NACE MR0103 & MR0175: A Brief History and Latest Requirements

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NACE MR0175 & MR0103

Overview

- NACE – A Look Back
- Benefits to end-user
- MR0103 & MR0175 Material Requirements, Limitations & Service Restrictions

Current NACE Specifications

- NACE MR0175/ISO 15156 – 2009 *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas Production*
  - PART 1 - General principles for selection of cracking-resistant materials
  - PART 2 - Cracking-resistant carbon and low-alloy steels, and the use of cast irons
  - PART 3 - Cracking-resistant CRAs (corrosion resistant alloys) and other alloys
  - currently set to be revised again (2014 version)
- NACE MR0103 – 2012 *Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments*

NACE – A Look Back

Highlights

- 1930's
  - Focus was on cathodic protection for underground pipes
  - The Mid-Continent Cathodic Protection Association (MCPA) held its first meeting on March 9, 1936 and met again on April 27, 1938
  - Up until 1939, the MCPA operated separately, when they joined API as the Cathodic Protection Subcommittee

NACE – A Look Back

Highlights

- 1940's
  - In 1940 the MCPA became affiliated with the Petroleum Industry Electronic Association (PIEA)
  - In 1942, MCPA attempted to revise the bylaws, which were rejected by PIEA. This drove members of MCPA to consider forming an independent group, specifically addressing corrosion.
  - Several meetings over the summer of 1943 were held and on October 10 & 11, 1943 the National Association of Corrosion Engineers (NACE) was formed.
  - Sour gas and affects of the gas were experienced in the oil & gas industries starting in West Texas, Ginger Field in the late 1940's to early 1950's.

NACE – A Look Back

Highlights, Con't

- Early 1950's
  - The Canadian Jumping Pound and Pincher Fields came on experiencing similar issues with sour gas
  - The Canadian failures were attributed to Sulfide Stress Cracking (SSC).
    - Considerable effort was put forth to understand and solve the Canadian failures, which would ultimately lead to safe and reliable production
  - NACE formed the T-1G committee
  - The purpose of the committee was to gather data and attempt to solve the H_2S cracking failures
    - NOTE: Many on the committee feared that if there was a disastrous event that the government would step in and require its own controls. The government standard could also hinder discussions and developments which encouraged fluid and technical discussions.

NACE – A Look Back

Highlights, Con't

- 1952
  - The T-1G committee held a SSC Symposium
  - Multiple papers were presented discussing ten (10) failures seen in the field.
  - They concluded that the failures resulted from improper material selection and how the material was processed, both of which made the materials vulnerable to H_2S.
- 1962
  - The early committee work occurred in a Canada industry group that became T-1B
  - The T-1B section released a report that addressed material recommendations for sour gas service in well equipment
- 1963
  - NACE formed task group T-1F, which combined the activities of other task group activities
  - They began to write valve document 1F166

NACE – A Look Back

Highlights, Con't

- 1966
  - T-1F issued 1F166 – "Sulfide Cracking Resistant Materials for Valves for Production and Pipeline Service"
  - 1F166 consisted of
    - Production and pipeline valve document for wellhead valves up to 15,000 psi service
    - Consistent manufacturing methods
    - Gate valve materials
- 1975
  - 1F166 was transitioned into a Materials Requirement for Valves and issued as MR0175, which became an industry standard for Christmas tree valves

NACE – A Look Back

Highlights, Con't

- Between 1975 and 1978
  - Several SSC failures were experienced by the Texas Railroad Commission, which lead them to require MR0175 for all production equipment
    - This became common throughout the refining industry up until MR0103 was issued
- 1978
  - Scope of MR0175 was expanded to include all equipment
- 1984
  - MR0175 stopped using material trade names and referenced UNS or SAE numbers (concerned with liable action if they limited the approved materials to the trade names)
- Late 1990's
  - The scope of MR0175 was expanded to include SSC cracking caused by chlorides
  - NACE approached ISO to create a global standard addressing sour environments combining the work done by NACE and European Federation of Corrosion (EFC)

NACE – A Look Back

Highlights, Con't

- 2000
  - NACE task group 231 was formed to create a refinery standard for sour gas
    - Would later become MR0103
- 2002
  - By this time issues with MR0175 had accumulated since 1975
    - High temperature SSC of the corrosion resistant alloy
    - Inconsistent alloy requirements
    - Unclear rules for alloys
    - Differing interpretations

