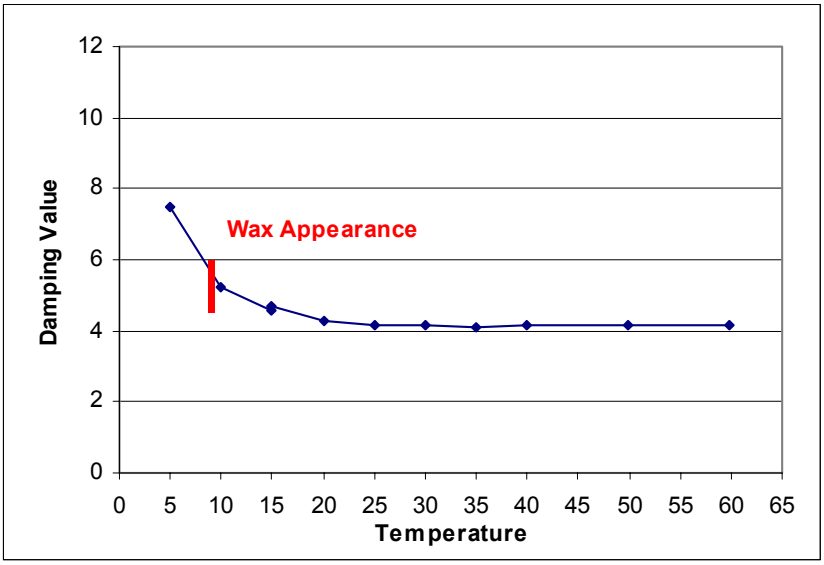
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	958.57		3.23
2	20.00	20.00	948.49	1558.1	5.29
3	25.00	24.98	945.05	1528.7	6.80
4	35.00	34.95	938.28	1480.5	10.03
5	60.00	59.88	922.61	1385.8	9.17
6	40.00	39.93	935.03	1457.6	10.57
7	10.00	10.02	955.09	1621.8	3.54
8	50.00	49.91	928.82	1420.4	10.16
9	30.00	29.96	941.52	1499.6	8.36
10	15.00	15.00	951.64	1585.1	4.14
11	5.00	5.03	958.58		3.18

Sample Details and Data

Sample Name:	Didon	**Sample Number:**	130
Sample Type:	Crude oil	**Sample date :**	15/02/2002

Damping Curve



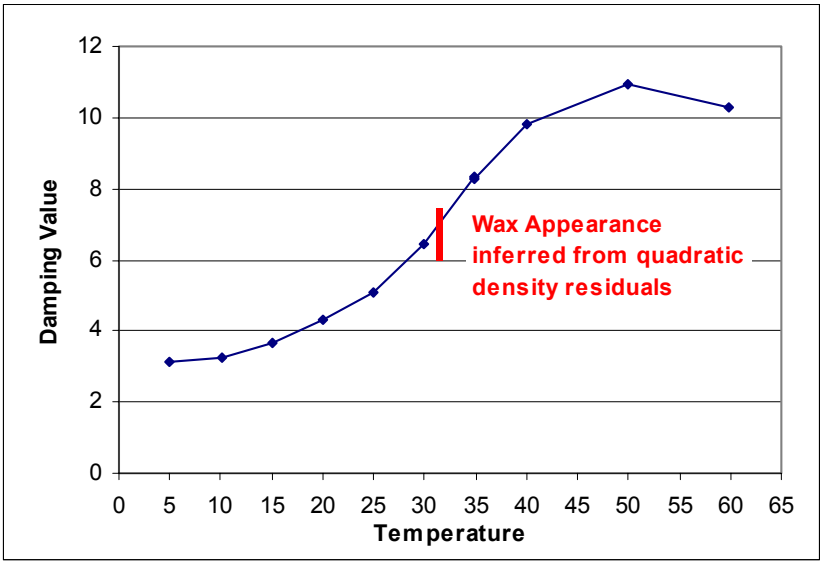
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.01	847.97	1373.2	4.70
2	40.00	39.94	829.36	1282.0	4.16
3	50.00	49.91	822.08	1246.3	4.14
4	20.00	19.99	843.97	1354.1	4.28
5	35.00	34.95	832.98	1299.9	4.13
6	60.00	59.88	814.83	1211.2	4.18
7	25.00	24.97	840.13	1335.6	4.15
8	10.00	10.02	852.47	1393.0	5.22
9	5.00	5.03	857.12	1413.1	7.49
10	30.00	29.97	836.66	1318.2	4.14
11	15.00	15.00	848.12	1373.4	4.57

Sample Details and Data

Sample Name:	Yombo	**Sample Number:**	131
Sample Type:	Crude oil	**Sample date :**	07/03/2002

Damping Curve



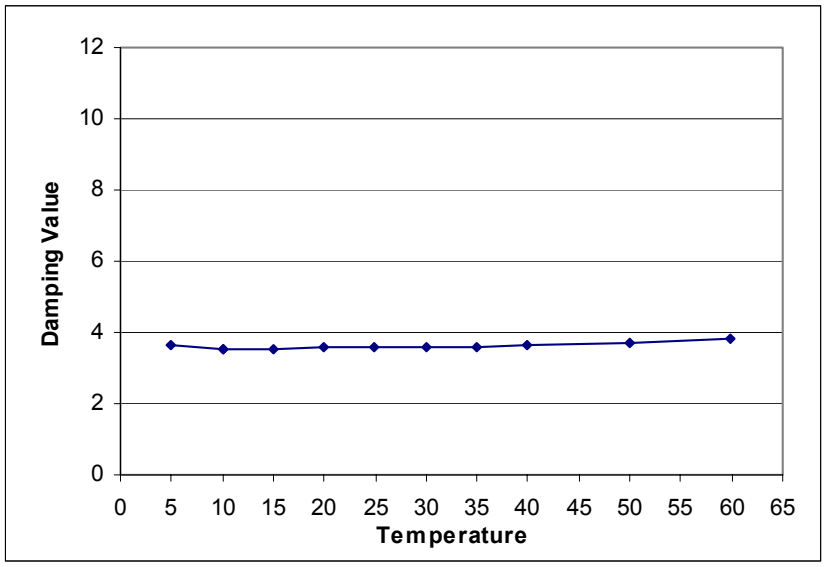
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	938.95	1470.7	8.28
2	5.00	5.03	960.09	1649.3	3.15
3	10.00	10.02	956.93	1612.9	3.24
4	30.00	29.97	942.60	1493.7	6.46
5	20.00	19.99	949.15	1542.4	4.31
6	15.00	15.00	952.79	1573.2	3.65
7	25.00	24.98	946.09	1517.9	5.11
8	60.00	59.88	922.91	1376.8	10.26
9	40.00	39.93	935.47	1449.8	9.81
10	50.00	49.91	929.10	1412.2	10.93
11	35.00	34.95	938.77	1469.9	8.36

Sample Details and Data

Sample Name:	Karachaganak Condensate	**Sample Number:**	132
Sample Type:	Crude oil	**Sample date :**	25/09/2001

Damping Curve



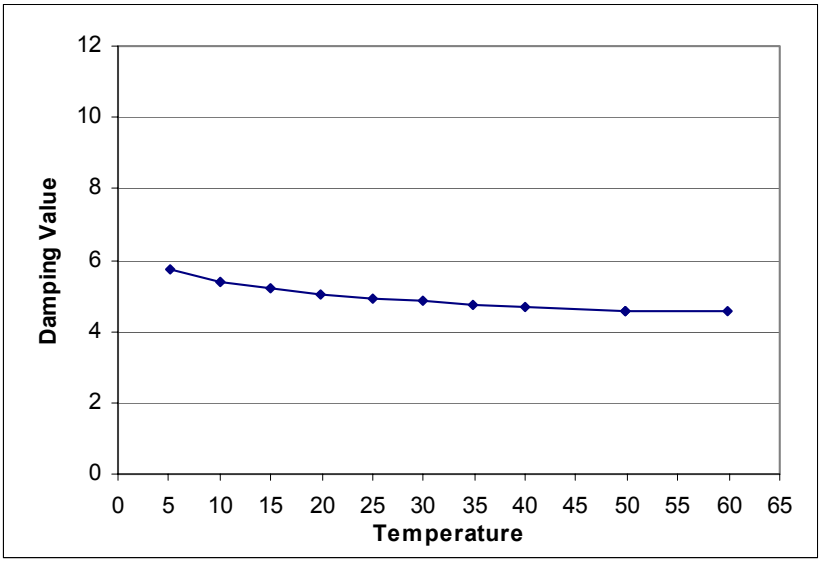
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	806.18	1331.1	3.54
2	50.00	49.91	776.01	1181.2	3.70
3	60.00	59.88	768.43	1144.9	3.84
4	35.00	34.95	787.37	1236.4	3.61
5	15.00	15.00	802.44	1312.0	3.55
6	30.00	29.97	791.25	1255.6	3.60
7	25.00	24.98	795.06	1274.1	3.58
8	5.00	5.03	810.58	1350.8	3.64
9	20.00	19.99	799.04	1293.1	3.57
10	40.00	39.94	783.95	1218.4	3.65
11	10.00	10.02	806.65	1331.2	3.56

Sample Details and Data

Sample Name:	Arab Medium	**Sample Number:**	133
Sample Type:	Crude oil	**Sample date :**	07/02/2002

Damping Curve



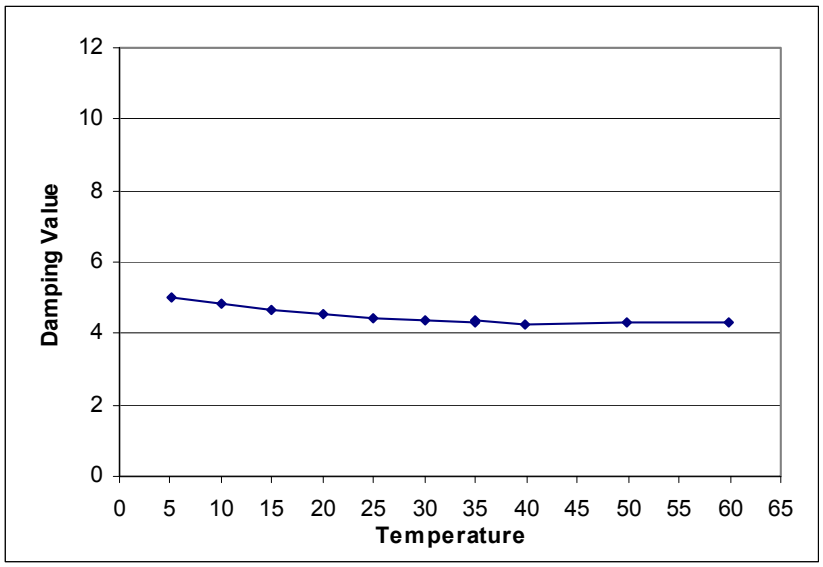
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	856.58	1275.5	4.60
2	35.00	34.95	867.13	1327.3	4.74
3	10.00	10.02	884.84	1416.9	5.41
4	25.00	24.98	874.21	1363.3	4.90
5	15.00	15.00	881.23	1398.6	5.20
6	60.00	59.89	849.51	1241.0	4.58
7	5.00	5.03	888.73	1435.8	5.74
8	40.00	39.94	863.63	1310.2	4.68
9	30.00	29.96	870.65	1344.9	4.83
10	20.00	19.99	877.68	1380.6	5.06
11	50.00	49.91	856.58	1275.4	4.60

Sample Details and Data

Sample Name:	Iranian Light	**Sample Number:**	134
Sample Type:	Crude oil	**Sample date :**	19/12/2001

Damping Curve



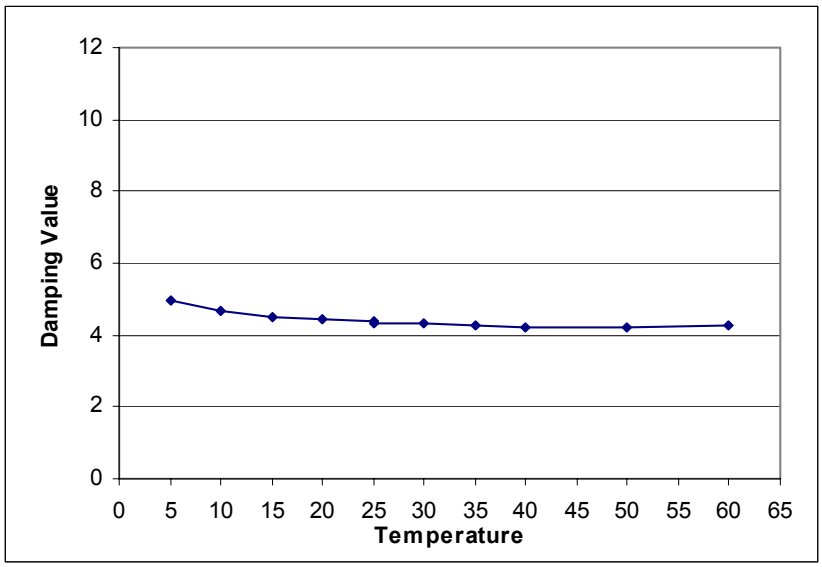
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	847.17	1308.6	4.34
2	50.00	49.91	836.48	1255.7	4.29
3	5.00	5.03	869.61	1419.6	5.01
4	15.00	15.01	862.02	1382.2	4.66
5	60.00	59.89	829.37	1221.3	4.32
6	25.00	24.97	854.23	1344.4	4.43
7	20.00	19.99	857.86	1362.6	4.52
8	10.00	10.02	865.62	1400.2	4.86
9	40.00	39.94	843.60	1291.3	4.28
10	30.00	29.96	850.68	1326.5	4.36
11	35.00	34.95	847.15	1309.0	4.32

Sample Details and Data

Sample Name:	Iranian Light	**Sample Number:**	135
Sample Type:	Crude oil	**Sample date :**	03/01/2002

Damping Curve



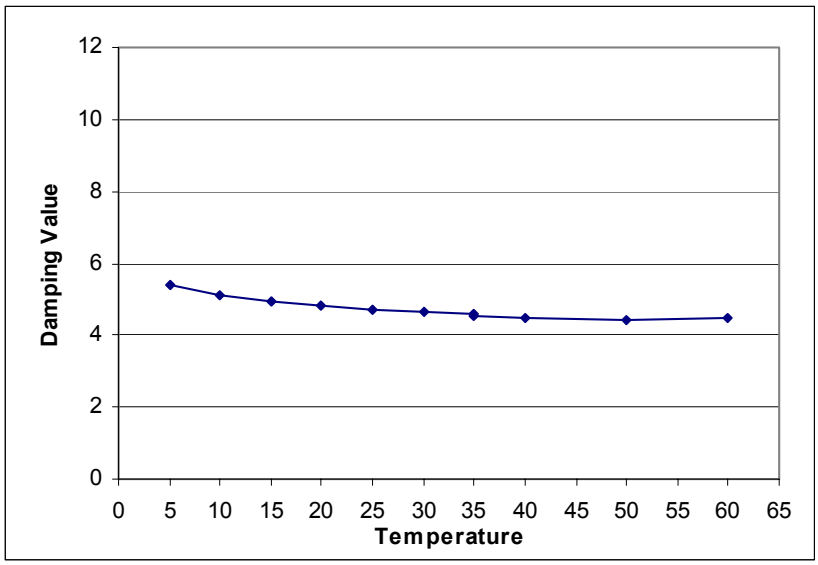
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	851.69	1339.1	4.37
2	50.00	49.91	833.79	1250.4	4.23
3	10.00	10.02	862.87	1394.3	4.68
4	30.00	29.97	848.15	1321.4	4.33
5	20.00	19.99	855.28	1357.0	4.42
6	5.00	5.03	866.89	1413.6	4.94
7	40.00	39.94	840.97	1285.6	4.22
8	60.00	59.88	826.59	1215.2	4.28
9	35.00	34.95	844.51	1302.6	4.26
10	15.00	15.00	858.93	1375.3	4.52
11	25.00	24.98	851.76	1339.4	4.35

Sample Details and Data

Sample Name:	Basrah Light	**Sample Number:**	136
Sample Type:	Crude oil	**Sample date :**	22/09/2001

Damping Curve



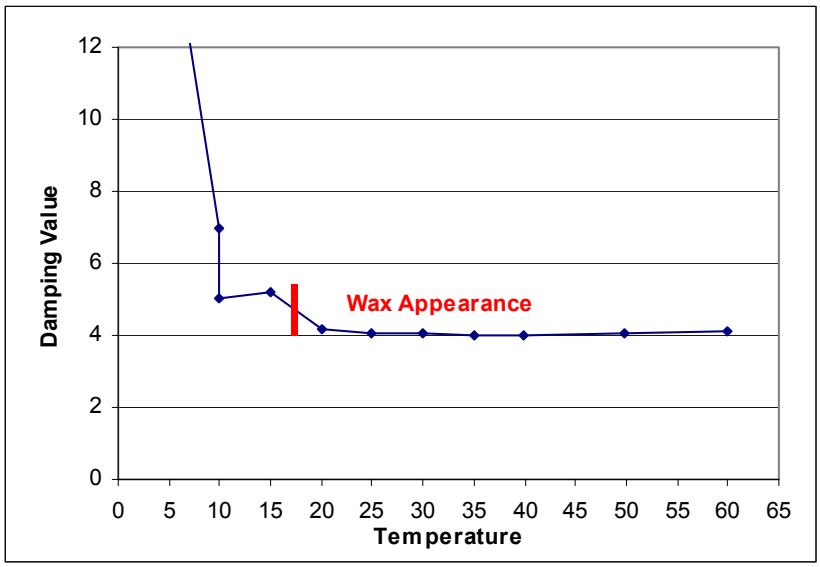
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	858.09	1311.5	4.56
2	30.00	29.96	861.62	1328.6	4.64
3	15.00	15.00	872.26	1382.5	4.93
4	50.00	49.91	847.45	1259.0	4.45
5	10.00	10.02	876.07	1401.2	5.12
6	20.00	19.99	868.86	1365.3	4.81
7	40.00	39.94	854.55	1293.9	4.50
8	5.00	5.03	879.95	1420.2	5.38
9	60.00	59.89	840.34	1224.4	4.46
10	25.00	24.97	865.16	1346.4	4.72
11	35.00	34.95	858.09	1311.5	4.57

Sample Details and Data

Sample Name:	Syrian Light	**Sample Number:**	137
Sample Type:	Crude oil	**Sample date :**	14/12/2001

Damping Curve



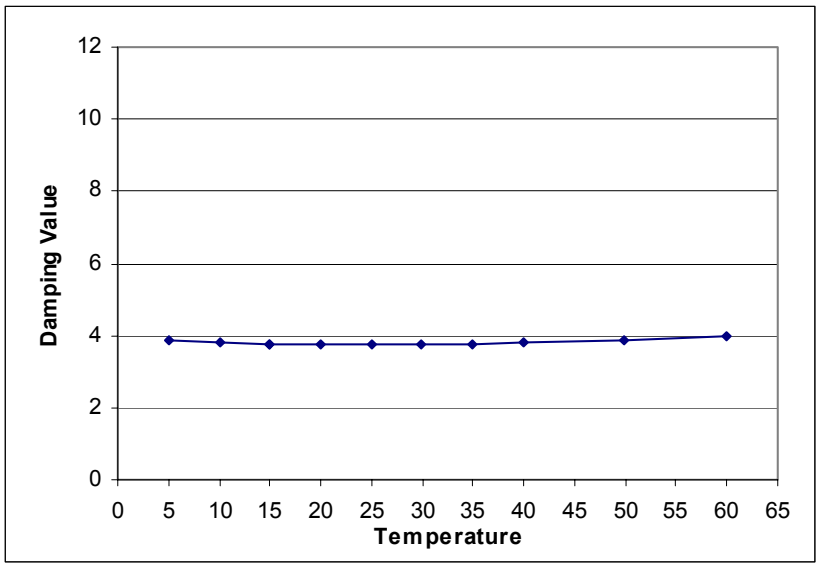
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	840.29	1381.2	6.96
2	15.00	15.01	836.03	1362.7	5.21
3	5.00	5.03	843.54	1400.9	15.67
4	30.00	29.97	824.38	1306.6	4.04
5	60.00	59.88	802.54	1199.0	4.11
6	20.00	19.99	831.72	1342.4	4.18
7	50.00	49.91	809.79	1234.3	4.05
8	35.00	34.95	820.57	1287.3	4.01
9	25.00	24.98	827.88	1323.8	4.07
10	40.00	39.94	817.05	1270.1	3.99
11	10.00	10.02	839.91	1380.9	5.04

Sample Details and Data

Sample Name:	Aktobinsk	**Sample Number:**	138
Sample Type:	Crude oil	**Sample date :**	01/01/2002

Damping Curve



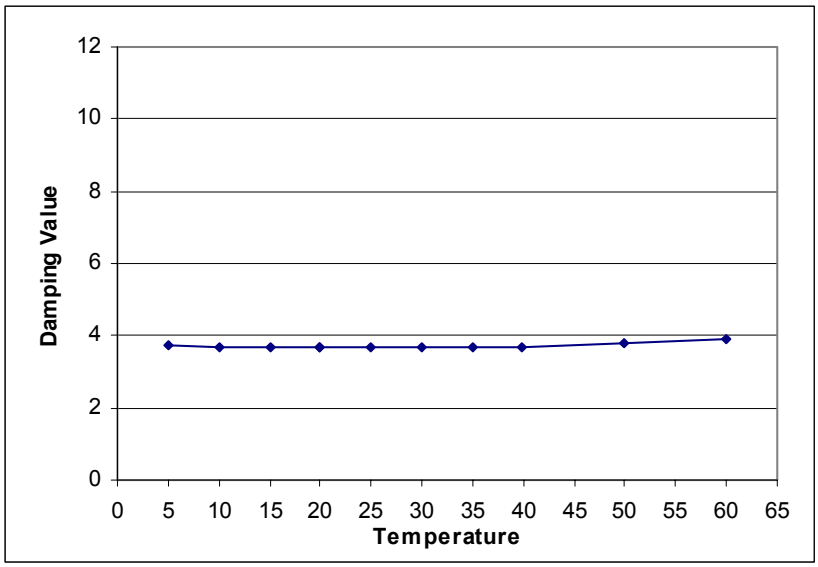
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.01	816.98	1326.1	3.76
2	40.00	39.94	798.46	1233.3	3.78
3	10.00	10.02	820.67	1345.1	3.80
4	50.00	49.91	790.99	1196.5	3.86
5	30.00	29.96	805.89	1269.7	3.76
6	60.00	59.88	783.45	1160.1	3.97
7	35.00	34.95	802.18	1251.1	3.76
8	5.00	5.03	824.55	1364.3	3.85
9	20.00	19.99	813.33	1307.6	3.76
10	25.00	24.98	809.62	1288.9	3.76
11	15.00	15.00	817.00	1326.2	3.77

Sample Details and Data

Sample Name:	Thevenard	**Sample Number:**	139
Sample Type:	Crude oil	**Sample date :**	20/11/2001

Damping Curve



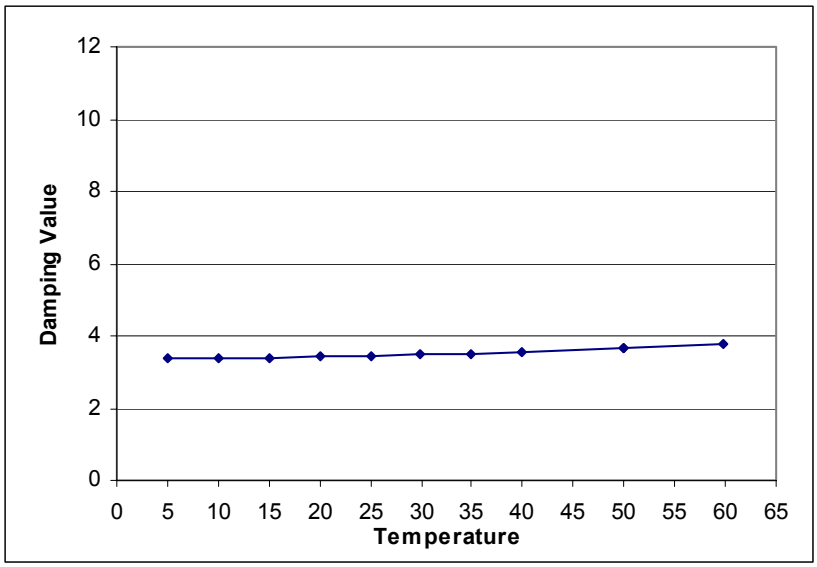
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	826.11	1331.4	3.68
2	35.00	34.95	815.15	1275.9	3.68
3	5.00	5.03	837.06	1388.1	3.71
4	25.00	24.98	822.47	1313.1	3.67
5	40.00	39.94	811.49	1257.7	3.70
6	10.00	10.02	833.41	1369.1	3.70
7	60.00	59.89	796.78	1185.4	3.89
8	15.00	15.00	829.78	1350.1	3.66
9	50.00	49.91	804.16	1221.3	3.77
10	30.00	29.96	818.82	1294.0	3.68
11	20.00	19.99	826.13	1331.3	3.66

Sample Details and Data

Sample Name:	Saharan Blend	**Sample Number:**	140
Sample Type:	Crude oil	**Sample date :**	09/01/2002

Damping Curve



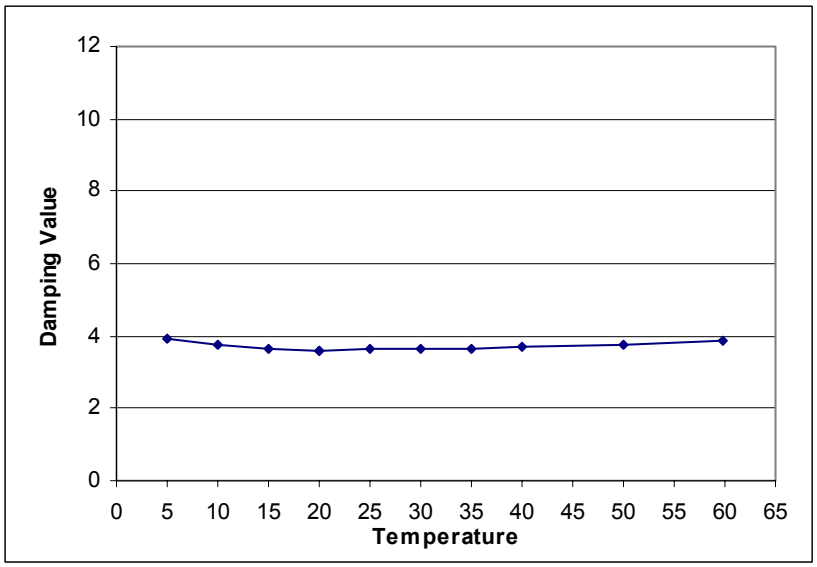
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	758.20	1147.0	3.64
2	10.00	10.02	789.23	1300.7	3.39
3	40.00	39.94	766.02	1184.7	3.53
4	5.00	5.03	793.07	1320.4	3.39
5	35.00	34.95	769.92	1204.0	3.49
6	60.00	59.88	750.31	1109.3	3.77
7	20.00	19.99	781.54	1261.6	3.44
8	25.00	24.98	777.68	1242.3	3.44
9	30.00	29.96	773.80	1223.0	3.47
10	15.00	15.00	785.39	1281.2	3.41
11	50.00	49.91	758.20	1146.9	3.65

Sample Details and Data

Sample Name:	Kyle/Curlew	**Sample Number:**	141
Sample Type:	Crude oil	**Sample date :**	30/12/2001

Damping Curve



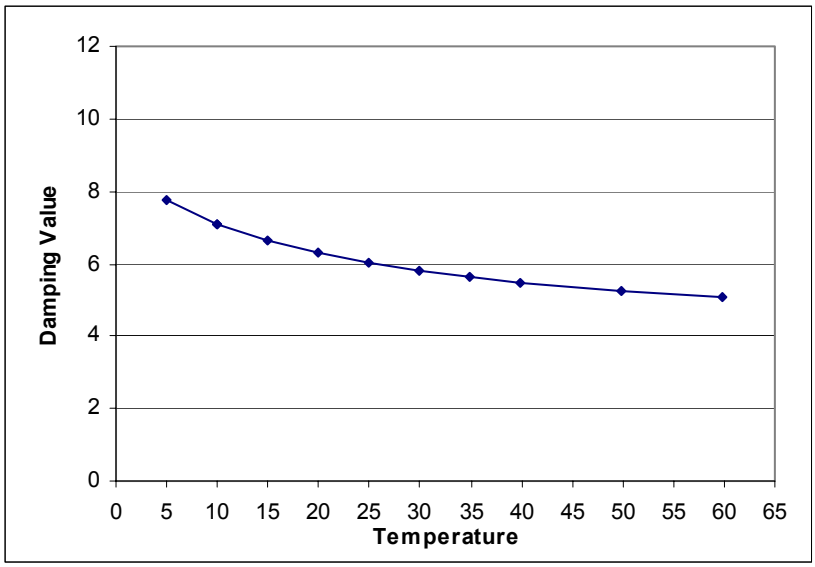
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	802.12	1293.4	3.60
2	25.00	24.98	798.33	1274.5	3.63
3	60.00	59.88	771.49	1144.1	3.88
4	40.00	39.93	786.84	1217.7	3.68
5	50.00	49.91	779.20	1180.8	3.75
6	30.00	29.96	794.47	1255.3	3.62
7	15.00	15.00	806.01	1312.7	3.67
8	5.00	5.03	814.18	1351.9	3.93
9	10.00	10.02	810.20	1332.5	3.76
10	35.00	34.95	790.71	1236.9	3.64
11	20.00	19.99	802.12	1293.5	3.61

Sample Details and Data

Sample Name:	Souedie	**Sample Number:**	142
Sample Type:	Crude oil	**Sample date :**	01/01/2002

Damping Curve



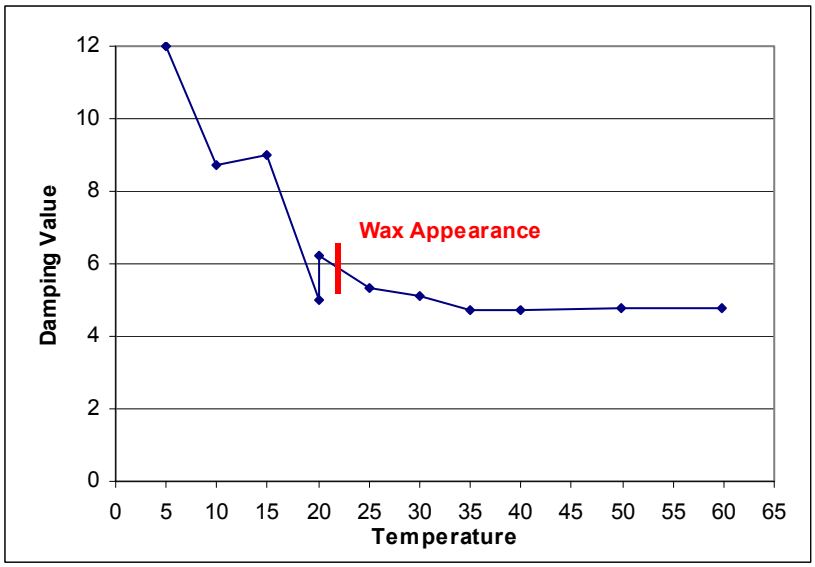
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	908.54	1426.5	7.07
2	5.00	5.04	912.39	1445.5	7.74
3	60.00	59.88	873.44	1250.6	5.11
4	50.00	49.91	880.42	1283.9	5.23
5	35.00	34.95	890.92	1335.9	5.62
6	20.00	19.99	901.47	1389.3	6.30
7	15.00	15.01	904.99	1407.3	6.65
8	30.00	29.97	894.49	1354.1	5.79
9	40.00	39.94	887.47	1318.9	5.47
10	25.00	24.97	897.95	1371.1	6.03
11	10.00	10.02	908.62	1425.7	7.10

Sample Details and Data

Sample Name:	Ross/Blake	**Sample Number:**	143
Sample Type:	Crude oil	**Sample date :**	22/12/2001

Damping Curve



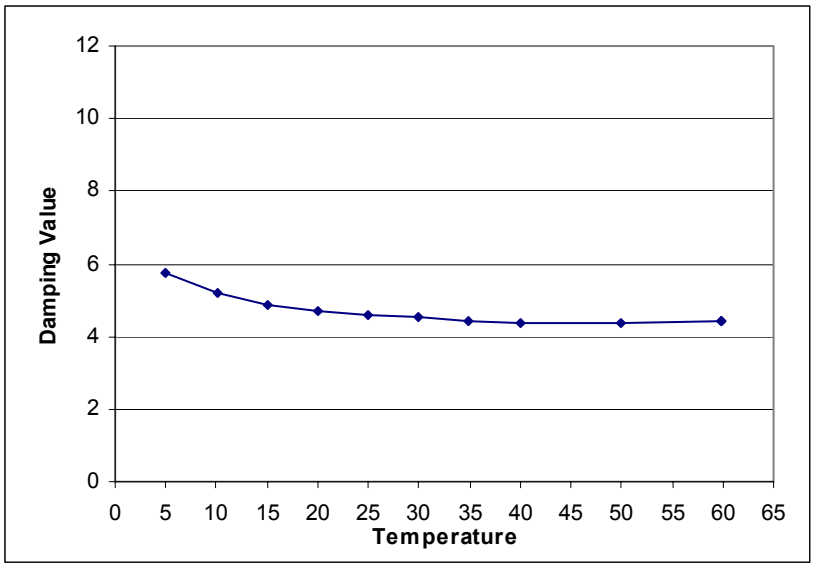
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	863.87	1398.8	5.02
2	40.00	39.94	849.49	1326.2	4.70
3	35.00	34.95	852.96	1342.7	4.70
4	15.00	15.00	868.09	1416.3	9.00
5	25.00	24.98	860.32	1379.6	5.35
6	60.00	59.88	835.66	1255.9	4.76
7	5.00	5.03	875.77	1455.3	11.97
8	10.00	10.02	872.21	1436.6	8.75
9	30.00	29.97	856.66	1361.2	5.08
10	50.00	49.91	842.57	1290.3	4.77
11	20.00	19.99	864.00	1396.9	6.25

Sample Details and Data

Sample Name:	Russian Export Blend	**Sample Number:**	144
Sample Type:	Crude oil	**Sample date :**	22/03/2001

Damping Curve



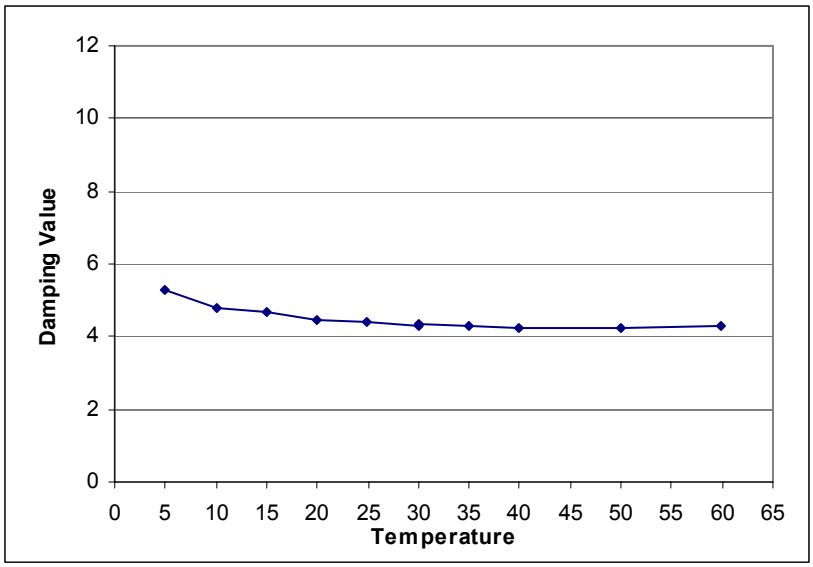
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.89	830.66	1227.5	4.40
2	5.00	5.03	871.03	1426.1	5.76
3	20.00	19.99	859.38	1369.9	4.72
4	35.00	34.95	848.44	1315.4	4.44
5	10.00	10.02	866.95	1406.6	5.22
6	25.00	24.98	855.63	1351.5	4.59
7	30.00	29.96	852.01	1333.4	4.51
8	50.00	49.91	837.76	1262.3	4.37
9	15.00	15.00	862.92	1387.4	4.87
10	40.00	39.94	844.86	1297.6	4.39
11	60.00	59.88	830.66	1227.4	4.41

Sample Details and Data

Sample Name:	Iranian Light	**Sample Number:**	145
Sample Type:	Crude oil	**Sample date :**	11/11/2001

Damping Curve



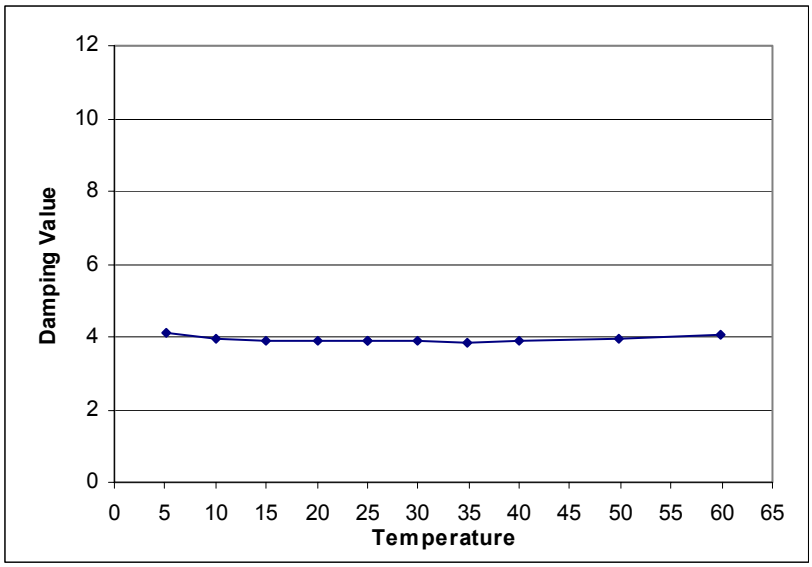
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	847.54	1321.7	4.30
2	15.00	15.00	858.73	1376.8	4.70
3	40.00	39.94	840.42	1286.8	4.24
4	50.00	49.91	833.23	1251.4	4.23
5	10.00	10.02	862.63	1395.8	4.77
6	60.00	59.88	826.02	1216.4	4.29
7	35.00	34.95	843.91	1303.8	4.28
8	20.00	19.99	854.86	1358.2	4.47
9	25.00	24.98	851.32	1340.7	4.38
10	5.00	5.03	866.66	1415.2	5.27
11	30.00	29.97	847.68	1322.8	4.32

Sample Details and Data

Sample Name:	Val d'Agri	**Sample Number:**	146
Sample Type:	Crude oil	**Sample date :**	16/12/2001

Damping Curve



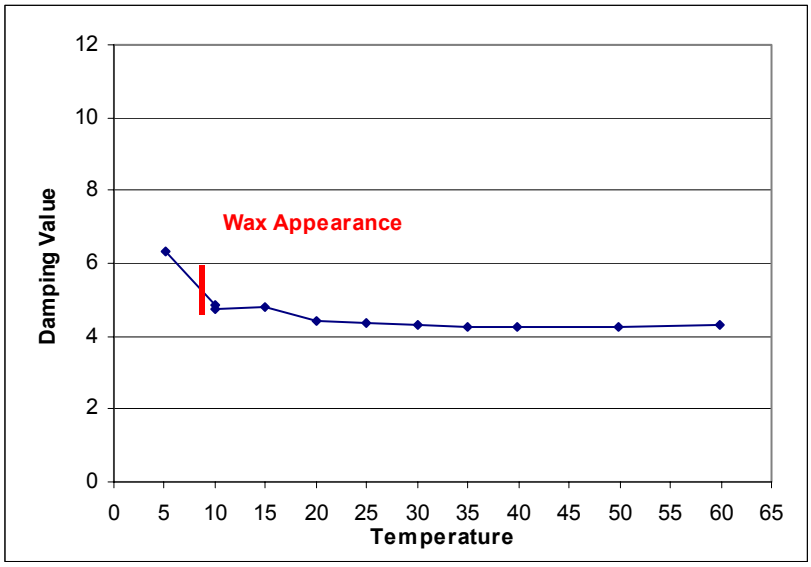
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	832.74	1298.8	3.87
2	15.00	15.00	840.18	1335.8	3.91
3	10.00	10.02	843.98	1354.6	3.95
4	30.00	29.97	829.06	1281.0	3.87
5	5.00	5.03	848.02	1373.8	4.11
6	20.00	19.99	836.53	1317.7	3.87
7	60.00	59.89	806.56	1172.4	4.03
8	50.00	49.91	814.06	1207.5	3.92
9	40.00	39.93	821.56	1243.7	3.88
10	35.00	34.95	825.29	1262.0	3.84
11	25.00	24.98	832.74	1298.7	3.87

Sample Details and Data

Sample Name:	Selmo Turkish Indigenous	**Sample Number:**	147
Sample Type:	Crude oil	**Sample date :**	01/11/2001

Damping Curve



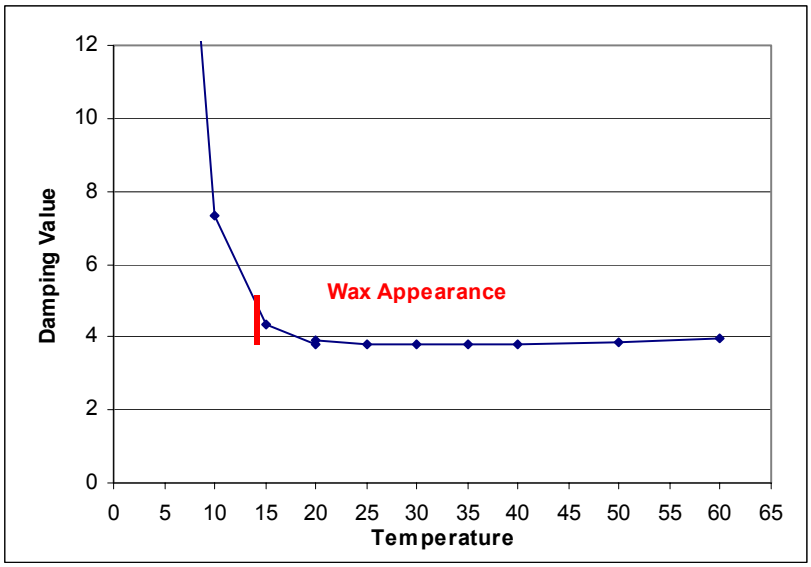
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	859.88	1407.8	4.88
2	30.00	29.97	845.25	1335.2	4.33
3	25.00	24.98	848.73	1352.4	4.38
4	5.00	5.03	864.05	1427.2	6.33
5	15.00	15.01	856.20	1389.8	4.78
6	60.00	59.89	824.20	1230.0	4.30
7	50.00	49.91	831.20	1263.9	4.25
8	40.00	39.93	838.22	1298.9	4.27
9	35.00	34.95	841.72	1316.5	4.28
10	20.00	19.99	852.22	1370.2	4.44
11	10.00	10.02	859.86	1407.6	4.72

Sample Details and Data

Sample Name:	Western Desert	**Sample Number:**	148
Sample Type:	Crude oil	**Sample date :**	13/09/2001

Damping Curve



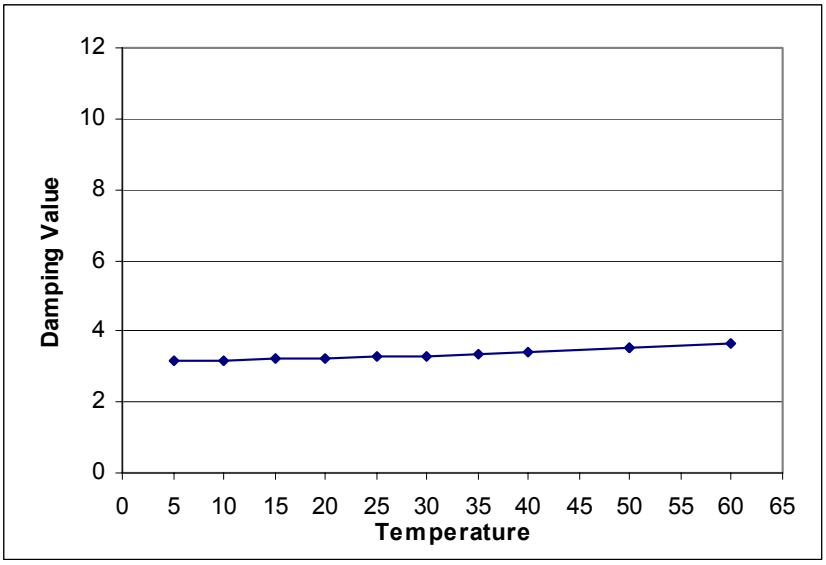
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	820.38	1317.2	3.90
2	60.00	59.89	789.98	1170.5	3.97
3	5.00	5.03	832.48	1377.4	24.65
4	10.00	10.02	829.93	1357.4	7.33
5	25.00	24.98	816.47	1298.8	3.82
6	35.00	34.95	808.83	1261.4	3.80
7	50.00	49.91	797.52	1206.5	3.87
8	30.00	29.96	812.50	1279.1	3.79
9	15.00	15.00	824.54	1336.2	4.34
10	40.00	39.94	805.08	1243.0	3.81
11	20.00	19.99	820.11	1316.6	3.83

Sample Details and Data

Sample Name:	Miskar Condensate	**Sample Number:**	149
Sample Type:	Crude oil	**Sample date :**	20/07/2001

Damping Curve



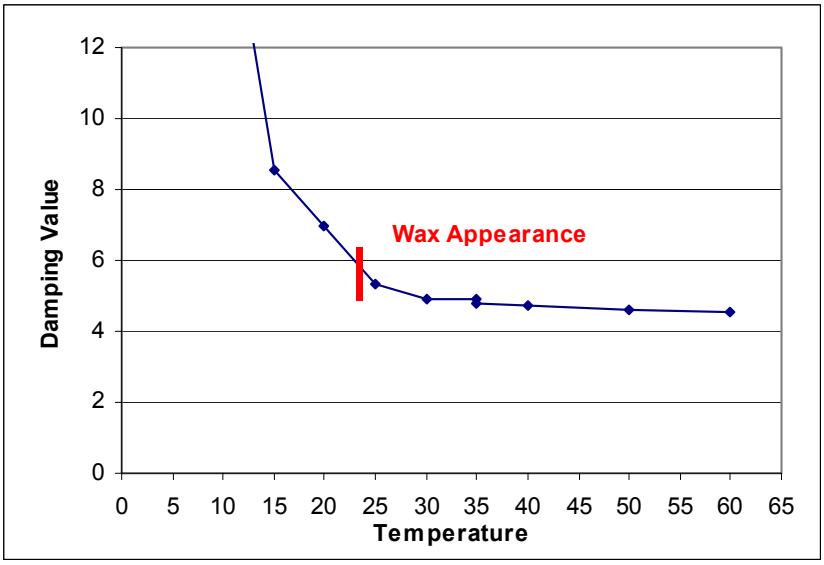
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	733.81	1110.3	3.52
2	15.00	15.00	762.52	1248.6	3.21
3	35.00	34.95	746.23	1169.1	3.34
4	5.00	5.03	770.58	1289.0	3.16
5	40.00	39.94	742.11	1149.5	3.40
6	30.00	29.96	750.32	1188.8	3.31
7	60.00	59.88	725.43	1071.6	3.67
8	10.00	10.02	766.57	1268.8	3.20
9	20.00	19.99	758.48	1228.7	3.25
10	25.00	24.98	754.42	1208.8	3.30
11	50.00	49.91	733.83	1110.3	3.51

Sample Details and Data

Sample Name:	Glitne	**Sample Number:**	150
Sample Type:	Crude oil	**Sample date :**	24/09/2001

Damping Curve



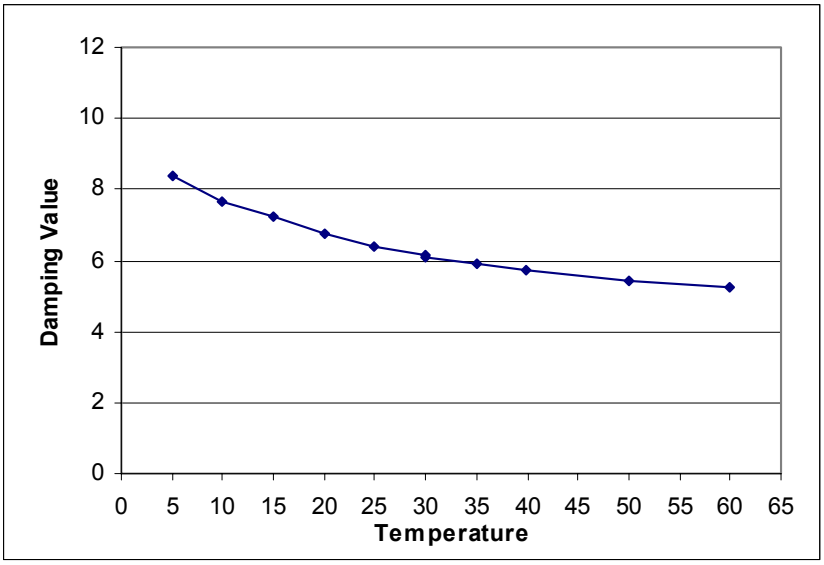
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	855.88	1342.3	4.79
2	5.00	5.03	877.98	1454.5	15.30
3	40.00	39.94	852.32	1325.0	4.71
4	30.00	29.96	859.31	1359.8	4.90
5	15.00	15.00	870.70	1415.2	8.55
6	20.00	19.99	866.86	1396.6	6.99
7	10.00	10.02	873.75	1434.7	17.37
8	60.00	59.88	838.39	1255.5	4.57
9	50.00	49.91	845.27	1289.2	4.59
10	25.00	24.97	862.92	1377.6	5.34
11	35.00	34.95	855.81	1342.1	4.91

Sample Details and Data

Sample Name:	Tempa Rossa	**Sample Number:**	151
Sample Type:	Crude oil	**Sample date :**	01/07/2001

Damping Curve



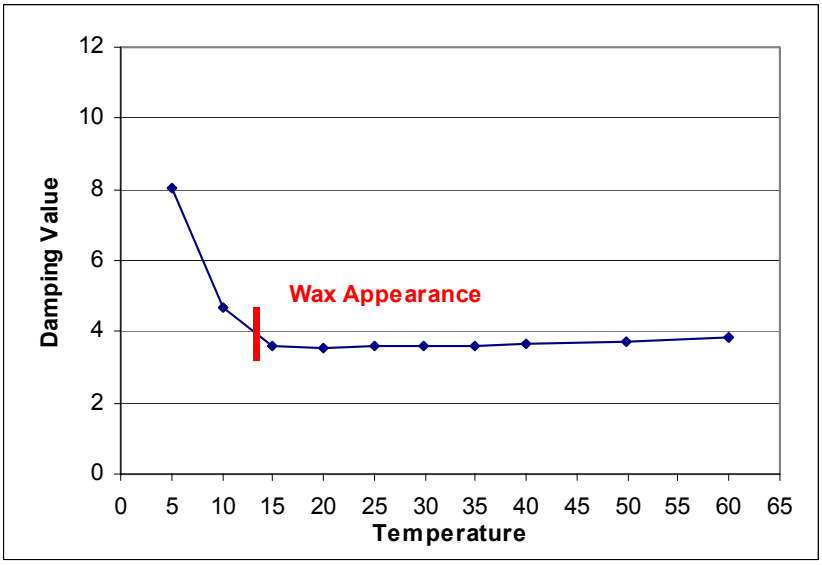
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	913.29	1361.5	6.12
2	50.00	49.91	899.19	1292.2	5.45
3	25.00	24.97	916.77	1378.8	6.42
4	20.00	19.99	920.29	1396.7	6.75
5	40.00	39.94	906.22	1326.5	5.72
6	10.00	10.02	927.60	1433.4	7.68
7	15.00	15.01	924.08	1415.5	7.22
8	60.00	59.88	892.14	1257.7	5.27
9	5.00	5.03	931.44	1452.4	8.36
10	35.00	34.95	909.76	1343.7	5.89
11	30.00	29.96	913.27	1360.8	6.11

Sample Details and Data

Sample Name:	Legendre	**Sample Number:**	152
Sample Type:	Crude oil	**Sample date :**	01/07/2001

Damping Curve



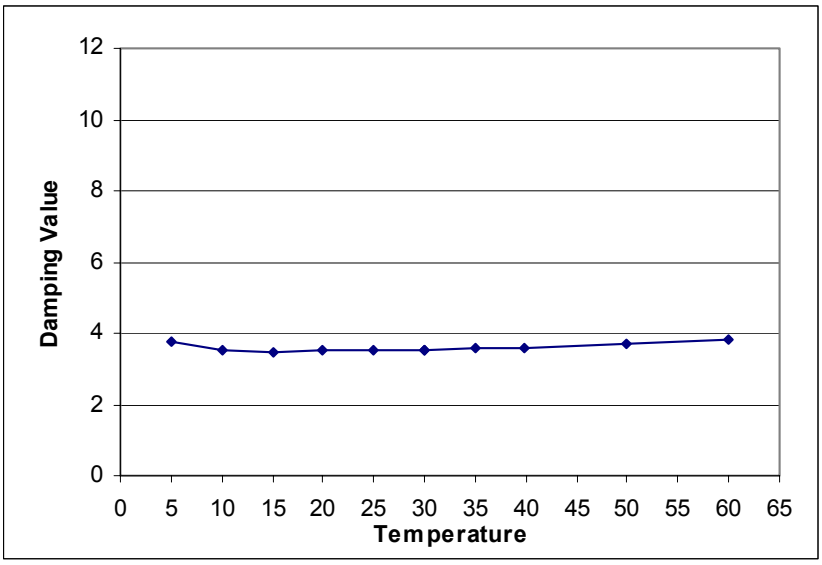
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	777.26	1162.7	3.87
2	40.00	39.93	792.44	1236.1	3.66
3	35.00	34.95	796.20	1254.7	3.62
4	25.00	24.97	803.70	1292.2	3.59
5	20.00	19.99	807.44	1311.1	3.56
6	30.00	29.97	799.96	1273.6	3.59
7	50.00	49.91	784.88	1199.3	3.74
8	15.00	15.00	811.23	1330.1	3.59
9	5.00	5.03	820.44	1372.7	8.03
10	10.00	10.02	815.79	1350.5	4.68
11	60.00	59.89	777.27	1162.7	3.86