NACE – A Look Back

Highlights, Con't

- Early 2003 MR0175 splits into MR0175 & MR0103
  - MR0175-2003
    - Intended for oilfield production where H_2S and saltwater/brine was present
    - Many materials previously allowed were either discontinued or heavily restricted
      - Updated austenitic stainless steel requirements, which meant 300 series stainless steels may not meet the environmental requirements it once may have met
    - Clarified welding requirements for carbon steels
  - MR0103-2003
    - Intended for sour refinery applications or other sour services but without saltwater/brine
    - Very similar to MR0175 pre-2003

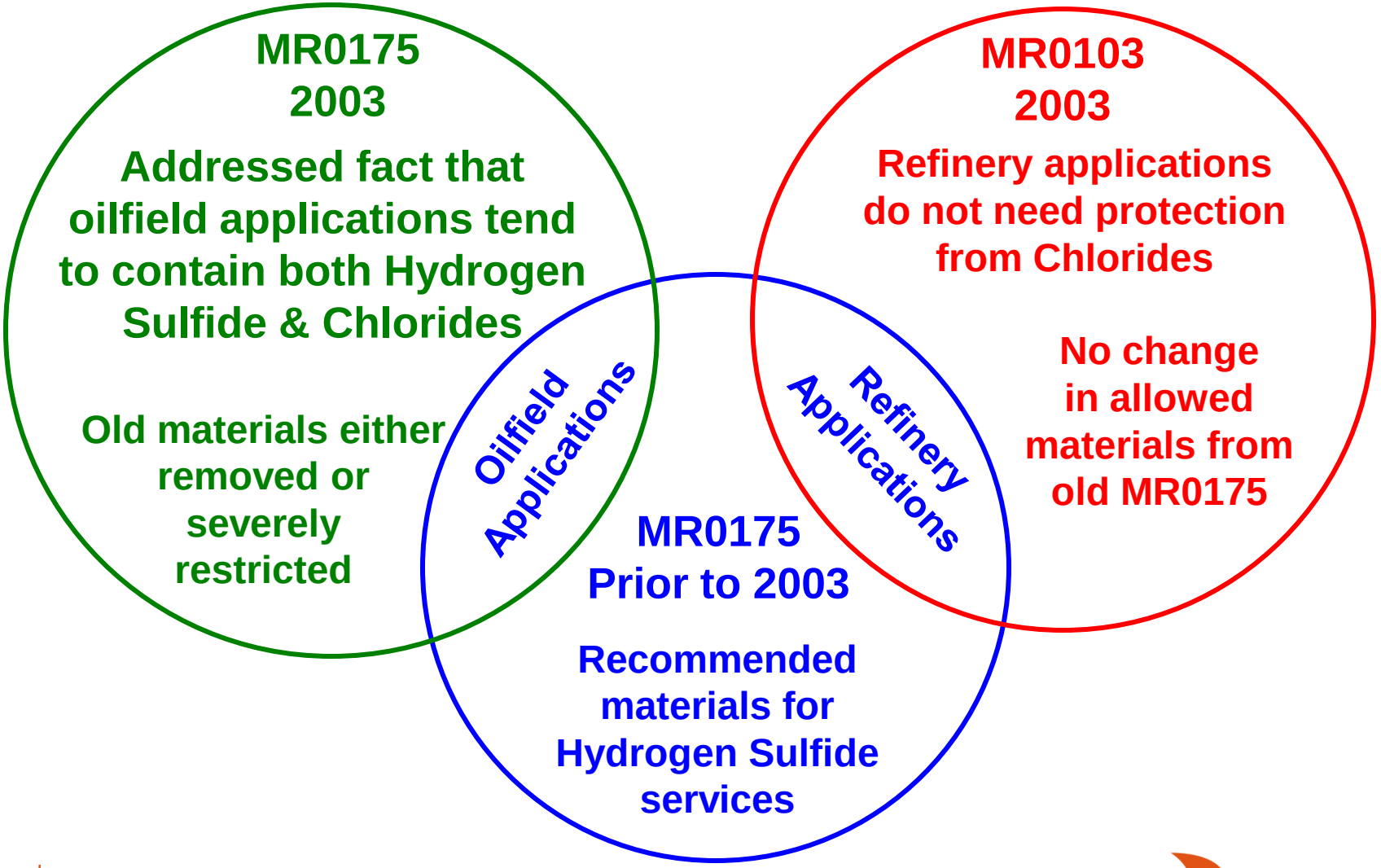
NACE – A Look Back

Highlights, Con't

- December 2003
  - NACE MR0175/ISO 15156 1ST Edition is issued
- 2004 to Present
  - Updates to MR0103 & MR0175/ISO15156 have consisted of adding or removing material requirements

NACE – A Look Back

Highlights, Con't: MR0175-2003 vs MR0103-2003



NACE MR0175 & MR0103

Benefit to the end-user

- Per MR0175/ISO 15156 the purpose is to provide "*general principles and gives requirements and recommendations for the selection and qualification of metallic materials for service in equipment used in oil and gas production and in natural-gas sweetening plants in* H_2S*-containing environments….*"
- Per MR0103, the purpose is to "*establishes material requirements for resistance to SSC in sour petroleum refining and related processing environments containing* H_2S *either as a gas or dissolved in an aqueous (liquid water) phase with or without the presence of hydrocarbon.*"
- In short, these standards reduce the risk of H_2S related cracking failures in equipment
- Benefits
  - Material requirements and recommendations for intended service
  - Minimizes health and safety accidents
  - Avoids equipment failures
  - Can extend the life of equipment that could have been subjected to H_2S cracking

NACE MR0103 & MR0175

Material Requirements, Limitations & Service Restrictions

Requirements & Limitations (general overview)		NACE MR0175	NACE MR0103
Material Requirements	Acceptable Materials	x	x
	Hardness Limits	x	x
	Heat Treatment Limitations	x	x
	Material Condition Limitations	x	x
	Chemical Compositions	x	x
	Welding (Fabrication)	x	x
Service Restrictions	Exposed Bolting	x	x