Sample Details and Data

Sample Name:	HS Russian Condensate	**Sample Number:**	153
Sample Type:	Crude oil	**Sample date :**	27/08/2001

Damping Curve



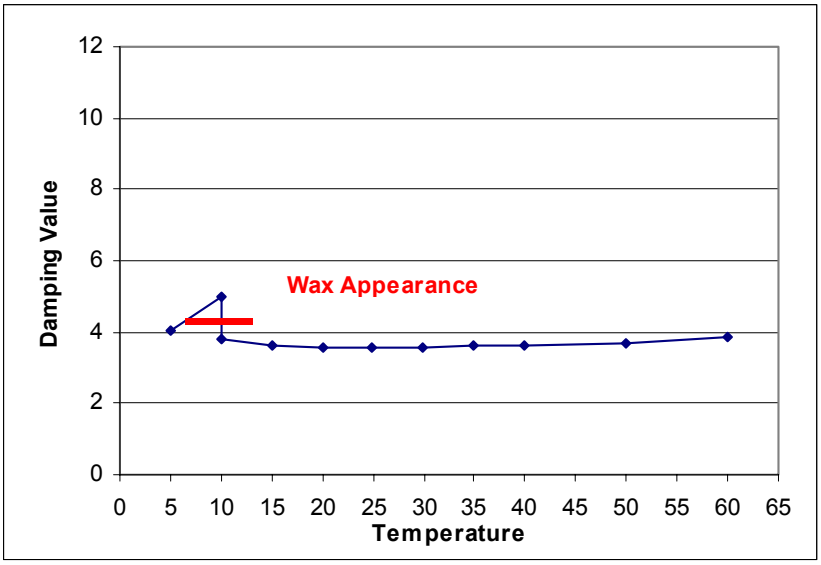
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	786.78	1246.3	3.53
2	25.00	24.98	790.57	1265.3	3.51
3	35.00	34.95	782.99	1227.6	3.56
4	20.00	19.99	794.38	1284.4	3.50
5	15.00	15.01	798.27	1303.5	3.49
6	5.00	5.03	806.32	1342.5	3.75
7	60.00	59.88	763.91	1135.6	3.81
8	40.00	39.93	779.21	1208.8	3.61
9	10.00	10.02	802.30	1323.0	3.55
10	50.00	49.91	771.61	1172.4	3.68
11	30.00	29.96	786.82	1246.4	3.54

Sample Details and Data

Sample Name:	Onako Light	**Sample Number:**	154
Sample Type:	Crude oil	**Sample date :**	20/07/2001

Damping Curve



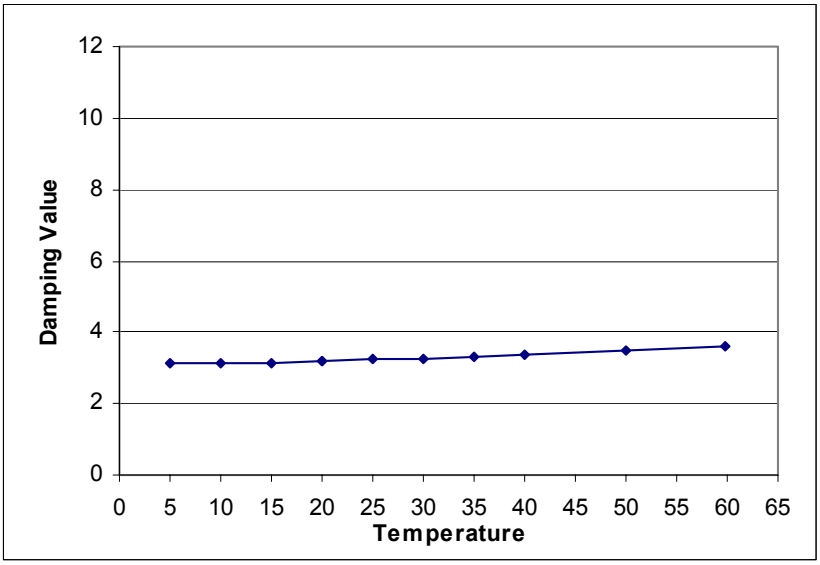
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	798.86	1331.6	5.01
2	50.00	49.91	767.81	1180.9	3.70
3	20.00	19.99	790.53	1292.8	3.56
4	40.00	39.94	775.41	1217.8	3.63
5	30.00	29.96	782.94	1254.9	3.57
6	5.00	5.03	802.96	1351.6	4.03
7	35.00	34.95	779.25	1236.6	3.62
8	15.00	15.00	794.63	1312.1	3.61
9	60.00	59.88	760.26	1144.2	3.85
10	25.00	24.97	786.77	1273.8	3.59
11	10.00	10.02	798.80	1331.7	3.78

Sample Details and Data

Sample Name:	Senipah Condensate	**Sample Number:**	155
Sample Type:	Crude oil	**Sample date :**	19/08/2001

Damping Curve



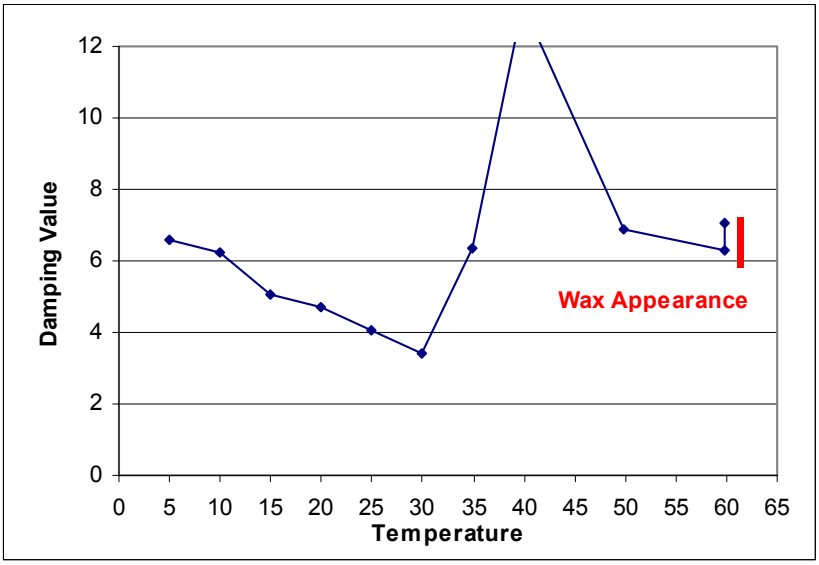
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	764.89	1223.5	3.20
2	10.00	10.02	773.16	1264.2	3.14
3	40.00	39.94	748.16	1143.1	3.37
4	25.00	24.98	760.74	1203.2	3.23
5	5.00	5.03	777.28	1284.9	3.11
6	15.00	15.01	769.03	1244.0	3.16
7	35.00	34.95	752.37	1163.1	3.31
8	30.00	29.96	756.56	1183.0	3.27
9	50.00	49.91	739.68	1103.3	3.51
10	60.00	59.88	731.12	1064.0	3.64
11	20.00	19.99	764.90	1223.5	3.20

Sample Details and Data

Sample Name:	Alexandria	**Sample Number:**	156
Sample Type:	Crude oil	**Sample date :**	26/06/2001

Damping Curve



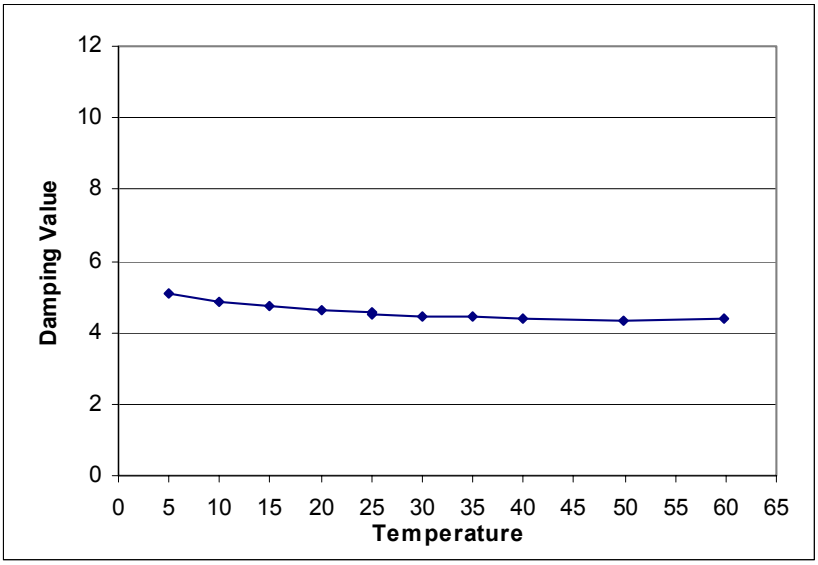
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.89	887.78	1346.0	6.29
2	10.00	10.02	931.11		6.24
3	30.00	29.97	914.21	1476.1	3.40
4	35.00	34.95	907.79	1441.9	6.37
5	15.00	15.00	929.61	1582.7	5.05
6	40.00	39.94	902.51	1418.5	13.17
7	50.00	49.91	894.51	1378.0	6.90
8	25.00	24.98	919.74	1509.7	4.06
9	20.00	19.99	925.02		4.69
10	5.00	5.03	934.06		6.57
11	60.00	59.89	887.74	1343.4	7.07

Sample Details and Data

Sample Name:	Dubai	**Sample Number:**	157
Sample Type:	Crude oil	**Sample date :**	18/07/2001

Damping Curve



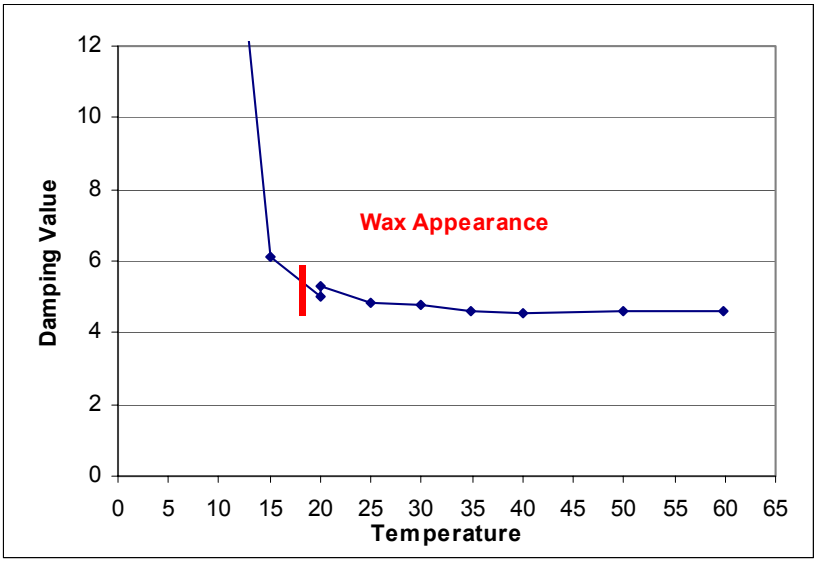
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.97	866.22	1349.1	4.54
2	30.00	29.96	862.67	1331.5	4.47
3	40.00	39.94	855.55	1296.1	4.38
4	35.00	34.95	859.10	1313.5	4.42
5	50.00	49.91	848.43	1261.1	4.35
6	5.00	5.03	881.06	1423.1	5.09
7	60.00	59.88	841.30	1226.5	4.37
8	20.00	19.99	869.76	1367.1	4.62
9	10.00	10.02	877.11	1404.0	4.88
10	15.00	15.01	873.56	1385.9	4.74
11	25.00	24.98	866.25	1349.7	4.52

Sample Details and Data

Sample Name:	Gullfaks	**Sample Number:**	158
Sample Type:	Crude oil	**Sample date :**	20/08/2001

Damping Curve



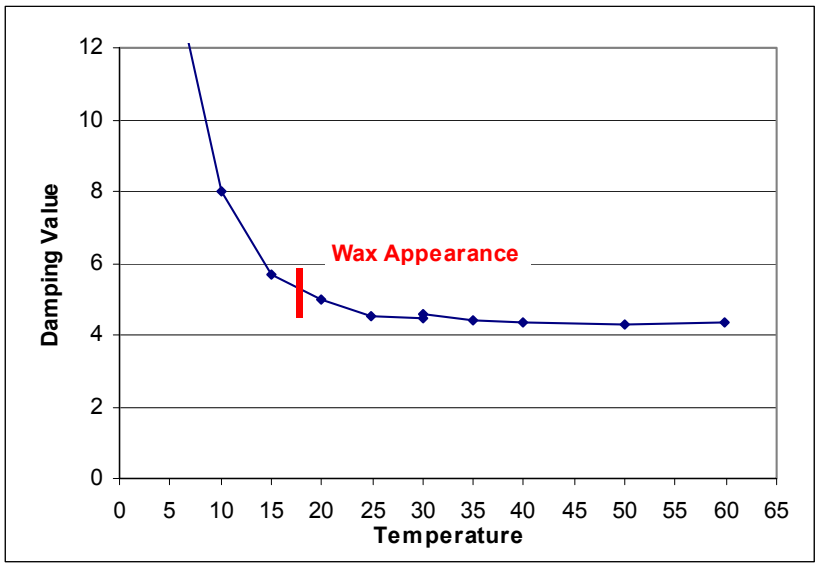
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	858.47	1390.4	4.99
2	35.00	34.95	847.63	1336.1	4.60
3	10.00	10.02	865.51	1428.3	20.12
4	50.00	49.91	837.02	1282.6	4.60
5	5.00	5.03	870.09	1447.9	14.62
6	60.00	59.88	830.08	1247.8	4.60
7	15.00	15.00	862.57	1408.5	6.14
8	30.00	29.97	851.25	1353.4	4.77
9	40.00	39.94	844.09	1317.6	4.53
10	25.00	24.98	854.76	1370.8	4.83
11	20.00	19.99	858.58	1389.4	5.29

Sample Details and Data

Sample Name:	Azeri Light	**Sample Number:**	159
Sample Type:	Crude oil	**Sample date :**	01/10/2000

Damping Curve



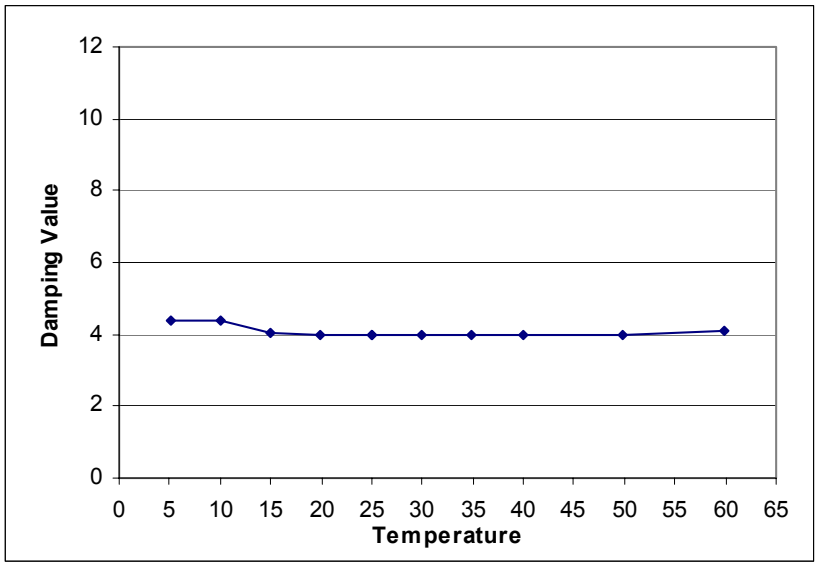
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	840.00	1343.2	4.56
2	35.00	34.95	836.38	1324.9	4.40
3	5.00	5.03	858.48	1436.6	14.53
4	10.00	10.02	855.23	1417.4	8.00
5	20.00	19.99	847.21	1379.3	4.98
6	15.00	15.01	850.94	1397.5	5.68
7	40.00	39.94	832.78	1306.7	4.33
8	50.00	49.91	825.72	1271.2	4.31
9	60.00	59.88	818.69	1236.4	4.33
10	25.00	24.97	843.29	1359.7	4.52
11	30.00	29.97	839.81	1342.2	4.44

Sample Details and Data

Sample Name:	West Texas Intermediate	**Sample Number:**	160
Sample Type:	Crude oil	**Sample date :**	15/12/2000

Damping Curve



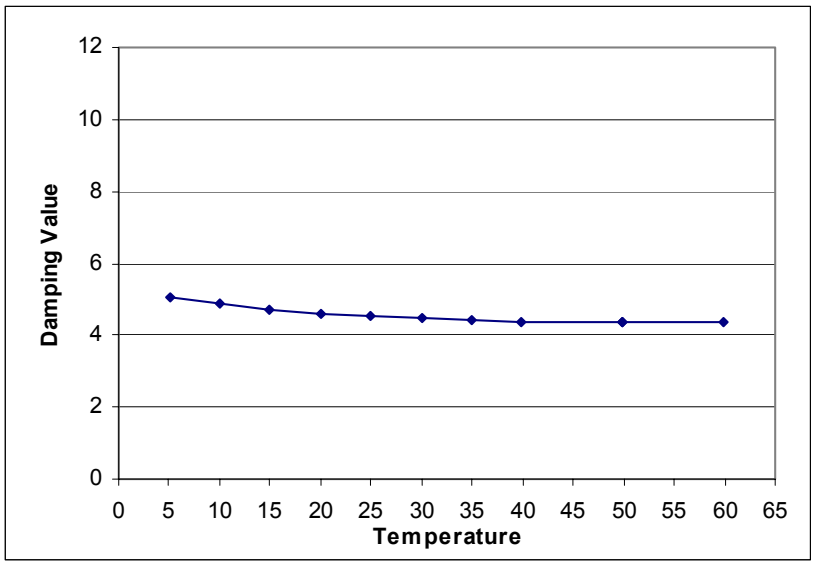
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	827.55	1319.0	3.99
2	35.00	34.95	820.29	1282.5	3.95
3	30.00	29.96	823.90	1300.5	3.97
4	15.00	15.00	834.87	1356.1	4.06
5	10.00	10.02	838.70	1375.1	4.36
6	60.00	59.89	802.08	1192.9	4.09
7	50.00	49.91	809.37	1227.9	4.00
8	5.00	5.03	842.58	1394.3	4.36
9	40.00	39.94	816.67	1264.6	3.96
10	20.00	19.99	831.13	1337.4	3.98
11	25.00	24.98	827.52	1319.0	3.96

Sample Details and Data

Sample Name:	Alaskan North Slope	**Sample Number:**	161
Sample Type:	Crude oil	**Sample date :**	19/04/2001

Damping Curve



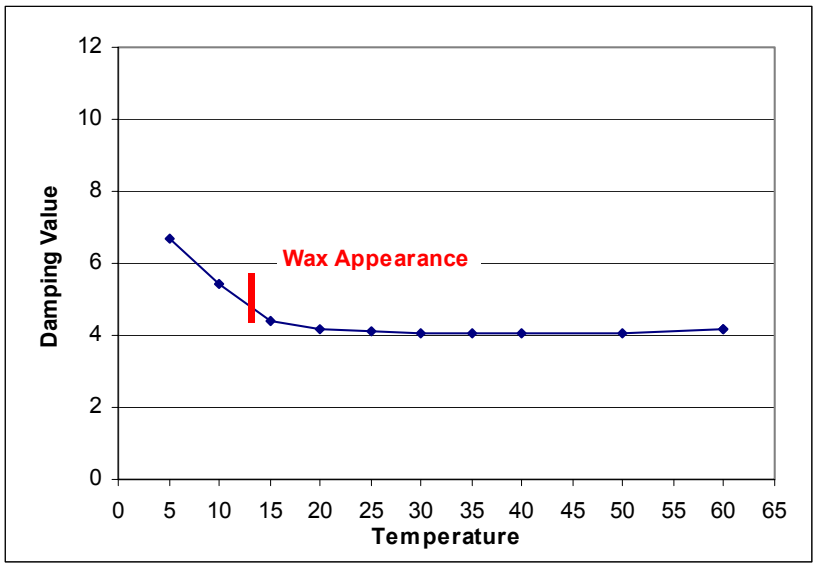
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	845.91	1254.9	4.37
2	60.00	59.88	838.72	1219.8	4.39
3	15.00	15.00	871.01	1380.9	4.73
4	10.00	10.02	874.73	1399.6	4.88
5	5.00	5.03	878.56	1418.7	5.07
6	20.00	19.99	867.53	1363.1	4.61
7	25.00	24.98	863.90	1344.8	4.53
8	40.00	39.94	853.12	1290.7	4.38
9	35.00	34.95	856.69	1308.2	4.42
10	30.00	29.96	860.26	1326.2	4.48
11	50.00	49.91	845.94	1255.1	4.34

Sample Details and Data

Sample Name:	Bonny Light	**Sample Number:**	162
Sample Type:	Crude oil	**Sample date :**	03/09/2000

Damping Curve



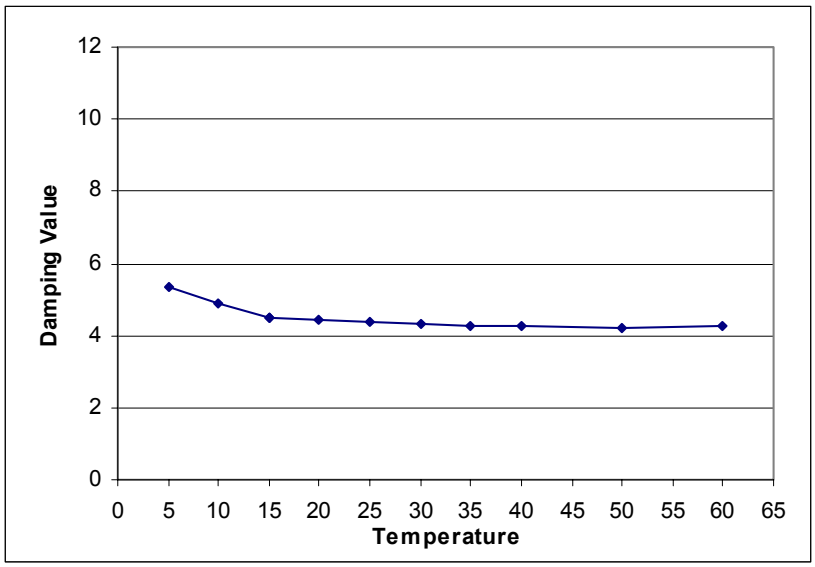
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	824.93	1222.7	4.15
2	30.00	29.96	846.41	1329.2	4.07
3	15.00	15.00	857.56	1384.6	4.41
4	35.00	34.95	842.88	1311.6	4.08
5	40.00	39.94	839.30	1293.6	4.05
6	5.00	5.03	866.44	1424.4	6.69
7	50.00	49.91	832.15	1258.0	4.07
8	10.00	10.02	861.87	1404.4	5.43
9	25.00	24.98	850.07	1347.6	4.13
10	20.00	19.99	853.63	1365.7	4.18
11	60.00	59.88	824.97	1222.7	4.16

Sample Details and Data

Sample Name:	Forcados	**Sample Number:**	163
Sample Type:	Crude oil	**Sample date :**	01/01/2002

Damping Curve



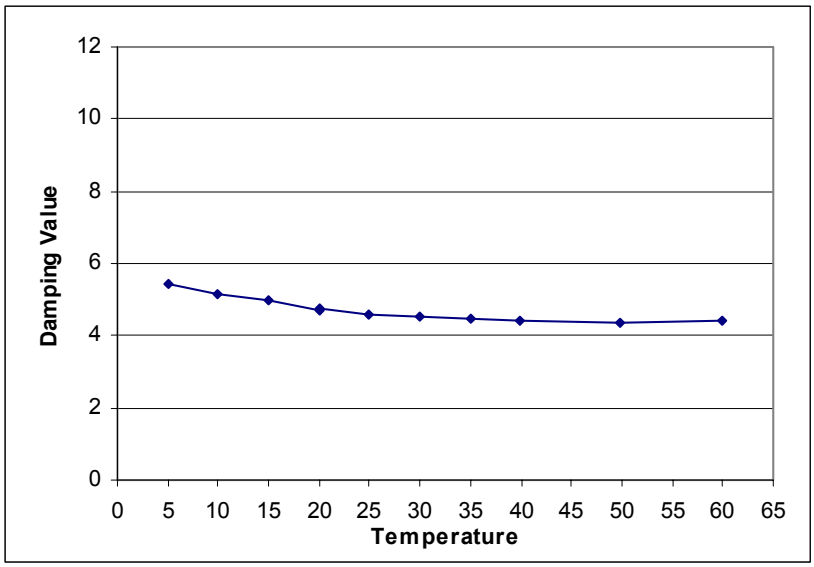
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	876.15	1407.5	4.50
2	5.00	5.03	884.39	1446.8	5.36
3	30.00	29.97	865.68	1353.7	4.30
4	20.00	19.99	872.66	1389.4	4.41
5	40.00	39.94	858.67	1318.0	4.24
6	25.00	24.97	869.15	1371.3	4.35
7	35.00	34.95	862.16	1335.7	4.29
8	60.00	59.88	844.67	1248.2	4.27
9	10.00	10.02	880.31	1427.1	4.89
10	50.00	49.91	851.68	1282.9	4.22
11	15.00	15.00	876.17	1407.5	4.52

Sample Details and Data

Sample Name:	Kirkuk	**Sample Number:**	164
Sample Type:	Crude oil	**Sample date :**	01/06/1999

Damping Curve



Density and Velocity of Sound Data Set

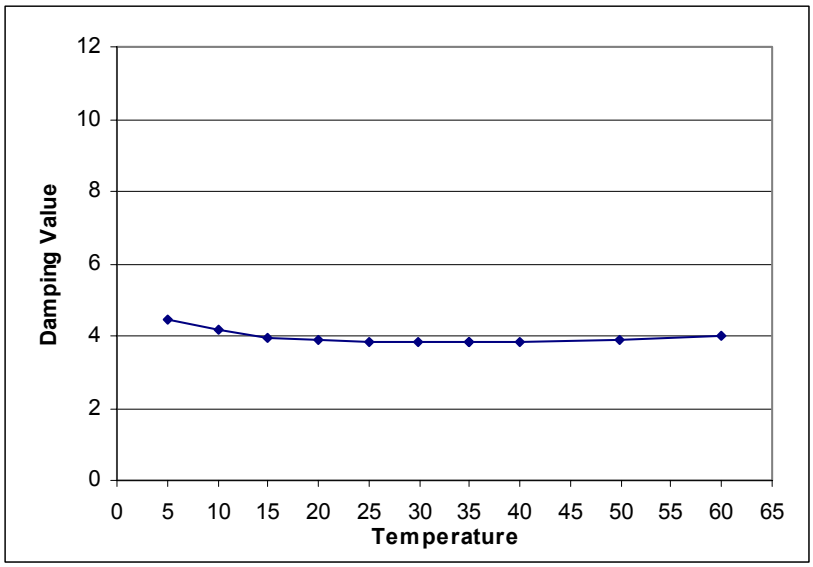
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	863.25	1378.3	4.75
2	10.00	10.02	870.71	1415.4	5.16
3	15.00	15.01	867.10	1397.3	4.97
4	30.00	29.97	856.17	1342.5	4.54
5	60.00	59.88	835.00	1237.6	4.41
6	25.00	24.97	859.49	1359.4	4.61
7	50.00	49.91	842.01	1271.9	4.38
8	40.00	39.93	849.00	1306.2	4.41
9	5.00	5.03	874.62	1434.1	5.41
10	35.00	34.95	852.55	1324.2	4.48
11	20.00	19.99	863.06	1377.5	4.70

Sample Details and Data

Sample Name: Murban **Sample Number:** 165

Sample Type: Crude oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

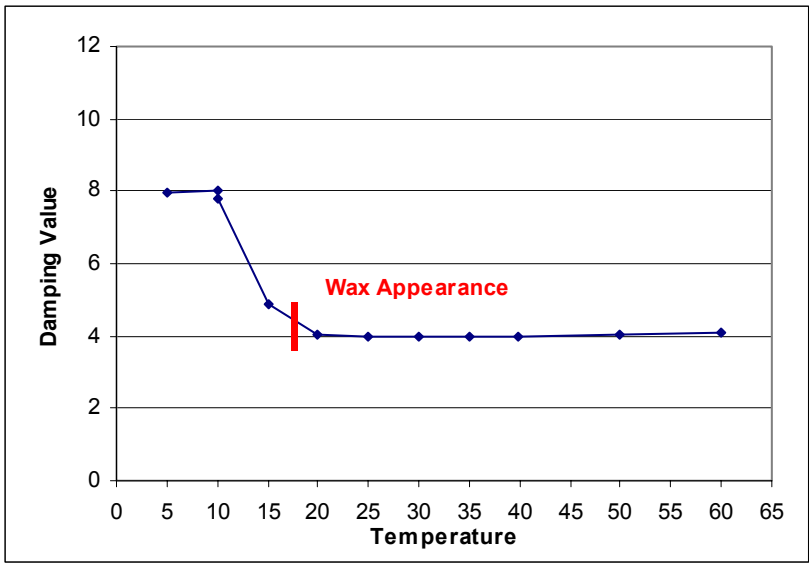
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	812.77	1276.0	3.84
2	20.00	19.99	823.74	1330.8	3.87
3	30.00	29.97	816.42	1294.3	3.84
4	40.00	39.94	809.12	1258.3	3.85
5	60.00	59.88	794.45	1186.8	4.02
6	15.00	15.00	827.64	1349.6	3.94
7	50.00	49.91	801.81	1222.4	3.92
8	25.00	24.97	820.02	1312.2	3.85
9	5.00	5.03	835.84	1388.4	4.45
10	10.00	10.02	831.93	1369.5	4.18
11	35.00	34.95	812.78	1276.5	3.84

Sample Details and Data

Sample Name: Qua Iboe **Sample Number:** 166

Sample Type: Crude oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

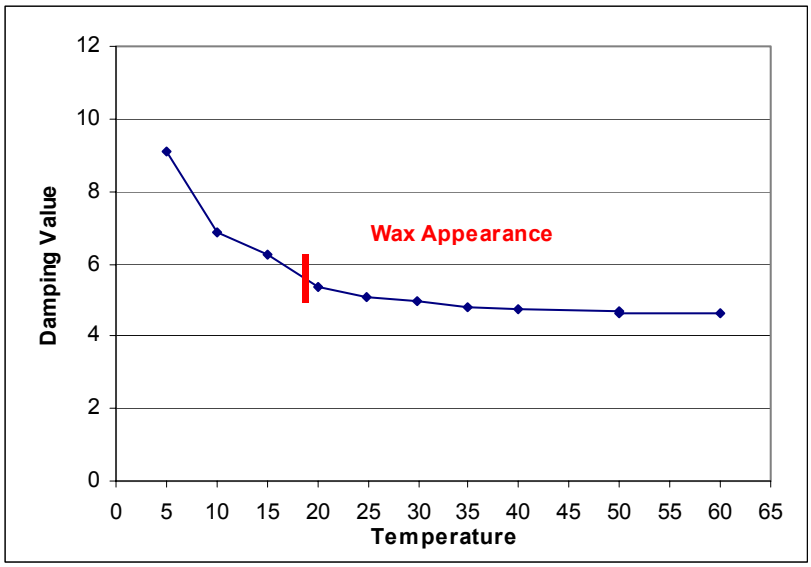
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	852.19	1388.9	8.00
2	40.00	39.94	828.94	1277.3	3.98
3	60.00	59.88	814.39	1205.7	4.12
4	20.00	19.99	843.31	1349.3	4.03
5	25.00	24.98	839.72	1331.3	3.98
6	5.00	5.03	856.50	1408.9	7.97
7	30.00	29.97	836.19	1313.3	4.00
8	35.00	34.95	832.57	1295.1	4.00
9	50.00	49.91	821.68	1241.0	4.03
10	15.00	15.00	847.55	1368.7	4.86
11	10.00	10.02	852.22	1388.6	7.82

Sample Details and Data

Sample Name: Iranian Heavy **Sample Number:** 167

Sample Type: Crude oil **Sample date :**

Damping Curve



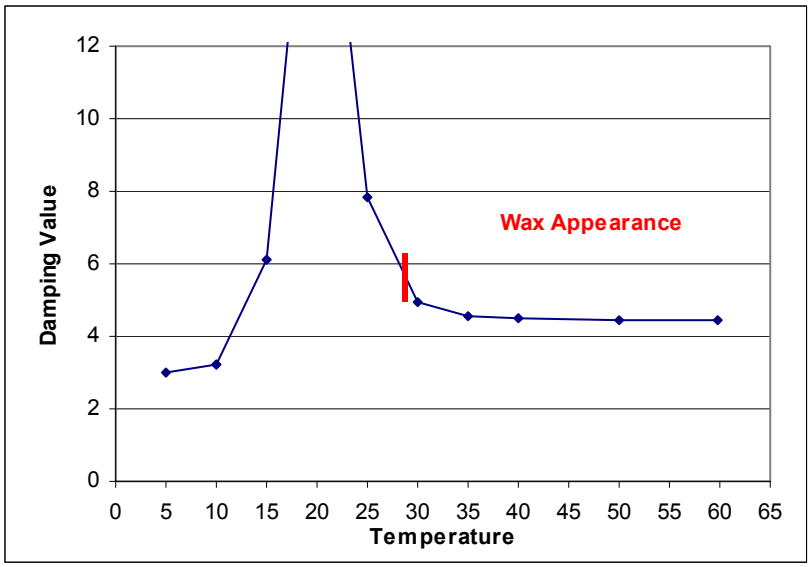
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	856.76	1277.0	4.66
2	25.00	24.98	874.42	1364.2	5.10
3	5.00	5.03	890.77	1441.5	9.10
4	15.00	15.01	882.84	1403.6	6.27
5	10.00	10.02	886.52	1421.6	6.85
6	60.00	59.89	849.72	1242.3	4.63
7	35.00	34.95	867.18	1328.2	4.83
8	30.00	29.96	870.78	1346.0	4.94
9	40.00	39.94	863.80	1311.5	4.75
10	20.00	19.99	878.28	1382.6	5.36
11	50.00	49.91	856.73	1276.6	4.65

Sample Details and Data

Sample Name:	Amna	**Sample Number:**	168
Sample Type:	Crude oil	**Sample date :**	22/06/1999

Damping Curve



Density and Velocity of Sound Data Set

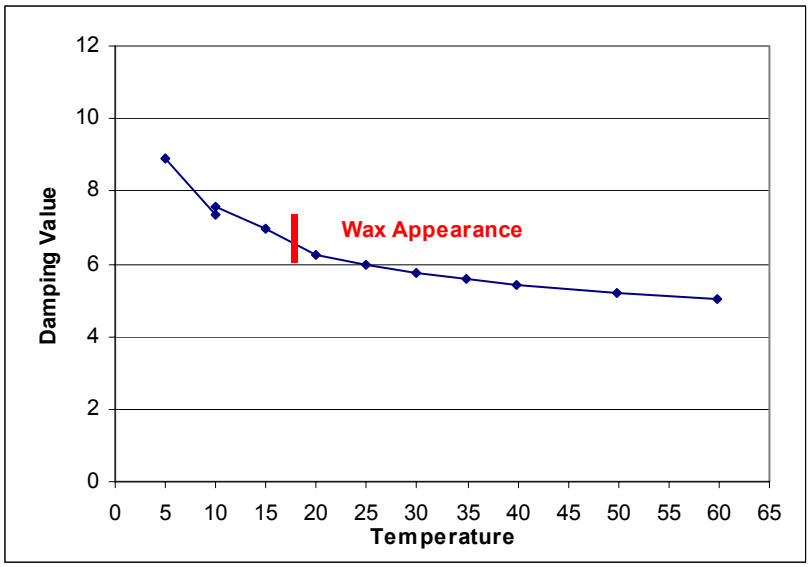
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	847.95	1424.4	3.24
2	15.00	15.01	843.20	1403.5	6.12
3	30.00	29.97	829.98	1344.1	4.92
4	50.00	49.91	815.70	1272.7	4.46
5	40.00	39.93	822.55	1307.1	4.47
6	60.00	59.88	808.71	1238.0	4.46
7	35.00	34.95	826.15	1324.9	4.57
8	20.00	19.99	836.98	1381.5	20.44
9	5.00	5.03	852.65	1446.6	2.98
10	25.00	24.98	834.14	1362.8	7.85
11	10.00	10.02	847.98	1424.0	3.21

Sample Details and Data

Sample Name: Kuwait **Sample Number:** 169

Sample Type: Crude oil **Sample date :**

Damping Curve



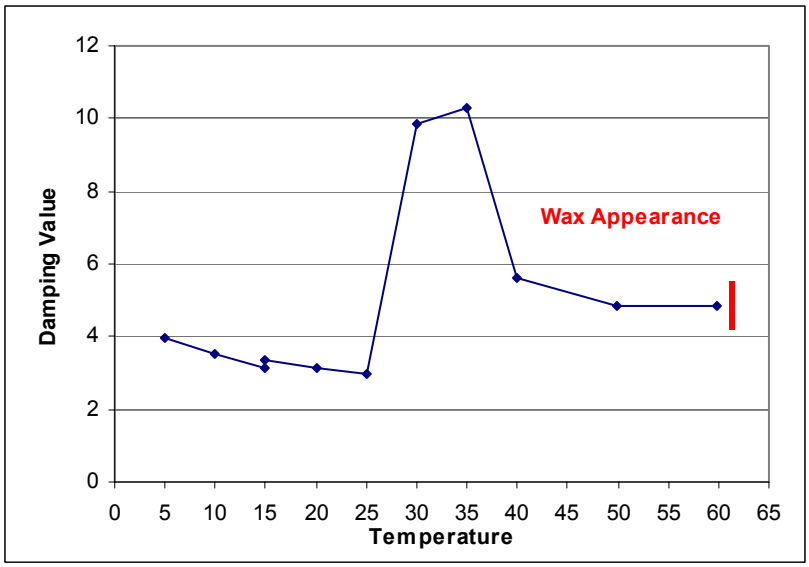
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	900.69	1448.0	7.55
2	30.00	29.97	886.41	1374.2	5.75
3	35.00	34.95	882.96	1356.5	5.57
4	5.00	5.03	904.57	1465.5	8.88
5	15.00	15.01	897.13	1428.0	6.96
6	25.00	24.98	889.85	1391.3	5.98
7	40.00	39.94	879.51	1338.8	5.42
8	20.00	19.99	893.24	1408.3	6.26
9	50.00	49.91	872.66	1304.4	5.17
10	60.00	59.88	865.84	1270.5	5.05
11	10.00	10.02	900.69	1445.7	7.38

Sample Details and Data

Sample Name:	Bach Ho	**Sample Number:**	170
Sample Type:	Crude oil	**Sample date :**	21/03/1999

Damping Curve



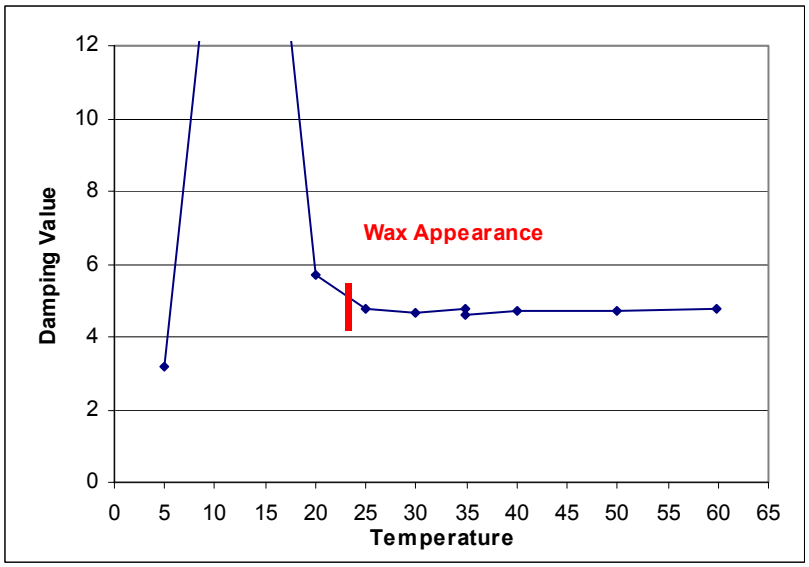
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	838.11	1417.1	3.14
2	30.00	29.97	819.95	1346.0	9.86
3	40.00	39.94	809.86	1305.7	5.60
4	50.00	49.91	801.74	1268.3	4.82
5	5.00	5.03	847.85		3.94
6	35.00	34.95	814.65	1324.8	10.29
7	10.00	10.02	843.39	1456.6	3.52
8	20.00	19.99	832.76	1396.7	3.12
9	60.00	59.88	794.60	1232.2	4.86
10	25.00	24.97	826.39	1370.6	2.99
11	15.00	15.01	838.00	1430.9	3.36

Sample Details and Data

Sample Name:	Azeri Light	**Sample Number:**	171
Sample Type:	Crude oil	**Sample date :**	10/07/2000

Damping Curve



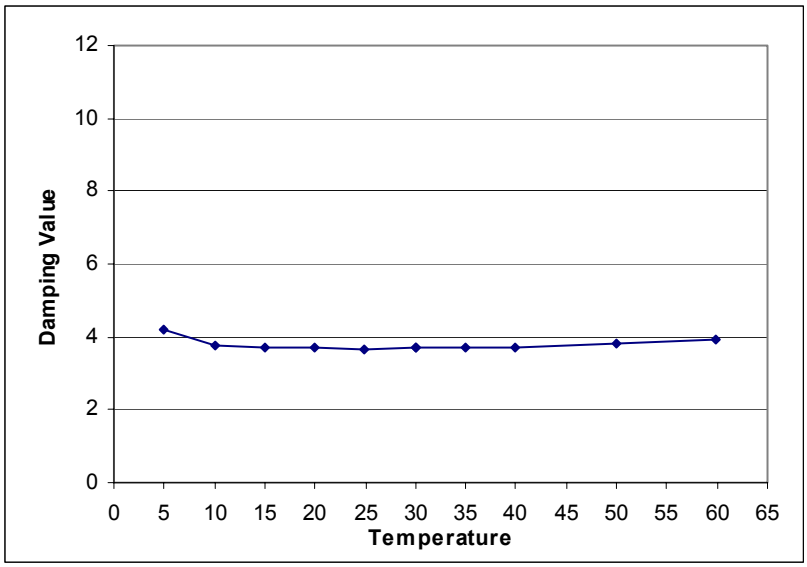
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	838.70	1336.8	4.76
2	5.00	5.03	864.36	1455.1	3.18
3	40.00	39.94	835.36	1319.8	4.70
4	50.00	49.91	828.53	1284.8	4.69
5	20.00	19.99	849.85	1391.1	5.67
6	15.00	15.01	853.36	1411.3	18.76
7	60.00	59.88	821.69	1250.2	4.77
8	30.00	29.96	842.32	1354.3	4.68
9	25.00	24.98	845.87	1372.2	4.74
10	10.00	10.02	858.35	1432.4	16.44
11	35.00	34.95	838.95	1337.2	4.62

Sample Details and Data

Sample Name:	Russian Export Blend	**Sample Number:**	172
Sample Type:	Crude oil	**Sample date :**	02/03/2001

Damping Curve



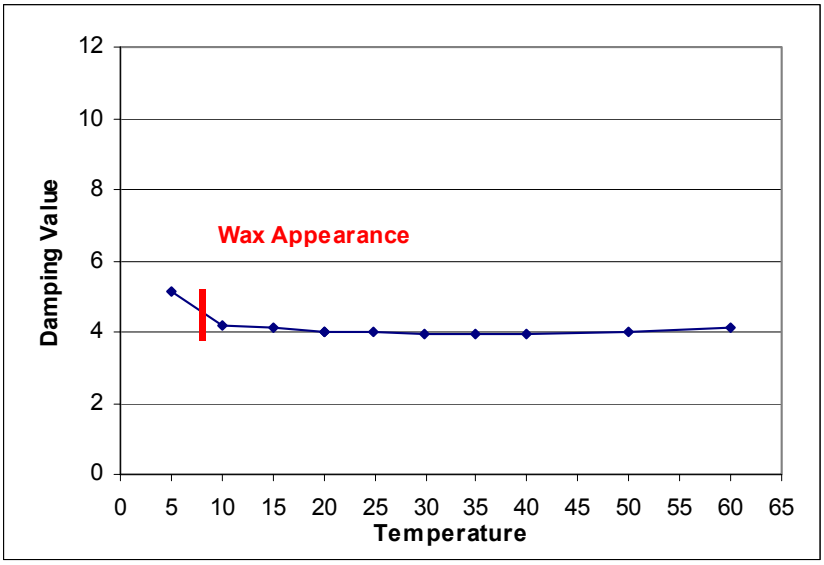
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.96	797.95	1266.3	3.70
2	20.00	19.99	805.46	1303.9	3.69
3	60.00	59.88	775.47	1157.0	3.94
4	40.00	39.93	790.45	1229.1	3.73
5	10.00	10.02	813.20	1342.1	3.76
6	25.00	24.98	801.79	1285.8	3.66
7	50.00	49.91	783.02	1193.4	3.80
8	35.00	34.95	794.21	1247.7	3.69
9	5.00	5.03	817.21	1361.6	4.17
10	15.00	15.01	809.41	1323.3	3.72
11	30.00	29.97	798.05	1267.2	3.68

Sample Details and Data

Sample Name:	Arab Extra Light	**Sample Number:**	173
Sample Type:	Crude oil	**Sample date :**	17/09/2000

Damping Curve



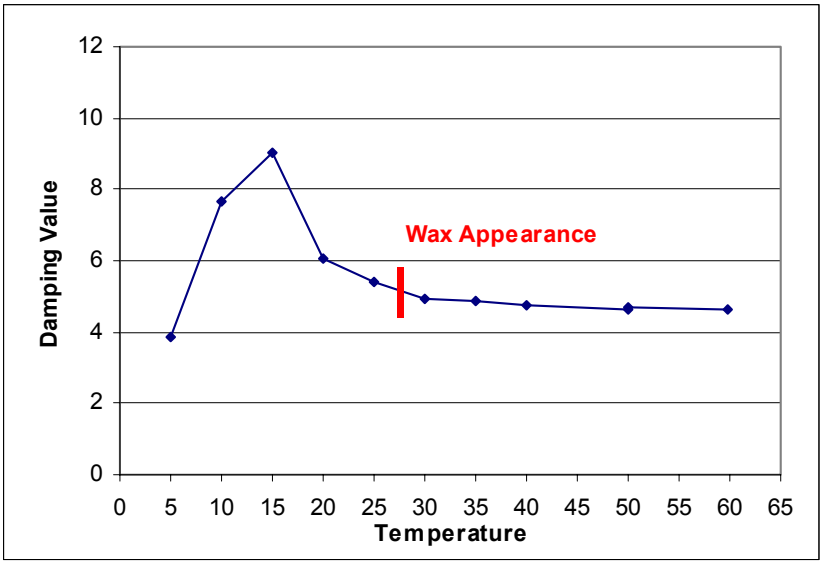
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	834.72	1345.1	4.02
2	5.00	5.03	846.48	1401.8	5.16
3	50.00	49.91	813.04	1237.1	4.00
4	10.00	10.02	842.38	1382.4	4.17
5	15.00	15.01	838.72	1364.0	4.11
6	40.00	39.94	820.27	1272.6	3.95
7	35.00	34.95	823.87	1290.5	3.96
8	25.00	24.98	831.06	1326.6	3.98
9	30.00	29.97	827.47	1308.7	3.96
10	60.00	59.89	805.84	1202.3	4.09
11	20.00	19.99	834.67	1344.8	4.01

Sample Details and Data

Sample Name:	Cabinda	**Sample Number:**	174
Sample Type:	Crude oil	**Sample date :**	20/11/2001

Damping Curve



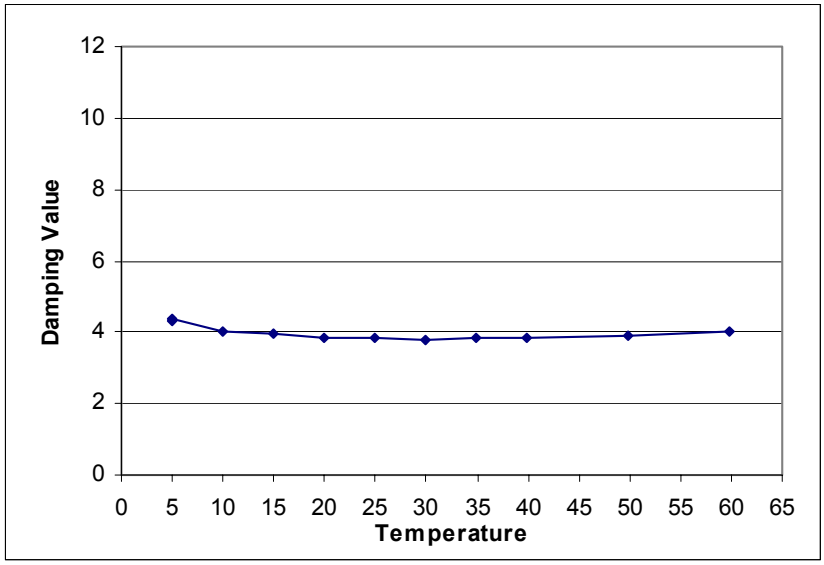
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	836.58	1283.1	4.67
2	15.00	15.00	863.37	1412.1	9.02
3	40.00	39.94	843.56	1317.8	4.77
4	30.00	29.96	850.46	1352.6	4.96
5	35.00	34.95	847.05	1335.3	4.86
6	20.00	19.99	858.56	1390.8	6.04
7	25.00	24.98	854.62	1372.2	5.41
8	5.00	5.03	873.09	1455.2	3.86
9	10.00	10.02	868.49	1434.7	7.69
10	60.00	59.88	829.59	1247.5	4.63
11	50.00	49.91	836.42	1281.2	4.66

Sample Details and Data

Sample Name:	Upper Zakum	**Sample Number:**	175
Sample Type:	Crude oil	**Sample date :**	01/12/2000

Damping Curve



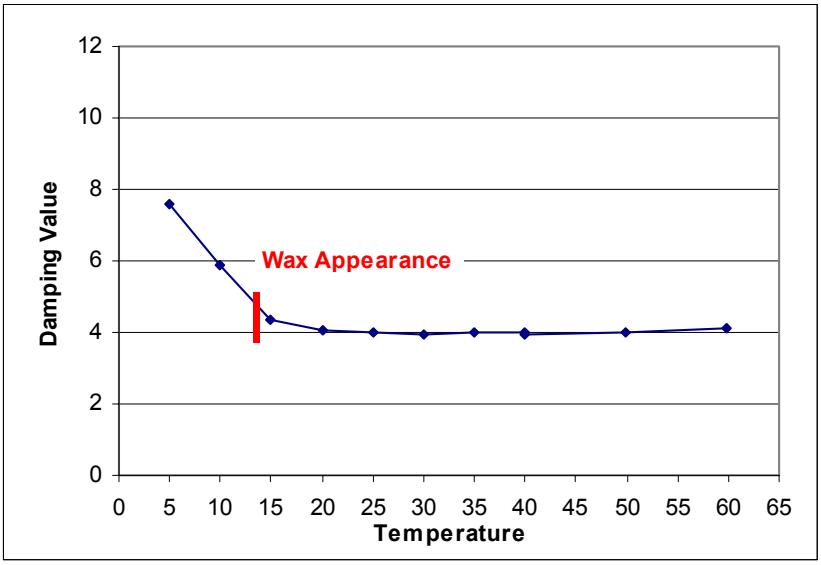
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	834.88	1383.6	4.34
2	35.00	34.95	811.89	1272.0	3.83
3	40.00	39.94	808.23	1253.8	3.83
4	60.00	59.88	793.48	1182.3	4.01
5	50.00	49.91	800.82	1216.9	3.90
6	25.00	24.97	819.18	1307.8	3.82
7	20.00	19.99	822.89	1326.3	3.82
8	10.00	10.02	830.82	1364.2	4.02
9	15.00	15.01	827.02	1345.6	3.96
10	30.00	29.97	815.59	1290.3	3.81
11	5.00	5.03	834.91	1383.7	4.36

Sample Details and Data

Sample Name:	Brent Blend	**Sample Number:**	176
Sample Type:	Crude oil	**Sample date :**	14/06/2002

Damping Curve



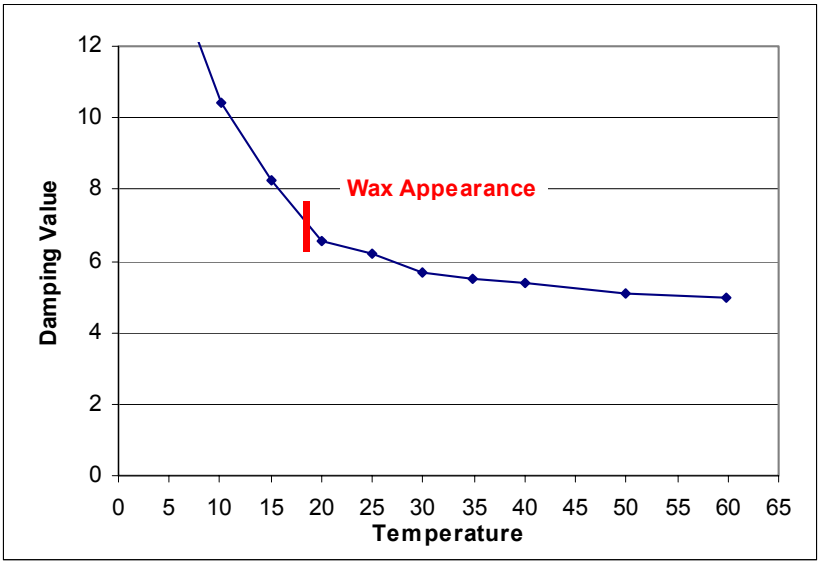
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	815.17	1259.5	3.97
2	30.00	29.96	822.53	1295.9	3.97
3	50.00	49.91	807.86	1223.5	4.03
4	25.00	24.97	826.32	1314.3	3.99
5	20.00	19.99	830.11	1333.0	4.06
6	15.00	15.01	834.00	1351.9	4.34
7	5.00	5.03	842.45	1390.8	7.56
8	10.00	10.02	838.45	1371.7	5.87
9	60.00	59.88	800.52	1187.6	4.13
10	35.00	34.95	818.92	1277.4	3.98
11	40.00	39.94	815.28	1259.5	3.99

Sample Details and Data

Sample Name:	Foinaven	**Sample Number:**	177
Sample Type:	Crude oil	**Sample date :**	23/07/2002