	Special Component Material Requirements	x	x
	Environment Exposure Restrictions	x	

NACE MR0103 & MR0175

Material Requirements, Limitations & Service Restrictions

- Not all of the requirements and limitations listed on the previous page are required for every material in every standard
- These standards only address material cracking in H_2S environments
  - All other types of failure modes need to be addressed separately by end-user
- Allowable environmental conditions for approved uses
  - MR0175 – environmental conditions are well defined
  - MR0103 – as compared to MR0175 environmental conditions are not as well defined for the end-user. End-user judgment on conditions may be required. As an example, field experience of an unlisted alloy may be used as justification for its use
- End-user is responsible to determine:
  - Operating conditions
  - If their application falls within MR0175 or MR0103
  - If the material is satisfactory for a given service

NACE MR0103 & MR0175

Material Requirements, Limitations & Service Restrictions

- To fully specify valve compliant to NACE MR0175-2003 or newer version, the end-user must define the following environmental restrictions:
  - Max temperature
  - Max system pressure
  - Existence of elemental sulfur
  - Max chloride content
  - pH
  - Partial pressure of H_2S
  - Will the valve be buried or insulated?
- Manufacturer is responsible to comply with requirements set forth by end-user & to ensure the materials supplied to the end-user metallurgically comply with NACE standards
- Purchasing a NACE compliant product only means the materials conform to NACE. It does not mean that the selected material is acceptable for all NACE MR0175 services.

References

- References:

  - D.H. Patrick, “MR0175 – A HISTORY AND DEVELOPMENT STUDY”, Paper No. 418, 1999
  - D. Bush, J. Brown & K. Lewis, “AN OVERVIEW OF NACE INTERNATIONAL MR0103 AND COMPARISON WITH MR0175”, Paper No. 04649, 2004
  - NACE, “NACE MR0175/ISO 15156 2009 2ND Edition”, NACE International Seminar, February 13, 2013
  - W. Brian Holtsbaum & Pierre Crevolin, “The History of NACE International The Corrosion Society, 1943-2013, 70 Years of Progress”, 2013
  - NACE MR0103, Multiple Versions
  - NACE MR0175, Multiple Versions

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