Damping Curve



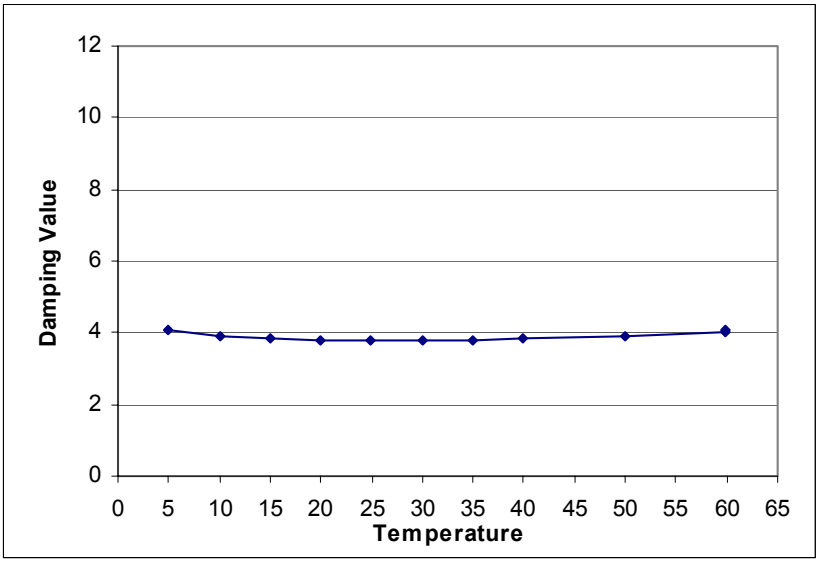
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	900.29	1501.7	14.34
2	25.00	24.98	885.62	1424.9	6.18
3	15.00	15.00	892.81	1461.0	8.23
4	60.00	59.88	861.82	1303.4	4.98
5	35.00	34.95	878.52	1388.0	5.48
6	30.00	29.96	881.90	1405.4	5.69
7	10.00	10.02	896.63	1480.1	10.43
8	50.00	49.91	868.50	1336.8	5.12
9	20.00	19.99	888.94	1441.2	6.58
10	40.00	39.94	875.24	1370.9	5.39
11	5.00	5.03	900.33	1500.3	13.74

Sample Details and Data

Sample Name:	Draugen	**Sample Number:**	178
Sample Type:	Crude oil	**Sample date :**	13/08/2002

Damping Curve



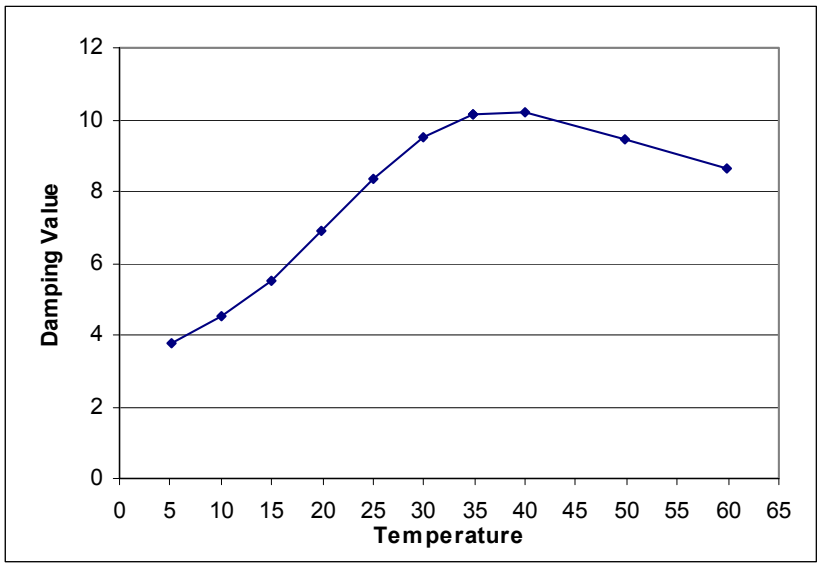
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.89	789.34	1164.7	4.06
2	15.00	15.00	823.11	1330.8	3.82
3	10.00	10.02	827.01	1350.1	3.89
4	40.00	39.94	804.37	1237.4	3.83
5	5.00	5.03	831.06	1369.8	4.08
6	20.00	19.99	819.40	1312.3	3.81
7	30.00	29.97	811.88	1274.7	3.80
8	25.00	24.98	815.58	1292.9	3.79
9	35.00	34.95	808.13	1256.0	3.81
10	50.00	49.91	796.87	1200.5	3.90
11	60.00	59.88	789.32	1163.9	4.01

Sample Details and Data

Sample Name:	HVI 650	**Sample Number:**	179
Sample Type:	Lube oil	**Sample date :**	03/01/2003

Damping Curve



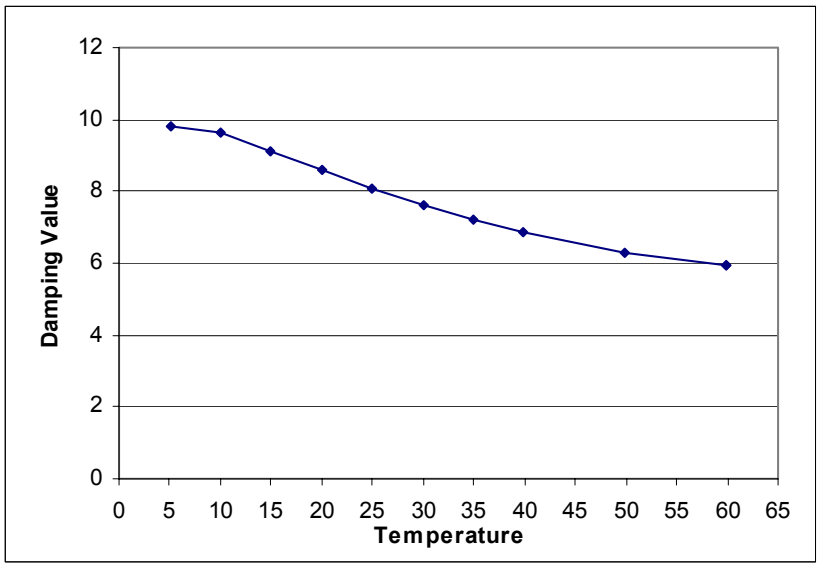
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	881.98	1462.6	10.13
2	60.00	59.88	867.07	1377.1	8.63
3	25.00	24.97	888.21	1501.1	8.36
4	10.00	10.02	897.71	1573.2	4.50
5	50.00	49.91	873.03	1410.4	9.44
6	20.00	19.99	891.39	1522.5	6.91
7	30.00	29.97	885.07	1481.4	9.51
8	40.00	39.94	878.97	1444.7	10.18
9	5.00	5.03	900.84	1604.5	3.77
10	15.00	15.01	894.56	1546.5	5.52
11	35.00	34.95	881.99	1462.9	10.14

Sample Details and Data

Sample Name:	HVI 115	**Sample Number:**	180
Sample Type:	Lube oil	**Sample date :**	03/01/2003

Damping Curve



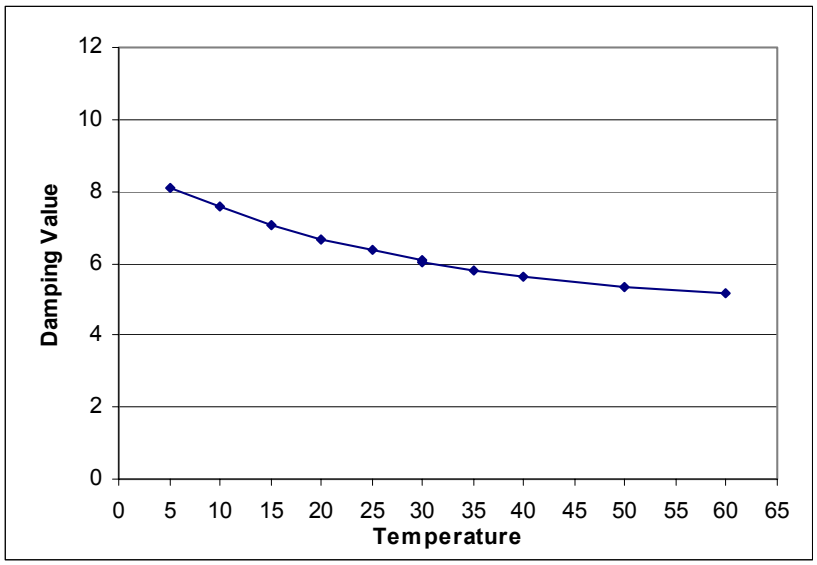
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	845.37	1337.5	5.93
2	35.00	34.94	860.79	1420.2	7.24
3	40.00	39.94	857.70	1403.9	6.87
4	20.00	19.99	870.11	1472.6	8.62
5	50.00	49.91	851.53	1370.5	6.29
6	10.00	10.02	876.31	1509.2	9.66
7	5.00	5.03	879.43	1528.5	9.80
8	30.00	29.97	863.90	1437.5	7.61
9	25.00	24.98	867.00	1454.9	8.09
10	15.00	15.00	873.21	1490.6	9.14
11	60.00	59.88	845.38	1337.5	5.92

Sample Details and Data

Sample Name:	VHVi 5.4	**Sample Number:**	181
Sample Type:	Lube oil	**Sample date :**	03/01/2003

Damping Curve



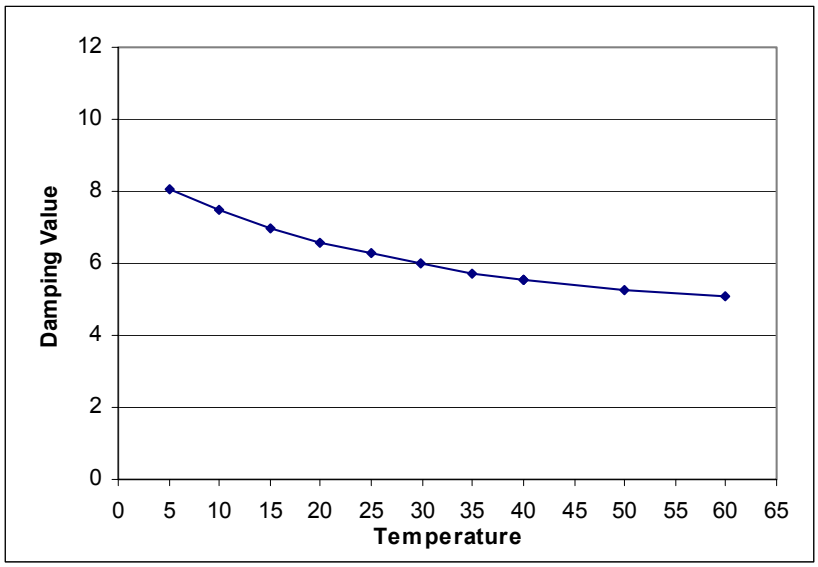
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	833.13	1410.5	6.05
2	50.00	49.91	820.58	1342.5	5.33
3	60.00	59.88	814.33	1309.3	5.16
4	10.00	10.02	845.79	1480.4	7.58
5	15.00	15.01	842.61	1462.6	7.08
6	40.00	39.94	826.85	1376.1	5.62
7	5.00	5.03	848.96	1498.4	8.09
8	20.00	19.99	839.45	1445.0	6.67
9	35.00	34.95	829.99	1393.1	5.82
10	25.00	24.98	836.29	1427.5	6.38
11	30.00	29.97	833.13	1410.2	6.08

Sample Details and Data

Sample Name:	HVI 60	**Sample Number:**	182
Sample Type:	Lube oil	**Sample date :**	03/01/2003

Damping Curve



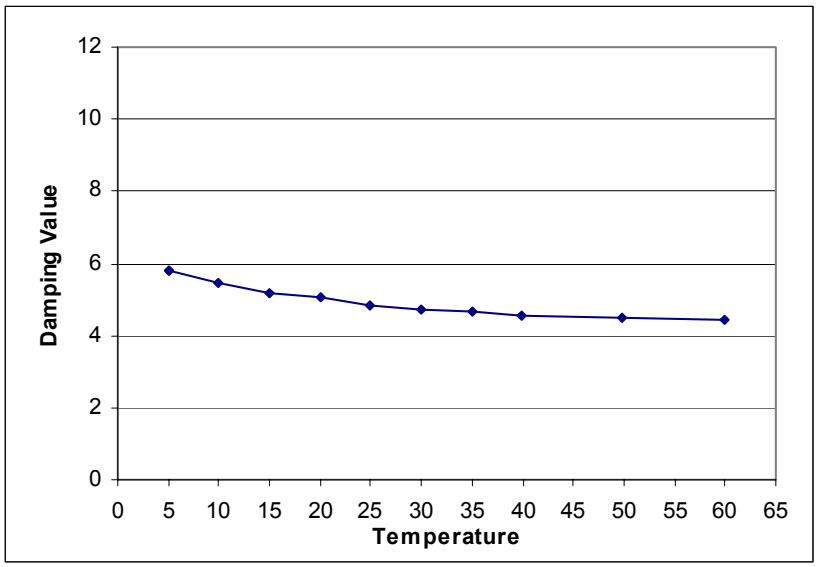
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	850.57	1381.7	5.52
2	25.00	24.98	860.08	1432.5	6.26
3	50.00	49.91	844.24	1347.6	5.24
4	15.00	15.00	866.46	1467.1	7.00
5	5.00	5.03	872.87	1503.2	8.04
6	20.00	19.99	863.27	1449.9	6.55
7	35.00	34.95	853.74	1398.0	5.72
8	10.00	10.02	869.67	1484.9	7.48
9	60.00	59.88	837.93	1313.7	5.08
10	30.00	29.96	856.90	1414.3	5.99
11	40.00	39.94	850.57	1380.6	5.55

Sample Details and Data

Sample Name:	MVIN 40	**Sample Number:**	183
Sample Type:	Lube oil	**Sample date :**	03/01/2003

Damping Curve



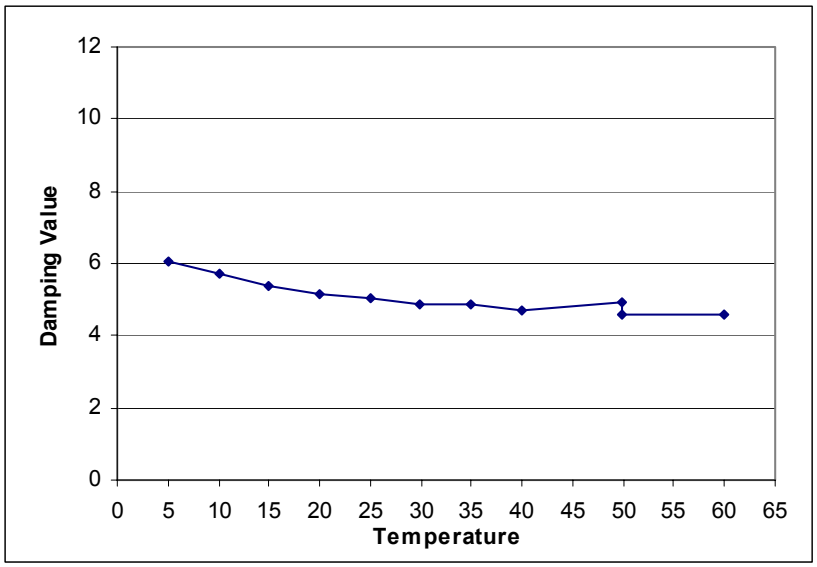
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	880.13	1468.1	5.80
2	60.00	59.89	843.79	1274.5	4.46
3	50.00	49.91	850.37	1308.1	4.47
4	20.00	19.99	870.19	1413.6	5.04
5	35.00	34.95	860.28	1360.7	4.64
6	25.00	24.98	866.88	1395.7	4.86
7	15.00	15.00	873.50	1431.6	5.19
8	40.00	39.94	856.98	1343.3	4.55
9	10.00	10.02	876.81	1449.8	5.47
10	30.00	29.97	863.58	1378.3	4.73
11	5.00	5.03	880.13	1468.2	5.80

Sample Details and Data

Sample Name:	Transformer Oil	**Sample Number:**	184
Sample Type:	Lube oil	**Sample date :**	03/01/2003

Damping Curve



Density and Velocity of Sound Data Set

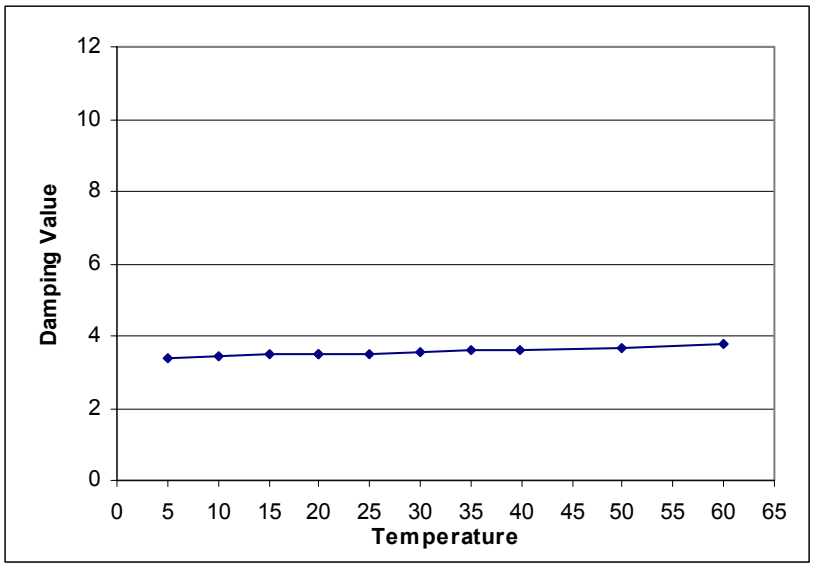
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	857.48	1321.8	4.90
2	35.00	34.95	867.63	1373.4	4.86
3	60.00	59.88	850.99	1287.9	4.57
4	25.00	24.97	874.26	1408.7	5.03
5	30.00	29.96	870.94	1391.3	4.87
6	5.00	5.03	887.48	1480.7	6.07
7	15.00	15.01	880.79	1444.6	5.38
8	40.00	39.94	864.29	1356.5	4.68
9	10.00	10.02	884.00	1462.6	5.69
10	20.00	19.99	877.36	1426.8	5.15
11	50.00	49.91	857.62	1322.1	4.58

Sample Details and Data

Sample Name: Jet A1 **Sample Number:** 185

Sample Type: Kerosine (Jet) **Sample date :**

Damping Curve



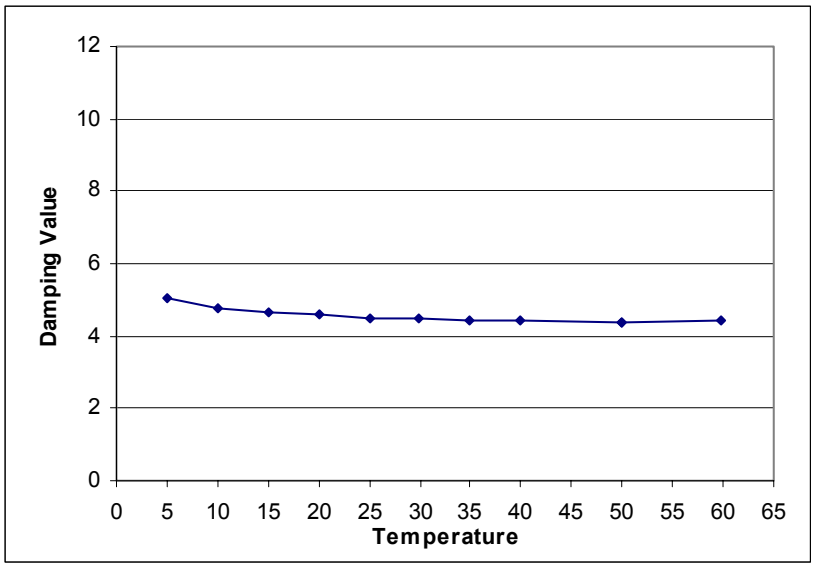
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	798.12	1308.5	3.47
2	35.00	34.95	786.91	1251.7	3.58
3	15.00	15.00	801.84	1327.9	3.47
4	5.00	5.03	809.28	1367.5	3.40
5	60.00	59.88	768.11	1162.3	3.79
6	10.00	10.02	805.56	1347.4	3.45
7	25.00	24.98	794.39	1289.2	3.51
8	40.00	39.94	783.17	1233.2	3.58
9	50.00	49.91	775.66	1197.1	3.66
10	30.00	29.96	790.66	1270.0	3.55
11	20.00	19.99	798.12	1308.3	3.50

Sample Details and Data

Sample Name:	Isthmus	**Sample Number:**	186
Sample Type:	Crude oil	**Sample date :**	24/01/2002

Damping Curve



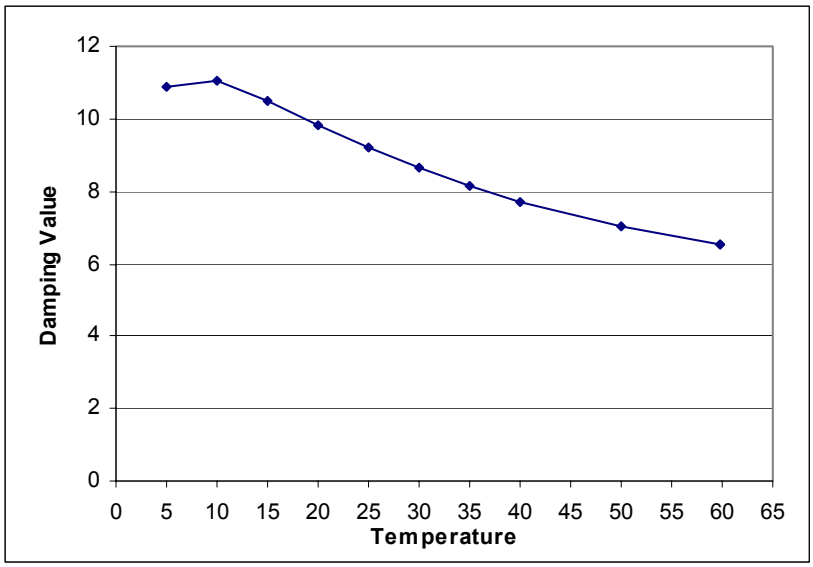
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	838.93	1258.9	4.37
2	30.00	29.96	853.13	1329.7	4.49
3	5.00	5.03	871.36	1421.5	5.02
4	20.00	19.99	860.25	1366.0	4.58
5	40.00	39.94	846.06	1294.8	4.41
6	35.00	34.95	849.60	1312.0	4.44
7	15.00	15.00	863.79	1383.8	4.67
8	10.00	10.02	867.34	1402.1	4.78
9	25.00	24.98	856.70	1347.9	4.49
10	60.00	59.88	831.84	1225.2	4.40
11	50.00	49.91	838.91	1259.8	4.39

Sample Details and Data

Sample Name:	Maya	**Sample Number:**	187
Sample Type:	Crude oil	**Sample date :**	24/01/2002

Damping Curve



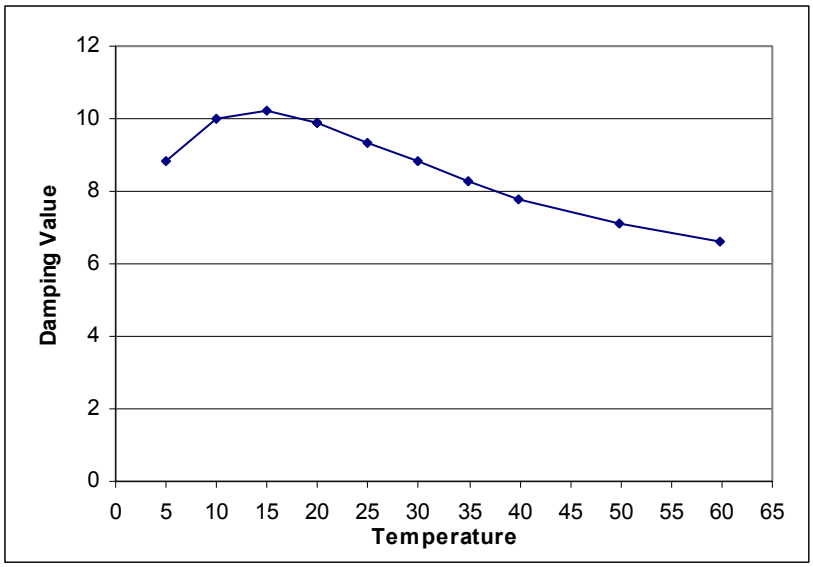
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.88	898.01	1286.6	6.55
2	25.00	24.97	921.91	1407.5	9.19
3	40.00	39.94	911.70	1354.7	7.73
4	30.00	29.96	918.52	1389.7	8.65
5	50.00	49.91	904.85	1320.5	7.04
6	10.00	10.02	932.33	1463.6	11.03
7	20.00	19.99	925.47	1426.4	9.83
8	35.00	34.95	915.16	1372.8	8.13
9	15.00	15.00	928.76	1444.4	10.47
10	5.00	5.03	936.06	1483.6	10.89
11	60.00	59.88	898.00	1286.6	6.55

Sample Details and Data

Sample Name:	Alba	**Sample Number:**	188
Sample Type:	Crude oil	**Sample date :**	24/01/2003

Damping Curve



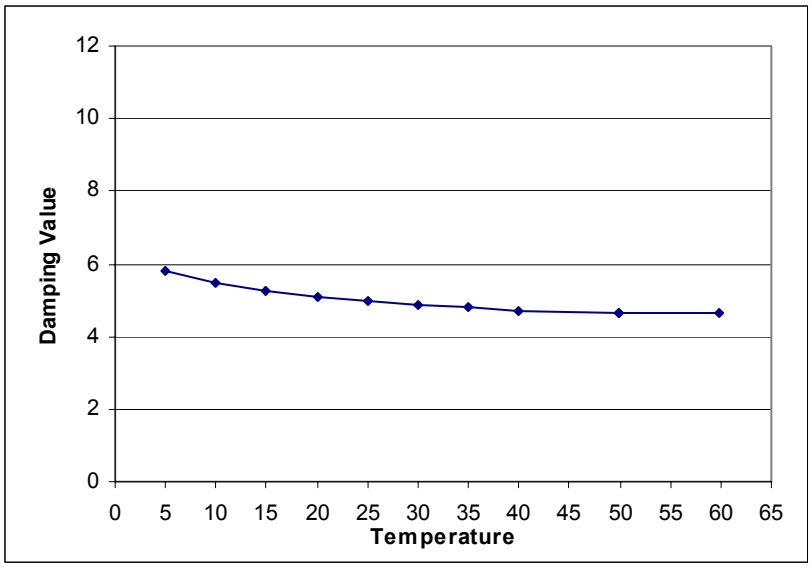
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	930.28	1480.6	9.88
2	25.00	24.98	927.07	1462.4	9.31
3	5.00	5.03	940.41	1541.7	8.84
4	15.00	15.01	933.75	1500.6	10.23
5	10.00	10.02	937.04	1520.5	10.01
6	40.00	39.94	917.36	1409.7	7.80
7	50.00	49.91	910.84	1375.6	7.11
8	60.00	59.88	904.33	1342.2	6.64
9	30.00	29.96	923.79	1444.0	8.82
10	35.00	34.95	920.56	1426.6	8.27
11	20.00	19.99	930.29	1480.4	9.87

Sample Details and Data

Sample Name:	Oman Export Blend	**Sample Number:**	189
Sample Type:	Crude oil	**Sample date :**	27/01/2003

Damping Curve



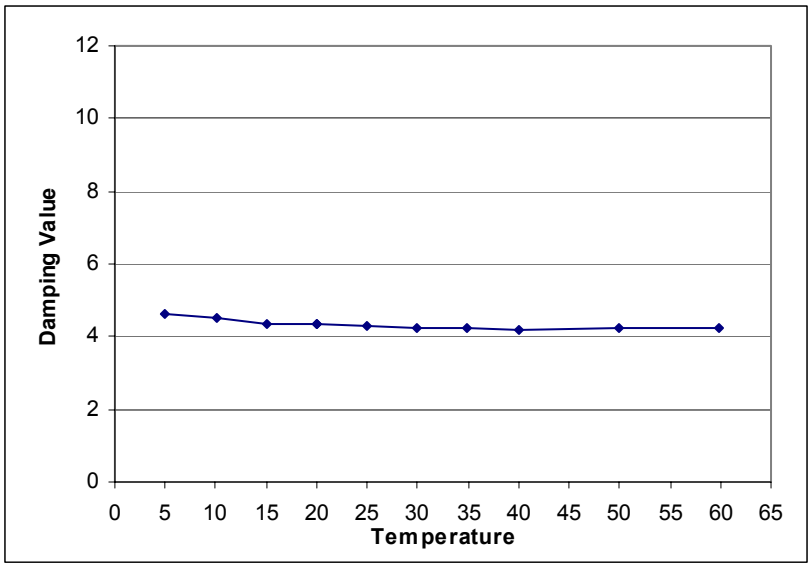
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	833.25	1264.8	4.64
2	40.00	39.93	840.18	1299.1	4.71
3	25.00	24.98	850.61	1352.7	4.99
4	60.00	59.88	826.28	1230.1	4.63
5	10.00	10.02	861.30	1407.8	5.50
6	35.00	34.95	843.72	1317.7	4.82
7	15.00	15.00	857.70	1389.3	5.24
8	30.00	29.97	847.21	1335.5	4.88
9	20.00	19.99	854.15	1371.0	5.08
10	5.00	5.03	864.98	1426.7	5.79
11	50.00	49.91	833.24	1264.7	4.64

Sample Details and Data

Sample Name:	Danish	**Sample Number:**	190
Sample Type:	Crude oil	**Sample date :**	06/02/2003

Damping Curve



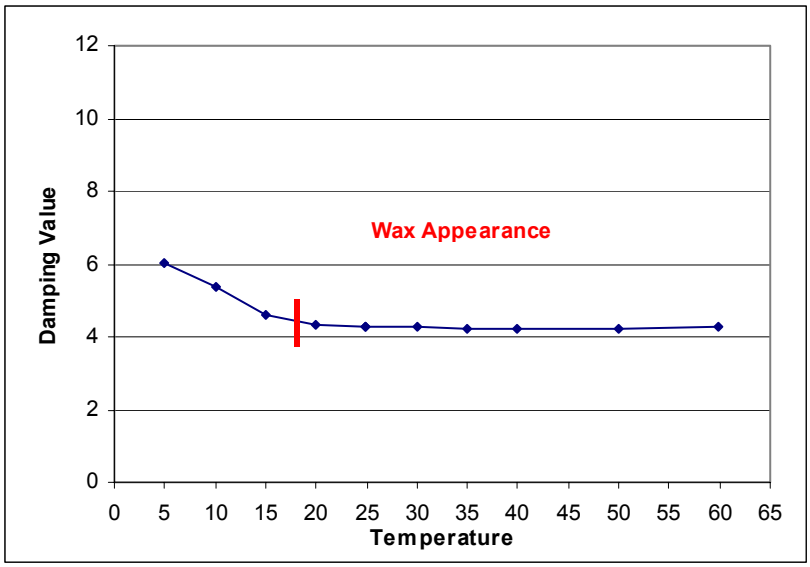
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	852.59	1361.6	4.33
2	35.00	34.95	841.87	1307.2	4.22
3	40.00	39.94	838.29	1289.2	4.21
4	60.00	59.88	823.95	1218.3	4.25
5	30.00	29.96	845.45	1324.9	4.25
6	25.00	24.98	849.03	1343.2	4.27
7	15.00	15.01	856.19	1380.1	4.36
8	5.00	5.03	863.55	1417.8	4.62
9	10.00	10.02	859.98	1399.4	4.53
10	50.00	49.91	831.14	1253.6	4.22
11	20.00	19.99	852.61	1361.6	4.33

Sample Details and Data

Sample Name:	Zarzaitine	**Sample Number:**	191
Sample Type:	Crude oil	**Sample date :**	04/10/2002

Damping Curve



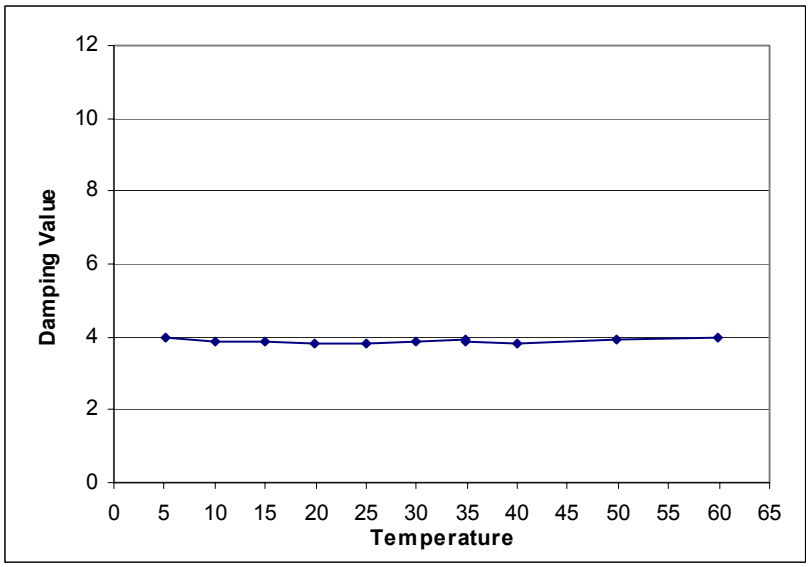
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	835.94	1335.0	4.26
2	35.00	34.95	828.68	1298.0	4.25
3	40.00	39.94	825.11	1279.9	4.21
4	60.00	59.88	810.81	1210.9	4.25
5	5.00	5.03	851.87	1412.4	6.00
6	15.00	15.01	843.71	1373.5	4.63
7	50.00	49.91	818.00	1244.9	4.21
8	30.00	29.96	832.26	1316.0	4.25
9	20.00	19.99	839.42	1353.2	4.31
10	10.00	10.02	847.56	1392.4	5.38
11	25.00	24.98	835.91	1335.2	4.27

Sample Details and Data

Sample Name:	Zarzaitine	**Sample Number:**	192
Sample Type:	Crude oil	**Sample date :**	06/02/2003

Damping Curve



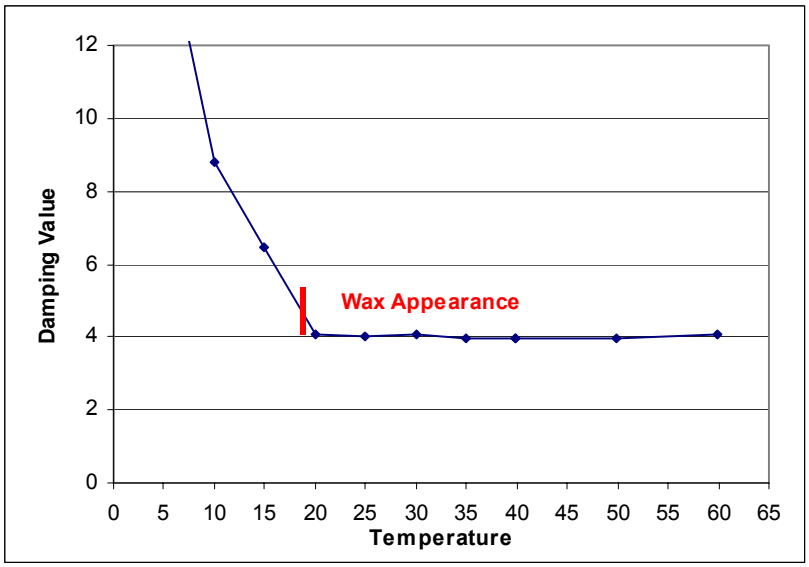
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	792.37	1252.7	3.94
2	50.00	49.91	781.33	1198.2	3.93
3	60.00	59.88	773.89	1163.3	4.00
4	15.00	15.00	807.01	1329.4	3.87
5	40.00	39.94	788.61	1234.4	3.84
6	25.00	24.98	799.56	1290.5	3.85
7	10.00	10.02	810.83	1349.4	3.89
8	30.00	29.97	795.91	1272.0	3.86
9	20.00	19.99	803.20	1310.0	3.84
10	5.00	5.03	814.73	1369.4	3.98
11	35.00	34.95	792.18	1253.0	3.87

Sample Details and Data

Sample Name:	Anasuria	**Sample Number:**	193
Sample Type:	Crude oil	**Sample date :**	14/01/2001

Damping Curve



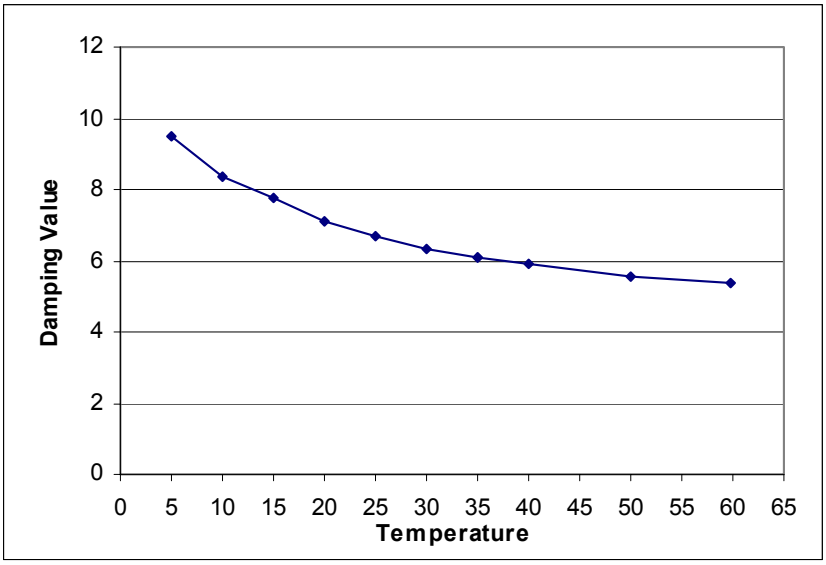
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	807.86	1255.9	3.96
2	35.00	34.95	811.52	1273.5	3.95
3	5.00	5.03	835.16	1390.4	15.23
4	10.00	10.02	831.85	1370.7	8.78
5	30.00	29.97	815.46	1293.3	4.09
6	15.00	15.00	827.71	1350.2	6.49
7	60.00	59.89	792.94	1185.1	4.09
8	25.00	24.97	819.05	1311.0	4.00
9	20.00	19.99	823.14	1330.4	4.07
10	50.00	49.91	800.42	1219.8	3.98
11	40.00	39.93	807.77	1254.9	3.94

Sample Details and Data

Sample Name:	Balder	**Sample Number:**	194
Sample Type:	Crude oil	**Sample date :**	22/08/2002

Damping Curve



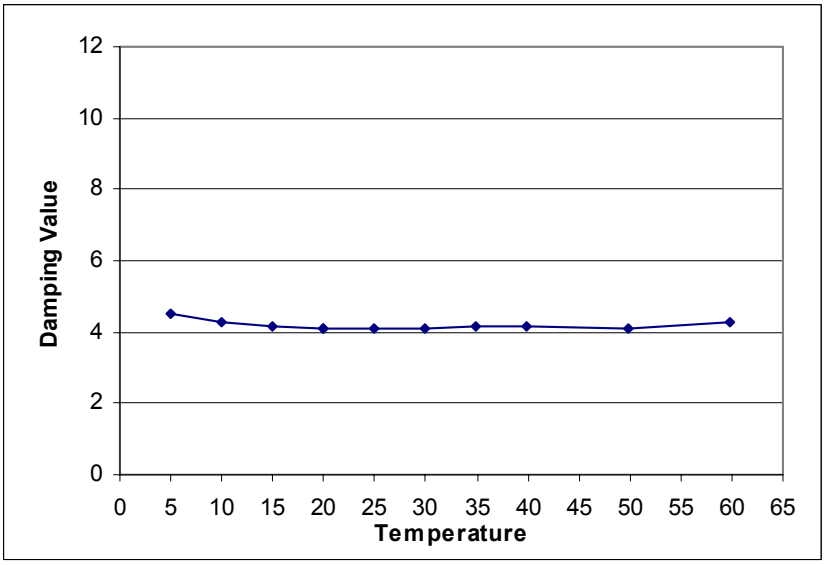
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	900.25	1393.5	6.07
2	10.00	10.02	917.52	1483.9	8.35
3	15.00	15.01	914.09	1465.6	7.74
4	5.00	5.03	921.11	1503.9	9.51
5	30.00	29.97	903.66	1411.2	6.33
6	60.00	59.88	883.55	1310.5	5.36
7	20.00	19.99	910.39	1446.0	7.11
8	40.00	39.94	896.90	1376.4	5.88
9	25.00	24.98	906.95	1428.0	6.66
10	50.00	49.91	890.20	1342.8	5.55
11	35.00	34.95	900.20	1392.9	6.07

Sample Details and Data

Sample Name:	Kittiwake	**Sample Number:**	195
Sample Type:	Crude oil	**Sample date :**	24/12/2002

Damping Curve



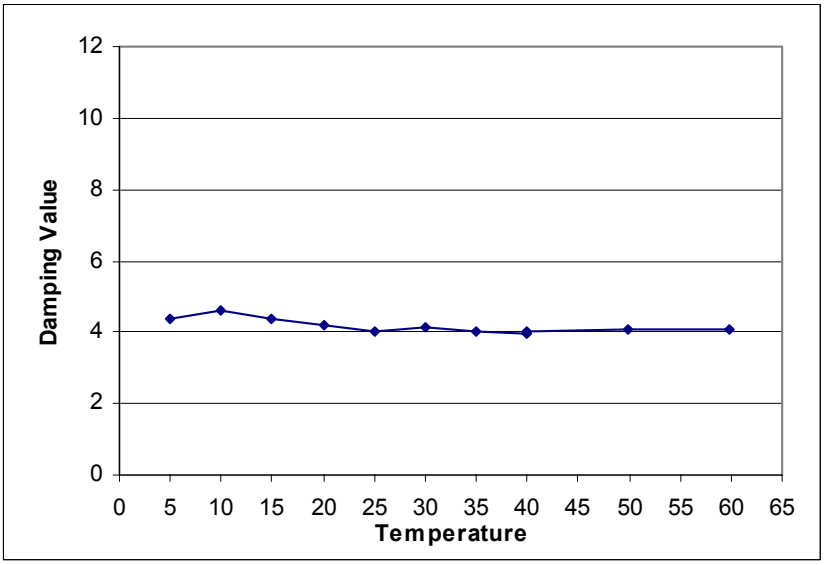
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	821.04	1334.3	4.08
2	40.00	39.94	806.45	1260.2	4.15
3	25.00	24.98	817.38	1315.1	4.12
4	30.00	29.96	813.79	1296.7	4.13
5	15.00	15.00	825.00	1353.1	4.14
6	5.00	5.03	833.10	1392.8	4.49
7	10.00	10.02	829.24	1373.5	4.29
8	35.00	34.95	810.31	1278.6	4.19
9	60.00	59.88	791.90	1190.0	4.25
10	50.00	49.91	799.24	1223.8	4.11
11	20.00	19.99	821.35	1334.0	4.12

Sample Details and Data

Sample Name:	Kittiwake	**Sample Number:**	196
Sample Type:	Crude oil	**Sample date :**	14/01/2001

Damping Curve



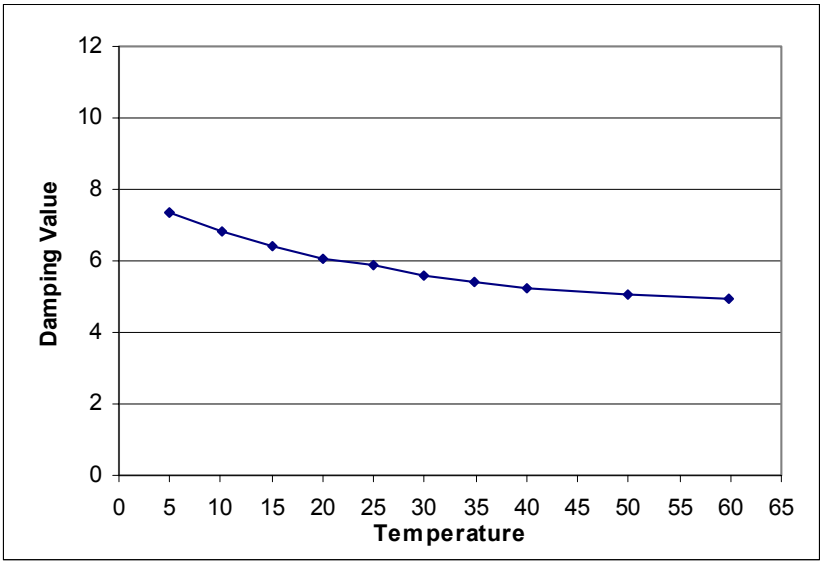
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	805.17	1259.6	3.98
2	15.00	15.00	824.12	1352.8	4.38
3	60.00	59.88	790.37	1190.4	4.08
4	25.00	24.97	816.15	1313.9	4.03
5	5.00	5.03	832.31	1393.3	4.38
6	30.00	29.97	812.82	1296.6	4.12
7	10.00	10.02	828.45	1372.9	4.61
8	20.00	19.99	820.56	1333.9	4.17
9	50.00	49.91	797.95	1224.5	4.06
10	35.00	34.95	808.86	1276.9	4.02
11	40.00	39.94	805.24	1259.2	4.01

Sample Details and Data

Sample Name:	SN90	**Sample Number:**	197
Sample Type:	Lube oil	**Sample date :**	03/01/2003

Damping Curve



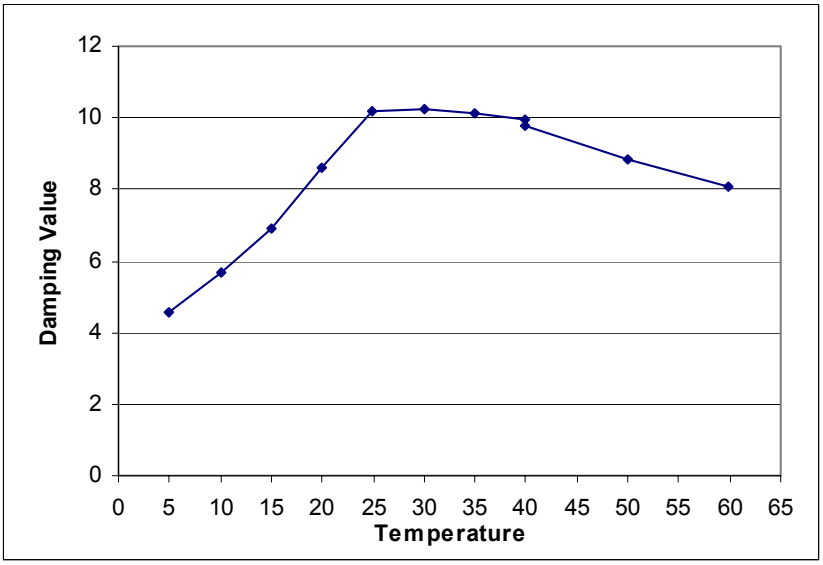
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	870.17	1497.5	7.34
2	15.00	15.01	863.71	1460.4	6.39
3	10.00	10.02	866.94	1478.7	6.82
4	35.00	34.95	850.86	1390.0	5.44
5	20.00	19.99	860.49	1442.0	6.07
6	30.00	29.97	854.07	1407.2	5.59
7	60.00	59.88	834.90	1307.9	4.94
8	40.00	39.93	847.66	1372.2	5.26
9	25.00	24.98	857.27	1424.1	5.86
10	50.00	49.91	841.28	1339.8	5.06
11	5.00	5.03	870.18	1497.5	7.34

Sample Details and Data

Sample Name:	Header Core 2500	**Sample Number:**	198
Sample Type:	Lube oil	**Sample date :**	07/01/2003

Damping Curve



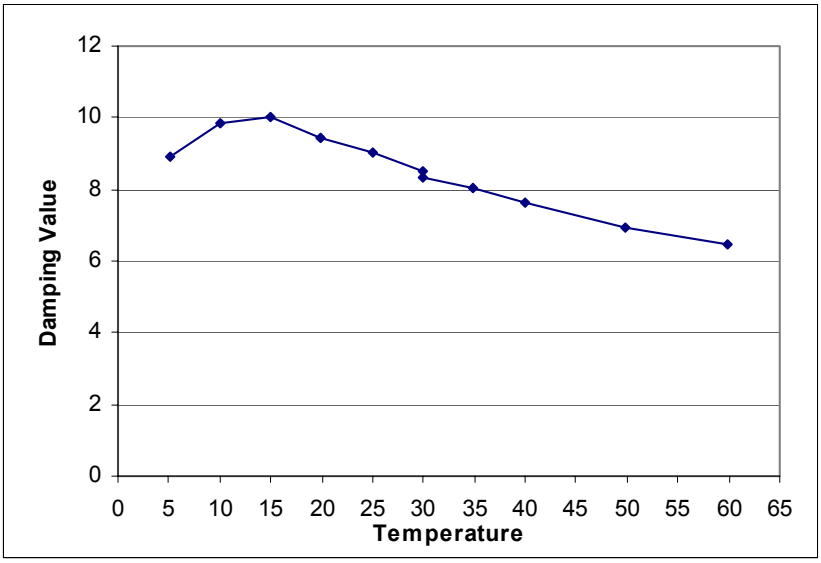
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	880.84	1440.5	9.95
2	25.00	24.97	889.99	1496.7	10.18
3	50.00	49.91	874.94	1407.2	8.82
4	20.00	19.99	893.26	1517.8	8.63
5	10.00	10.02	899.69	1568.3	5.66
6	5.00	5.03	902.89	1599.6	4.54
7	30.00	29.97	887.02	1477.2	10.23
8	60.00	59.88	869.00	1375.2	8.07
9	15.00	15.00	896.57	1541.2	6.91
10	35.00	34.95	884.06	1458.4	10.12
11	40.00	39.94	881.06	1440.6	9.78

Sample Details and Data

Sample Name:	Core 600	**Sample Number:**	199
Sample Type:	Lube oil	**Sample date :**	09/01/2003

Damping Curve



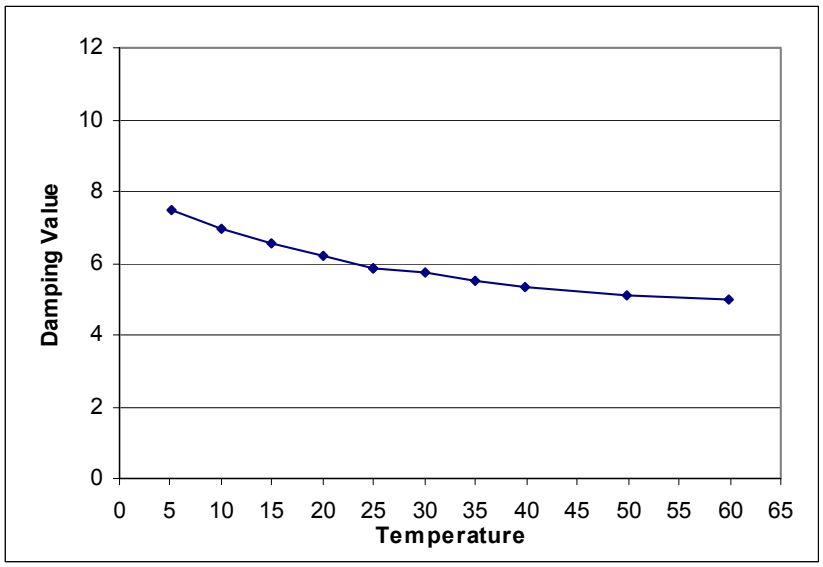
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	873.67	1450.0	8.35
2	15.00	15.00	882.90	1505.2	10.02
3	50.00	49.91	861.36	1383.0	6.91
4	10.00	10.02	886.07	1525.1	9.83
5	20.00	19.99	879.86	1486.1	9.45
6	35.00	34.95	870.62	1432.6	8.02
7	60.00	59.88	855.26	1351.3	6.45
8	25.00	24.97	876.80	1467.0	9.04
9	5.00	5.03	889.30	1546.5	8.90
10	40.00	39.94	867.55	1415.5	7.62
11	30.00	29.96	873.72	1449.1	8.51

Sample Details and Data

Sample Name:	Core 100	**Sample Number:**	200
Sample Type:	Lube oil	**Sample date :**	09/01/2003

Damping Curve



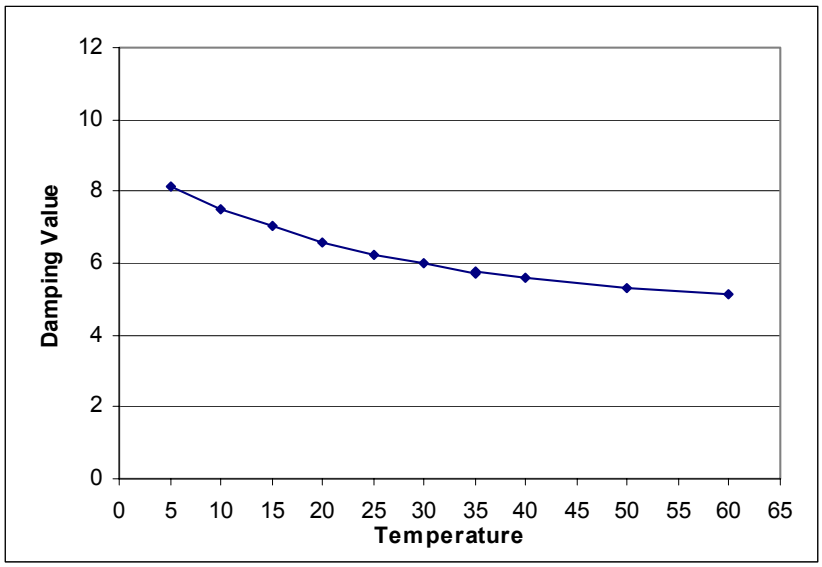
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.98	858.43	1426.2	5.88
2	50.00	49.91	842.46	1341.8	5.11
3	20.00	19.99	861.64	1443.6	6.22
4	60.00	59.88	836.09	1309.8	4.99
5	30.00	29.96	855.22	1408.1	5.72
6	10.00	10.02	868.09	1480.2	6.98
7	15.00	15.01	864.86	1461.8	6.53
8	40.00	39.94	848.83	1374.4	5.36
9	35.00	34.95	852.03	1391.1	5.52
10	5.00	5.03	871.32	1499.1	7.50
11	25.00	24.98	858.44	1426.1	5.87

Sample Details and Data

Sample Name:	Core 150	**Sample Number:**	201
Sample Type:	Lube oil	**Sample date :**	12/01/2003

Damping Curve



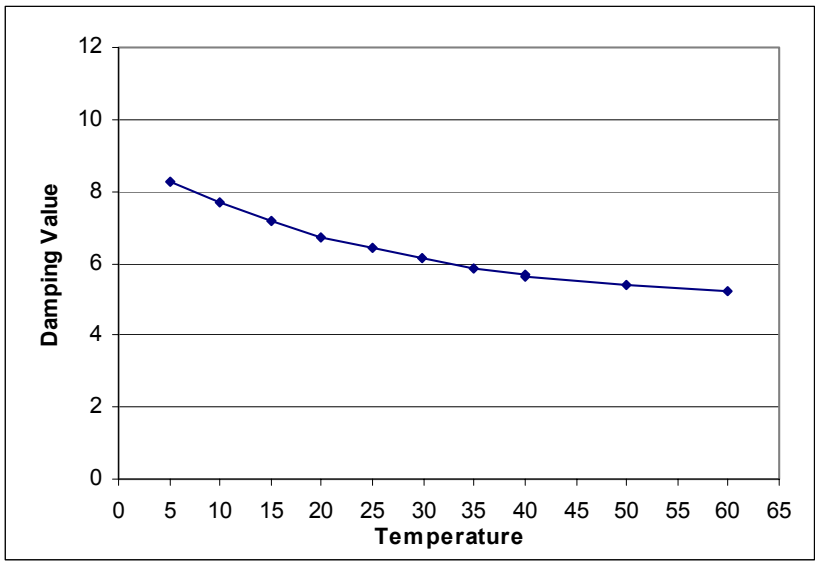
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	855.40	1400.3	5.73
2	10.00	10.02	871.37	1489.3	7.51
3	25.00	24.98	861.77	1435.0	6.23
4	40.00	39.94	852.24	1383.4	5.57
5	50.00	49.91	845.90	1350.3	5.31
6	30.00	29.96	858.58	1416.5	6.02
7	60.00	59.88	839.58	1318.1	5.13
8	15.00	15.00	868.17	1469.5	7.04
9	5.00	5.03	874.58	1507.1	8.11
10	20.00	19.99	864.97	1451.8	6.60
11	35.00	34.95	855.41	1399.4	5.77

Sample Details and Data

Sample Name:	Core 145	**Sample Number:**	202
Sample Type:	Lube oil	**Sample date :**	09/01/2330

Damping Curve



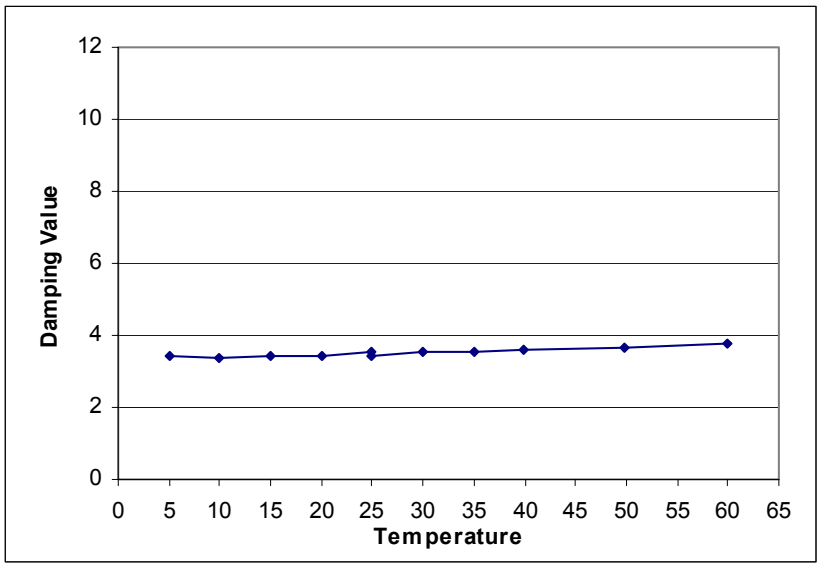
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	40.00	39.94	850.16	1382.2	5.67
2	5.00	5.03	872.44	1507.4	8.27
3	60.00	59.88	837.56	1318.0	5.20
4	15.00	15.00	866.06	1469.7	7.20
5	50.00	49.91	843.87	1349.8	5.38
6	25.00	24.97	859.68	1433.7	6.42
7	10.00	10.02	869.25	1488.3	7.69
8	20.00	19.99	862.87	1451.9	6.73
9	35.00	34.95	853.35	1399.6	5.85
10	30.00	29.96	856.50	1416.3	6.12
11	40.00	39.94	850.18	1382.7	5.65

Sample Details and Data

Sample Name:	Jet A1	**Sample Number:**	203
Sample Type:	Kerosine (Jet)	**Sample date :**	27/01/2003

Damping Curve



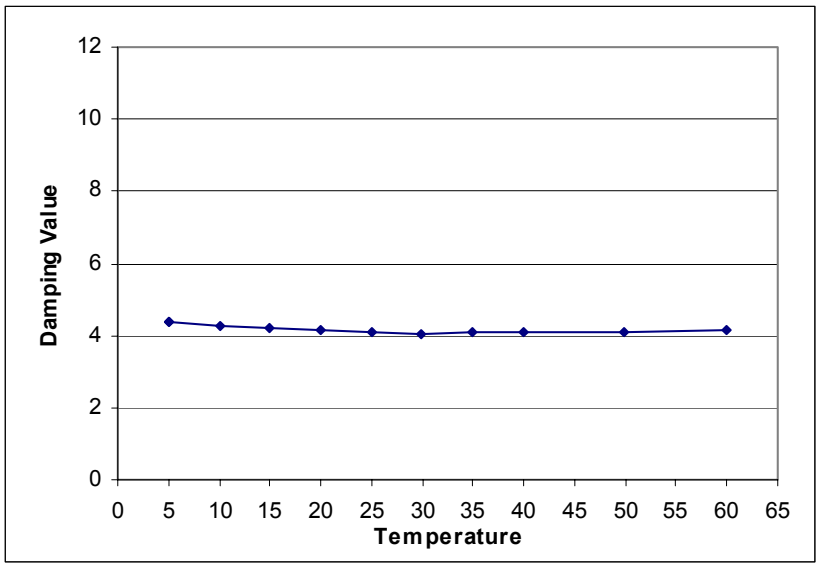
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.97	786.95	1283.2	3.52
2	50.00	49.91	768.20	1191.2	3.64
3	5.00	5.03	801.85	1361.9	3.42
4	40.00	39.94	775.73	1227.4	3.58
5	10.00	10.02	798.15	1342.0	3.40
6	60.00	59.88	760.64	1156.3	3.80
7	35.00	34.95	779.49	1245.7	3.55
8	15.00	15.00	794.43	1322.2	3.43
9	30.00	29.97	783.23	1264.6	3.52
10	20.00	19.99	790.70	1302.7	3.45
11	25.00	24.98	786.97	1283.6	3.46

Sample Details and Data

Sample Name:	Gas Oil undyed	**Sample Number:**	204
Sample Type:	Gas oil	**Sample date :**	04/12/2002

Damping Curve



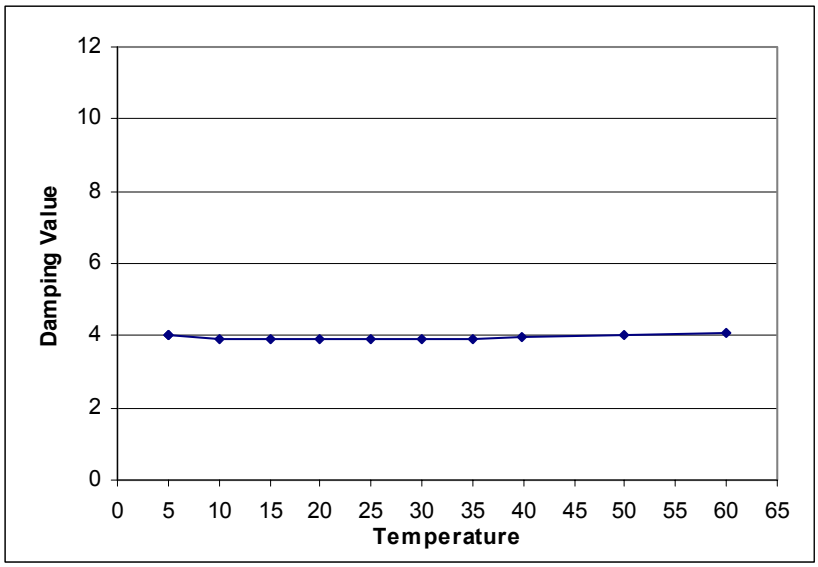
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	866.03	1453.6	4.36
2	35.00	34.95	845.27	1343.8	4.07
3	25.00	24.98	852.18	1379.1	4.09
4	50.00	49.91	834.91	1292.3	4.11
5	15.00	15.00	859.10	1415.8	4.20
6	20.00	19.99	855.64	1397.4	4.13
7	30.00	29.97	848.73	1361.4	4.06
8	10.00	10.02	862.57	1434.6	4.24
9	60.00	59.88	828.00	1259.3	4.17
10	40.00	39.93	841.82	1325.9	4.09
11	5.00	5.03	866.04	1453.5	4.36

Sample Details and Data

Sample Name:	Olmeca	**Sample Number:**	205
Sample Type:	Crude oil	**Sample date :**	14/03/2003

Damping Curve



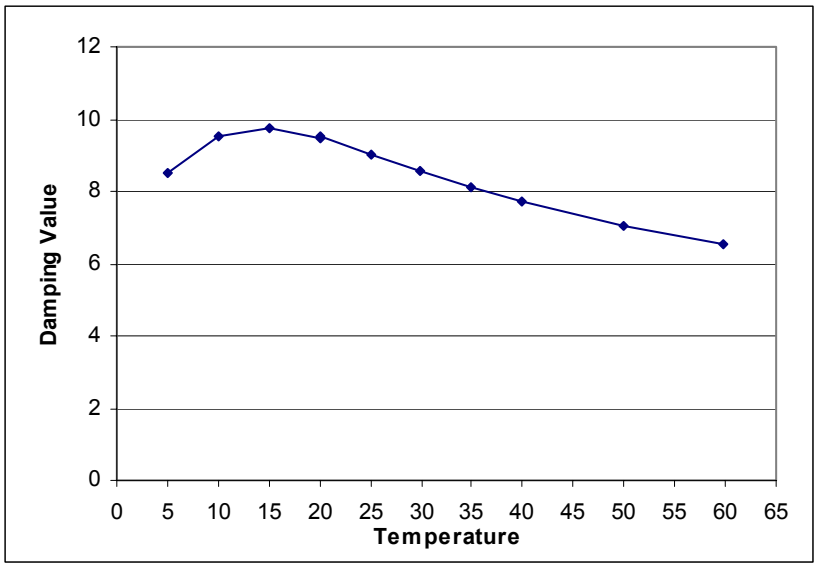
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.03	842.46	1392.7	4.03
2	30.00	29.96	823.88	1297.1	3.88
3	60.00	59.88	801.98	1191.7	4.10
4	35.00	34.95	820.25	1278.6	3.93
5	40.00	39.93	816.61	1260.8	3.95
6	25.00	24.98	827.53	1315.4	3.90
7	10.00	10.02	838.42	1372.5	3.93
8	15.00	15.00	834.79	1353.4	3.88
9	50.00	49.91	809.32	1225.9	4.01
10	20.00	19.99	831.16	1334.2	3.90
11	5.00	5.03	842.43	1392.7	4.02

Sample Details and Data

Sample Name:	800N	**Sample Number:**	206
Sample Type:	Lube oil	**Sample date :**	14/03/2003

Damping Curve



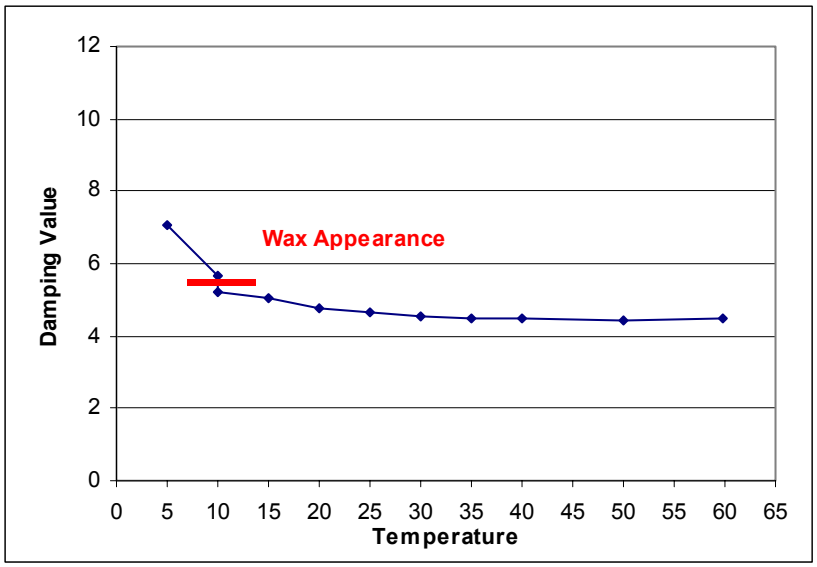
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	872.14	1485.0	9.46
2	25.00	24.98	869.09	1466.7	8.99
3	35.00	34.95	862.97	1431.2	8.10
4	50.00	49.91	853.79	1380.8	7.04
5	60.00	59.88	847.71	1348.9	6.53
6	5.00	5.03	881.61	1544.8	8.49
7	30.00	29.97	866.08	1447.7	8.57
8	40.00	39.94	859.95	1413.2	7.71
9	10.00	10.02	878.40	1522.8	9.54
10	15.00	15.01	875.28	1503.1	9.76
11	20.00	19.99	872.20	1483.8	9.52

Sample Details and Data

Sample Name:	Mesa 30	**Sample Number:**	207
Sample Type:	Crude oil	**Sample date :**	24/11/2002

Damping Curve



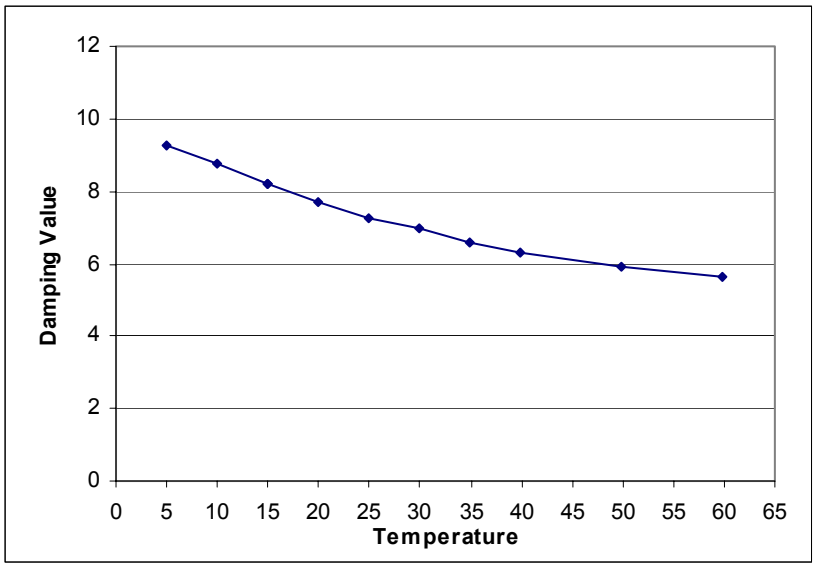
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	10.00	10.02	880.01	1419.4	5.67
2	30.00	29.97	865.05	1343.9	4.56
3	5.00	5.03	884.05	1439.6	7.06
4	25.00	24.98	868.63	1362.1	4.67
5	40.00	39.94	857.95	1308.3	4.47
6	35.00	34.95	861.45	1325.4	4.51
7	15.00	15.00	875.96	1399.2	5.05
8	50.00	49.91	850.91	1274.0	4.46
9	20.00	19.99	872.04	1379.8	4.76
10	60.00	59.88	843.87	1240.8	4.48
11	10.00	10.02	879.93	1419.1	5.20

Sample Details and Data

Sample Name:	225N	**Sample Number:**	208
Sample Type:	Lube oil	**Sample date :**	14/03/2003

Damping Curve



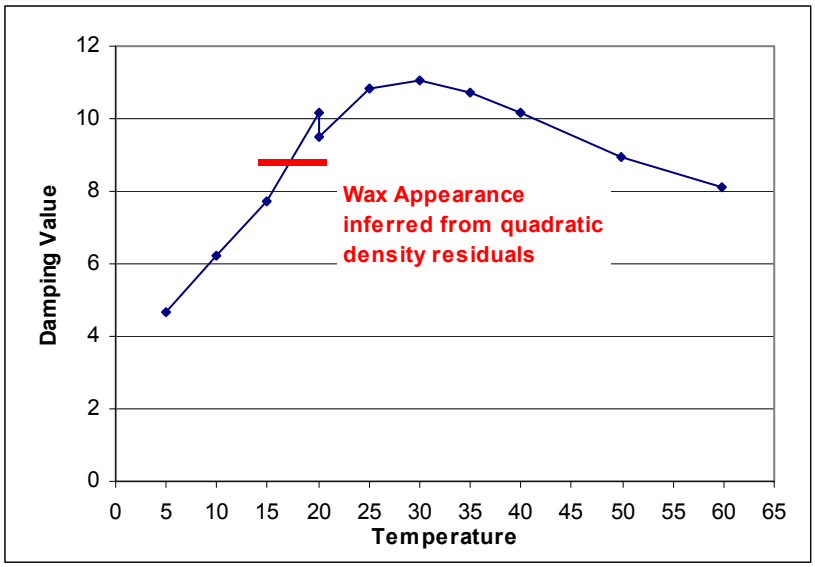
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	868.11	1479.6	8.23
2	30.00	29.97	858.69	1426.0	6.98
3	50.00	49.91	846.25	1359.1	5.94
4	10.00	10.02	871.36	1498.9	8.77
5	5.00	5.03	874.51	1518.5	9.26
6	20.00	20.00	865.09	1461.7	7.71
7	40.00	39.94	852.56	1392.0	6.29
8	35.00	34.95	855.70	1408.9	6.56
9	25.00	24.98	861.99	1443.7	7.27
10	60.00	59.88	840.12	1327.4	5.61
11	15.00	15.00	868.29	1480.0	8.23

Sample Details and Data

Sample Name:	Merey	**Sample Number:**	209
Sample Type:	Crude oil	**Sample date :**	13/08/2002

Damping Curve



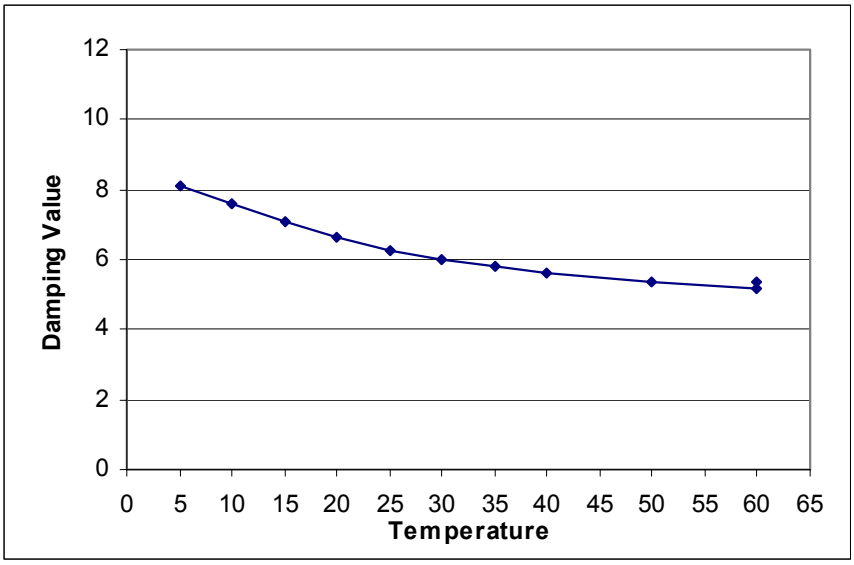
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	19.99	952.60	1487.5	10.14
2	10.00	10.02	959.84	1534.1	6.21
3	40.00	39.94	939.34	1409.5	10.18
4	50.00	49.91	932.83	1374.5	8.96
5	25.00	24.97	949.10	1464.6	10.84
6	30.00	29.97	945.81	1445.6	11.06
7	5.00	5.03	963.59	1559.6	4.65
8	35.00	34.95	942.63	1427.1	10.74
9	15.00	15.00	956.17	1507.6	7.75
10	60.00	59.89	926.31	1341.2	8.10
11	20.00	19.99	952.57	1484.9	9.51

Sample Details and Data

Sample Name:	110N	**Sample Number:**	210
Sample Type:	Lube oil	**Sample date :**	14/03/2003

Damping Curve



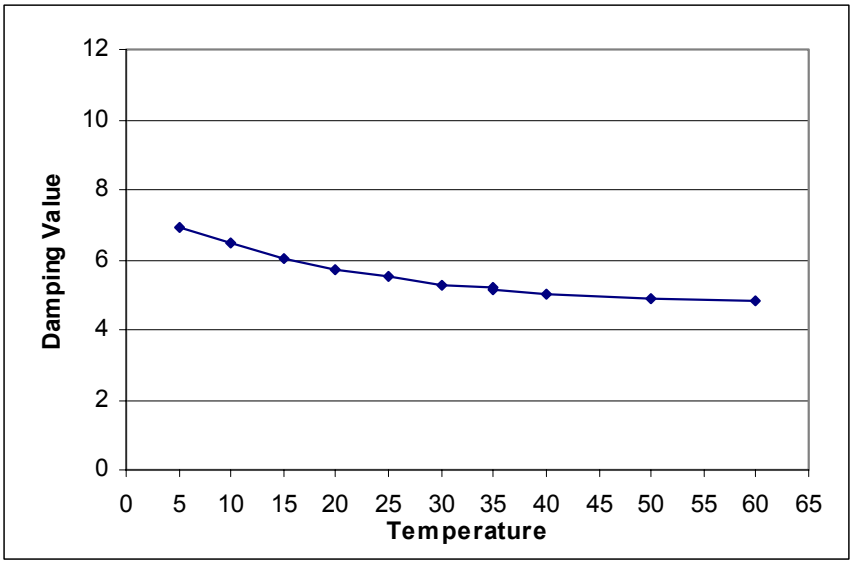
Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.89	831.76	1312.0	5.35
2	35.00	34.95	847.61	1393.1	5.84
3	50.00	49.91	838.21	1343.9	5.35
4	15.00	15.00	860.31	1464.3	7.08
5	40.00	39.94	844.51	1377.0	5.60
6	10.00	10.02	863.48	1483.0	7.57
7	20.00	19.99	857.11	1446.6	6.63
8	5.00	5.03	866.62	1502.1	8.14
9	25.00	24.98	853.91	1428.8	6.27
10	30.00	29.96	850.76	1411.3	6.00
11	60.00	59.88	831.88	1312.1	5.17

Sample Details and Data

Sample Name:	80N	**Sample Number:**	211
Sample Type:	Lube oil	**Sample date :**	14/03/2003

Damping Curve



Density and Velocity of Sound Data Set

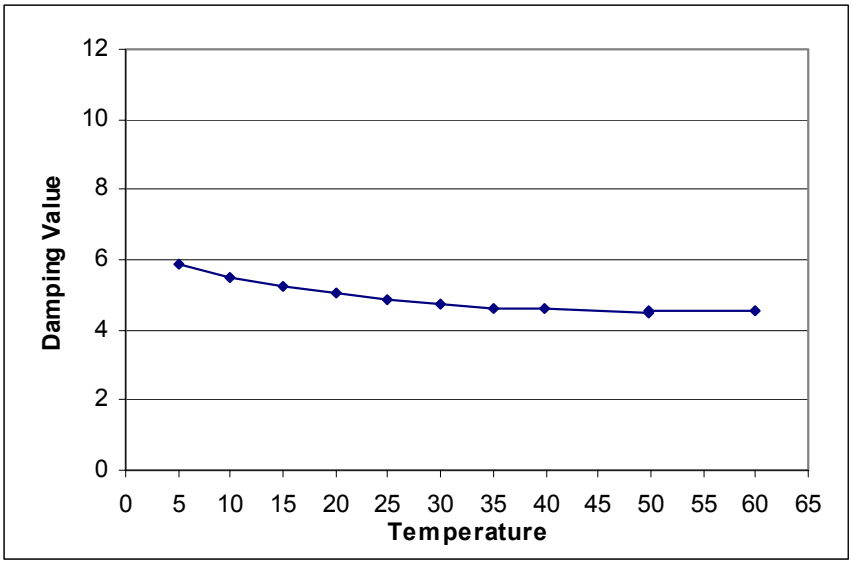
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.95	852.11	1382.7	5.19
2	10.00	10.02	868.25	1473.0	6.46
3	5.00	5.03	871.49	1492.0	6.92
4	30.00	29.97	855.33	1401.0	5.30
5	25.00	24.97	858.54	1418.3	5.53
6	15.00	15.01	865.00	1454.6	6.06
7	20.00	19.99	861.77	1436.7	5.73
8	50.00	49.91	842.49	1333.3	4.88
9	40.00	39.93	848.89	1366.1	5.04
10	60.00	59.89	836.08	1300.8	4.80
11	35.00	34.95	852.10	1383.2	5.16

Sample Details and Data

Sample Name: 60 Solvent pale **Sample Number:** 300

Sample Type: Lube oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

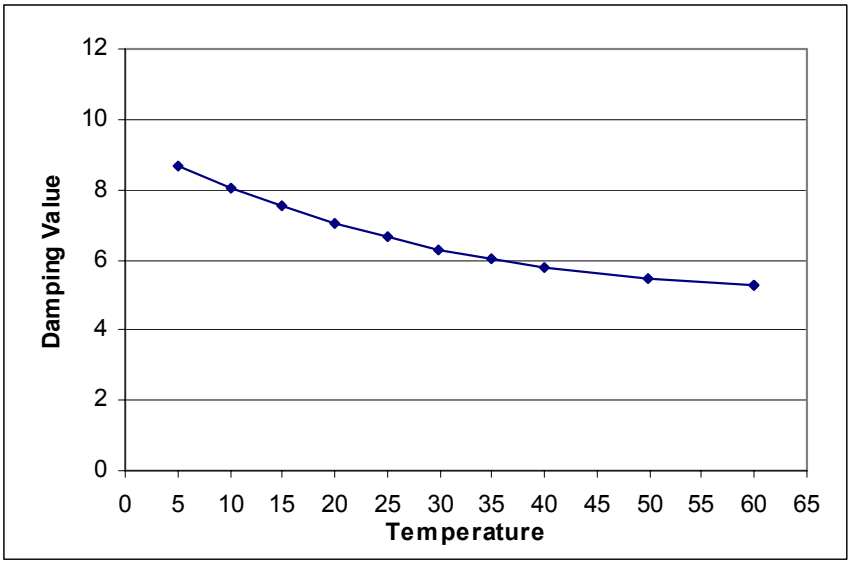
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	50.00	49.91	847.91	1310.5	4.51
2	15.00	15.01	870.98	1433.2	5.23
3	10.00	10.02	874.29	1452.0	5.49
4	30.00	29.97	861.07	1378.8	4.71
5	25.00	24.97	864.37	1396.6	4.85
6	5.00	5.03	877.60	1471.2	5.84
7	35.00	34.95	857.77	1361.2	4.63
8	60.00	59.89	841.31	1277.5	4.52
9	40.00	39.93	854.48	1343.5	4.59
10	20.00	19.99	867.67	1414.6	5.03
11	50.00	49.91	847.89	1309.9	4.52

Sample Details and Data

Sample Name: 150SN **Sample Number:** 301

Sample Type: Lube oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

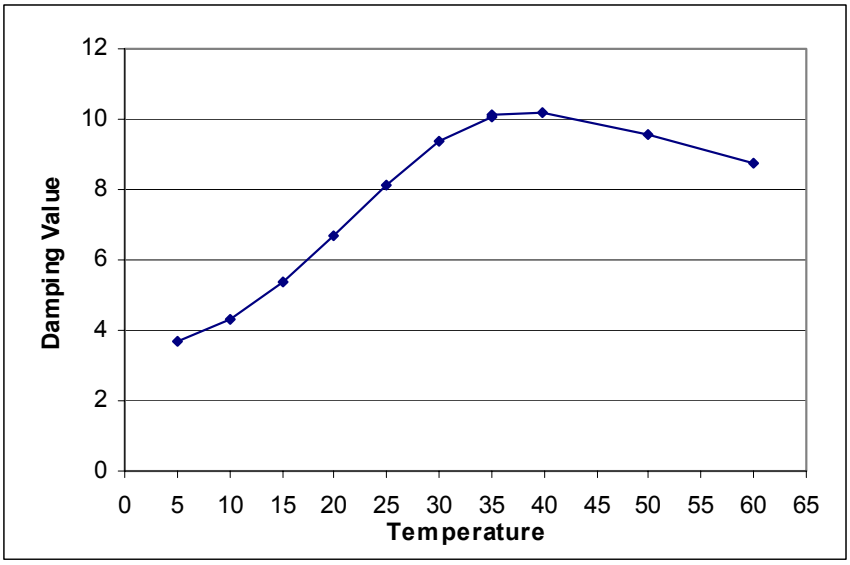
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.89	844.11	1321.9	5.29
2	5.00	5.03	878.96	1511.1	8.65
3	40.00	39.95	856.71	1385.9	5.80
4	35.00	34.95	859.87	1402.6	6.02
5	15.00	15.01	872.58	1473.2	7.51
6	20.00	19.99	869.39	1455.1	7.01
7	50.00	49.91	850.40	1353.1	5.48
8	25.00	24.97	866.21	1437.0	6.64
9	30.00	29.97	863.04	1419.6	6.29
10	10.00	10.02	875.78	1491.7	8.05
11	60.00	59.89	844.11	1321.5	5.28

Sample Details and Data

Sample Name: SBS 150 **Sample Number:** 302

Sample Type: Lube oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

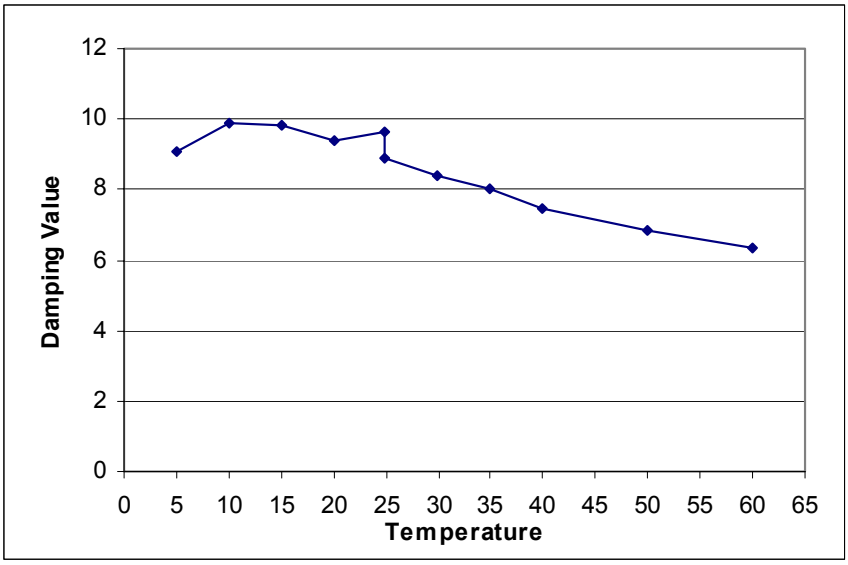
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	35.00	34.96	895.14	1463.4	10.09
2	5.00	5.02	914.18	1612.0	3.67
3	60.00	59.89	880.08	1379.6	8.73
4	25.00	24.97	901.44	1501.8	8.15
5	40.00	39.93	892.10	1445.2	10.22
6	50.00	49.91	886.09	1411.3	9.57
7	20.00	20.01	904.65	1524.1	6.66
8	30.00	29.97	898.27	1482.3	9.37
9	15.00	15.01	907.86	1549.3	5.35
10	10.00	10.02	911.03	1578.3	4.33
11	35.00	34.96	895.16	1463.3	10.09

Sample Details and Data

Sample Name: 500 SN **Sample Number:** 303

Sample Type: Lube oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

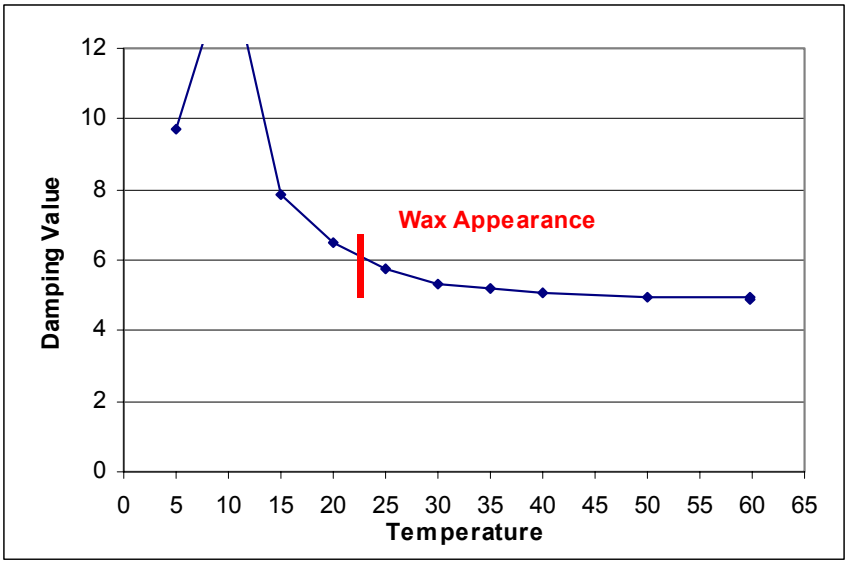
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.97	882.73	1464.6	9.63
2	35.00	34.96	876.89	1429.9	8.00
3	15.00	15.01	889.32	1501.7	9.85
4	20.00	20.01	886.22	1482.8	9.40
5	50.00	49.91	867.61	1380.8	6.84
6	10.00	10.02	892.47	1521.5	9.86
7	30.00	29.99	880.02	1446.9	8.36
8	40.00	39.93	873.81	1413.0	7.49
9	5.00	5.01	895.70	1542.8	9.08
10	60.00	59.89	861.44	1349.4	6.37
11	25.00	24.97	883.13	1464.2	8.92

Sample Details and Data

Sample Name: Bouri **Sample Number:** 304

Sample Type: Crude oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

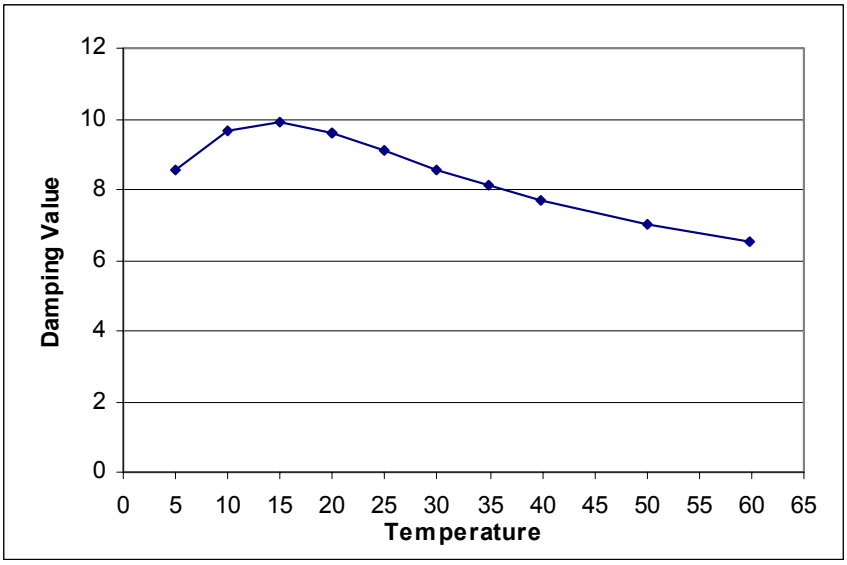
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	60.00	59.89	862.06	1273.2	4.98
2	20.00	20.01	891.21	1413.6	6.49
3	40.00	39.93	876.04	1340.4	5.08
4	15.00	15.00	895.63	1434.3	7.88
5	35.00	34.97	879.64	1357.9	5.22
6	10.00	10.02	899.46	1455.6	14.49
7	50.00	49.91	869.10	1306.4	4.94
8	30.00	29.97	882.98	1374.6	5.35
9	25.00	24.97	886.96	1393.5	5.74
10	5.00	5.02	904.22	1477.3	9.70
11	60.00	59.89	862.19	1273.5	4.88

Sample Details and Data

Sample Name: 600 SN **Sample Number:** 305

Sample Type: Lube oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

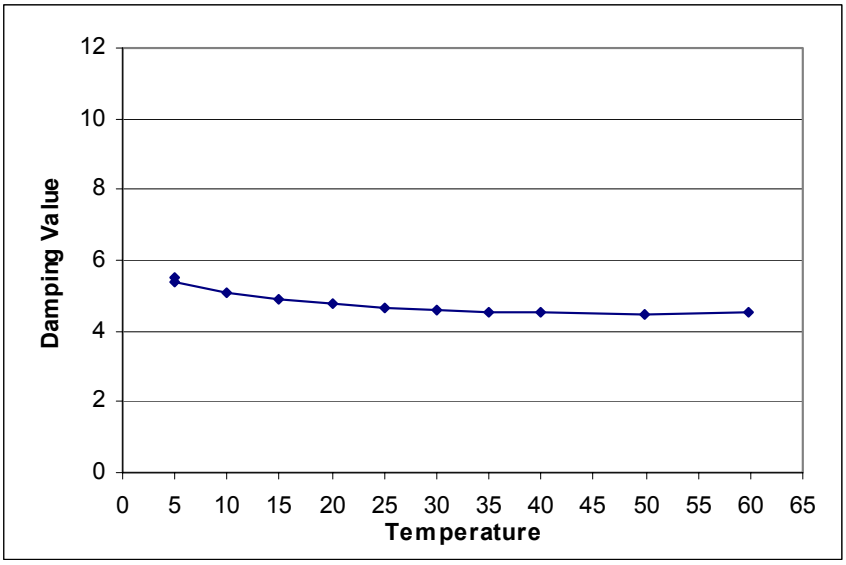
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	20.00	881.70	1485.4	9.60
2	25.00	24.97	878.63	1467.0	9.10
3	5.00	5.02	891.17	1546.6	8.58
4	50.00	49.96	863.24	1382.5	6.99
5	10.00	10.02	887.96	1524.7	9.65
6	30.00	29.97	875.57	1449.4	8.58
7	35.00	34.96	872.49	1432.1	8.12
8	15.00	15.00	884.81	1504.4	9.90
9	60.00	59.89	857.11	1350.8	6.50
10	40.00	39.93	869.40	1414.5	7.70
11	20.00	20.00	881.72	1485.0	9.61

Sample Details and Data

Sample Name: Gach Saran **Sample Number:** 306

Sample Type: Crude oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

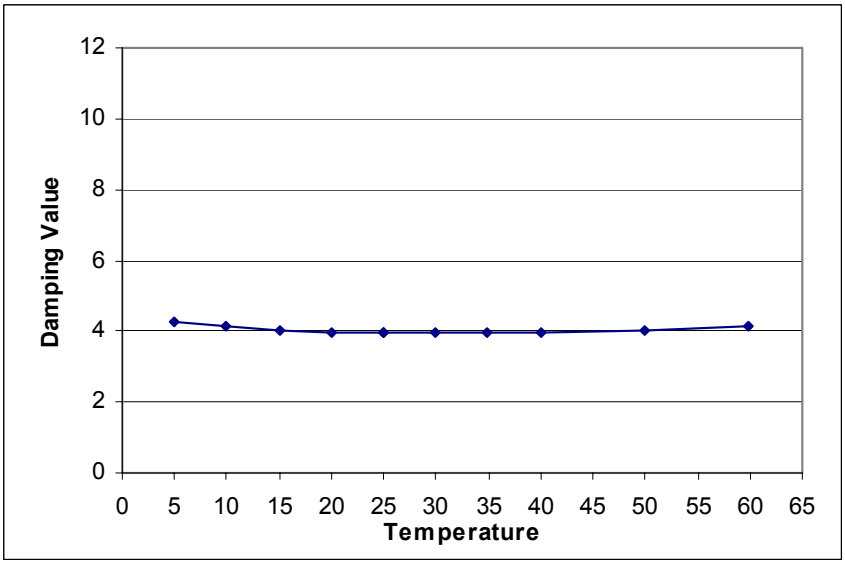
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	5.00	5.02	879.34	1422.2	5.51
2	50.00	49.93	846.83	1257.8	4.50
3	35.00	34.97	857.50	1309.6	4.54
4	10.00	10.01	875.38	1402.1	5.08
5	15.00	15.00	871.83	1383.2	4.91
6	40.00	39.93	853.95	1292.1	4.50
7	60.00	59.89	839.69	1224.4	4.51
8	30.00	29.98	861.04	1327.4	4.61
9	20.00	20.01	868.15	1364.1	4.78
10	25.00	24.97	864.61	1345.8	4.66
11	5.00	5.02	879.32	1422.3	5.38

Sample Details and Data

Sample Name: Flotta **Sample Number:** 307

Sample Type: Crude oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

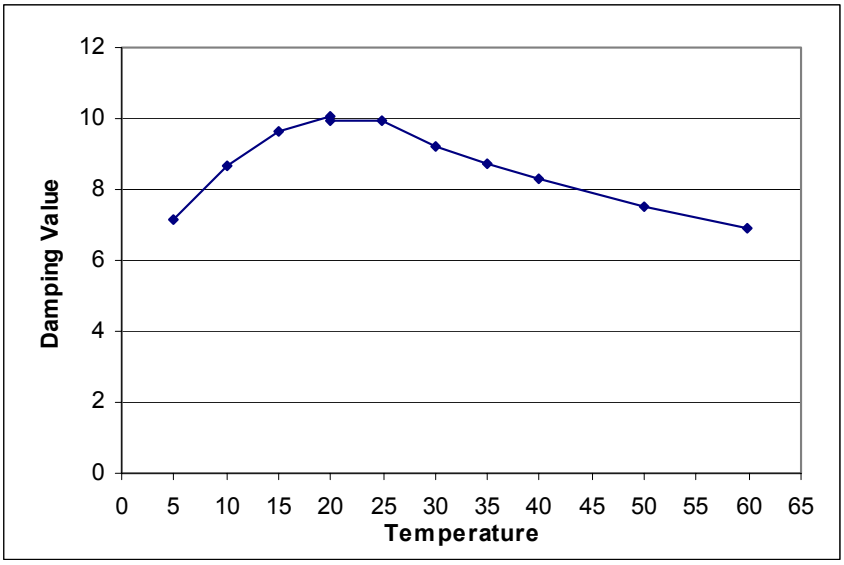
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	25.00	24.97	835.43	1317.7	3.96
2	35.00	34.96	828.10	1281.0	3.96
3	50.00	49.91	817.10	1227.8	4.04
4	60.00	59.89	809.74	1193.7	4.13
5	15.00	15.01	842.72	1355.4	4.02
6	40.00	39.94	824.44	1263.0	3.99
7	30.00	29.97	831.76	1299.1	3.96
8	5.00	5.02	850.88	1395.7	4.26
9	10.00	10.00	847.01	1375.8	4.15
10	20.00	20.01	839.12	1336.7	3.97
11	25.00	24.97	835.41	1317.8	3.94

Sample Details and Data

Sample Name: Lube A90 **Sample Number:** 308

Sample Type: Lube oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

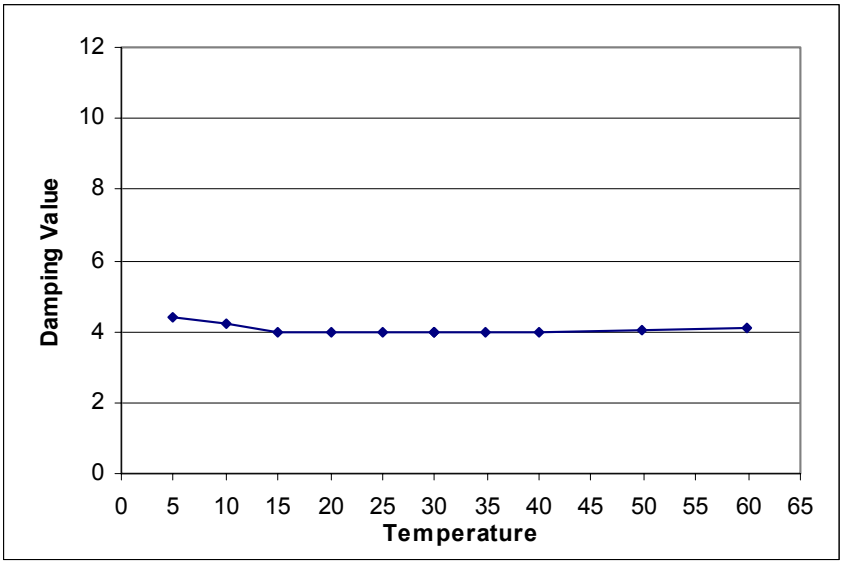
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	20.00	20.01	886.79	1494.4	10.06
2	50.00	49.91	868.35	1389.5	7.53
3	15.00	15.01	889.95	1513.0	9.64
4	30.00	29.97	880.66	1456.5	9.21
5	5.00	5.02	896.45	1558.1	7.12
6	60.00	59.90	862.23	1356.8	6.92
7	25.00	24.97	883.74	1472.8	9.96
8	35.00	34.98	877.60	1437.7	8.76
9	10.00	10.02	893.18	1533.0	8.70
10	40.00	39.93	874.53	1420.7	8.29
11	20.00	20.01	886.82	1491.5	9.96

Sample Details and Data

Sample Name: Wytch Farm **Sample Number:** 309

Sample Type: Crude oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

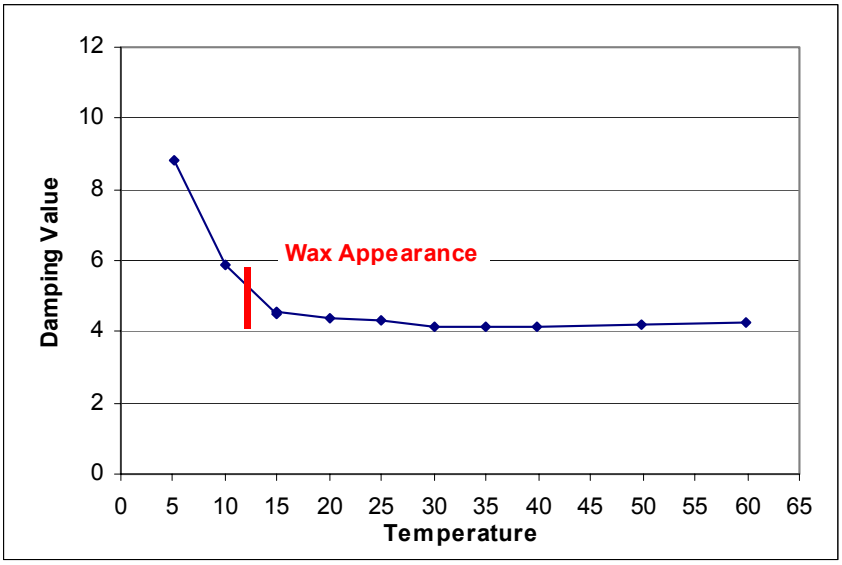
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	809.10	1281.7	3.97
2	10.00	10.02	824.06	1359.0	4.25
3	5.00	5.01	828.11	1379.5	4.40
4	60.00	59.89	787.17	1174.9	4.12
5	20.00	20.01	816.35	1319.5	3.98
6	40.00	39.93	801.80	1245.1	3.97
7	25.00	24.97	812.72	1300.4	3.96
8	15.00	15.00	819.97	1338.8	3.97
9	35.00	34.96	805.43	1263.3	3.95
10	50.00	49.91	794.48	1209.3	4.04
11	30.00	29.97	809.08	1281.7	3.95

Sample Details and Data

Sample Name: Oseberg **Sample Number:** 310

Sample Type: Crude oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

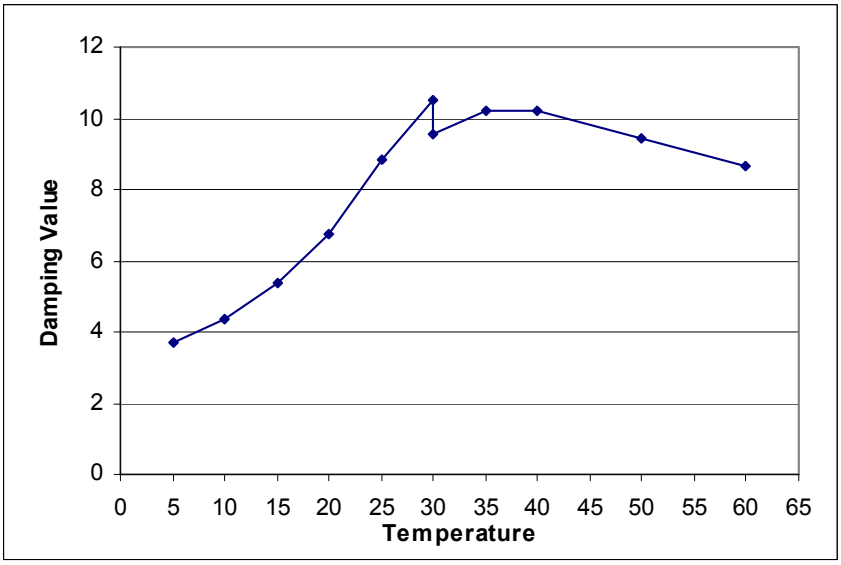
Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	15.00	15.00	850.10	1379.8	4.48
2	60.00	59.89	817.65	1219.5	4.28
3	5.00	5.01	858.00	1419.5	8.82
4	50.00	49.91	824.86	1253.3	4.19
5	35.00	34.96	835.56	1305.1	4.17
6	10.00	10.02	853.96	1399.3	5.91
7	20.00	20.01	846.50	1361.1	4.41
8	25.00	24.97	842.85	1342.6	4.30
9	40.00	39.93	832.04	1288.1	4.16
10	30.00	29.97	839.15	1323.3	4.17
11	15.00	15.00	850.11	1379.6	4.58

Sample Details and Data

Sample Name: WBS 160 **Sample Number:** 312

Sample Type: Lube oil **Sample date :**

Damping Curve



Density and Velocity of Sound Data Set

Test Point	Set Temp °C	Actual Temp °C	Density kg/m3	Velocity of Sound m/s	Damping Value
1	30.00	29.97	906.28	1489.3	10.52
2	25.00	24.97	909.54	1511.5	8.81
3	50.00	49.91	894.10	1415.0	9.46
4	35.00	34.96	903.24	1467.1	10.21
5	10.00	10.02	919.28	1594.6	4.38
6	20.00	20.01	912.83	1533.9	6.78
7	5.00	5.01	922.46		3.68
8	60.00	59.89	888.03	1381.7	8.63
9	15.00	15.00	916.08	1559.2	5.40
10	40.00	39.93	900.17	1447.8	10.22
11	30.00	29.97	906.39	1485.3	9.54

APPENDIX 3

VELOCITY OF SOUND STANDARDS
NATIONAL PHYSICAL LABORATORY LETTER

National Physical Laboratory | Queens Road | Teddington | Middlesex | United Kingdom | TW11 0LW
Telephone 020 8977 3222 (Switchboard) | NPL Helpline 020 8943 6880 | Facsimile 020 8943 6458

Our Ref: AL044090
Your Ref:

NPL
National Physical Laboratory

Denis Fitzgerald
H&D Fitzgerald Ltd
Cefn Du
Tremeirchion
St Asaph
LL17 OUS

Direct Line 020-8943-6806
Direct Fax 020-8943-6161
Date 22 October 2003
E-mail bajram.zeqiri@npl.co.uk

Dear Denis

RE: Development of VoS Standards

It has been a while since I last contacted you, so I felt it appropriate to bring you up-to-date with the development work at NPL regarding velocity of sound (VoS) standards. You may recall that, as part of the formulation process for the 2001 – 2004 Acoustical Metrology Programme, you contributed to what we call a "Deep Study" survey. This was aimed at assessing requirements for traceable measurements of VoS of improved uncertainty. The findings and recommendations of the Study are summarised in the NPL Report CMAM 52. In recognition of the growing need to develop new standards for VoS, our main customer agreed to fund Work Package 1 of the recommendations involving the development of a reference facility for VoS characterisation.

Despite a few technical hitches, we feel we are on track to be able to offer precision measurements of VoS to industry, from May onwards next year. The validation of the measurements currently under way will include an assessment of measurement uncertainties, but, at the moment, we believe we are on schedule to deliver to industry an uncertainty no poorer than ± 0.2 m s^{-1}, a requirement which came out of the User Survey which formed part of the "Deep Study".

In relation to the "Deep Study", you might also be interested to note that we are currently formulating the next Acoustical Metrology Programme, running from October 2004 – September 2007. Within this, we are hoping to implement Work Package 2 of the CMAM 52 recommendations "Develop and disseminate reference liquids for speed of sound". This represents a mainly experimental package of work, following on from the development of the reference facility. It will be necessary to reconsider the position at the end of the current 2001-2004 programme, but it is anticipated that potentially three or four liquids covering the required range of propagation speeds will be required.

NPL
National Physical Laboratory

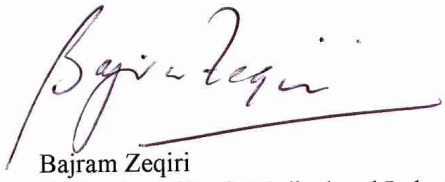
Key factors of importance which will need to be considered:

- determination of the temperature dependence of speed of sound for the liquids;
- identifying three or four liquids covering the range of speeds (approximately 1000 – 1700 ms^{-1});
- establishing the optimum way of making the liquids available to the end user and
- identifying a single supplier for a particular liquid, so minimising batch-to-batch variation.

We are hopeful that activity along these lines will take place in the next NMS programme, although this will inevitably depend on the priorities of our customer, The National Measurement System Policy Unit the customer. Nevertheless, come Spring 2004 NPL should be in a position to provide reference VoS measurements on customer liquid samples to high accuracy, fulfilling a requirements which clearly came out of the "Deep Study" survey.

I hope that this information is useful. Please let me know if I can be of any further help.

Yours sincerely



Bajram Zeqiri
Technology Head, Medical and Industrial Ultrasonics
CAIR-NPL