

Controlling Off-flavours

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Off-flavours to control

1	Acetaldehyde	10	Hydrogen Sulphide (H ₂ S)
2	Acetic	11	Isovaleric
3	Bitter	12	Lightstruck
4	Butyric	13	Mercaptan
5	Chlorophenol	14	Metallic
6	Diacetyl (Vicinal Diketone)	15	Musty - TCA
7	DMS (Dimethyl Sulphide)	16	Papery
8	Ethyl Acetate	17	4 - Vinylguaiacol
9	Ethyl Hexanoate	18	4 - Ethyl Guaiacol

1. Acetaldehyde

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Aldehydic, Bready, Bruised apples, Cidery, Fruity, Grassy, Green apple, Green leaves, Emulsion paint</p>	<p>Generally no</p>	<p>American Standard and Lite Lagers</p>	<p>1. Precursor of ethanol production Highly flocculent yeast strains, Poor yeast health, Too cool fermentation temperature, Vigorous fermentation, Incomplete fermentation, Premature yeast removal from wort, Increasing fermentation pressure,</p> <p>2. Oxidation of finished product Aeration during conditioning and packaging</p> <p>3. Bacterial action & oxidation <i>Zygomonas</i> and <i>Acetobacter</i> spp.</p>	<p>1. Good yeast health/quality, Correct yeast strain, Correct pitching rate, Correct fermentation temperatures, Longer fermentation/conditioning times, Reduced fermentation pressure,</p> <p>2. Minimise O₂ pick up, Quiet fills</p> <p>3. Good CIP</p>

2. Acetic

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Acidic, Cidery, Lingering or sharp sourness, Sour, Sour apples, Tangy, Tart, Vinagary</p>	<p>Generally no</p>	<p>Low levels in Belgian Sour Ales and Lambics</p>	<p>1. Precursor of ethanol production V. low levels occur during fermentation</p> <p>2. Exposure of green or finished beer to atmosphere to pick up bacteria or wild yeast infections</p> <p>Bacterial action & oxidation - <i>Acetobacter</i>, (forms white film) <i>Acetomonas</i> (forms slimey ropey film), <i>Zymomonas</i> spp.</p> <p>Yeast Action in anaerobic conditions - <i>Kloeckera</i> & <i>Brettanomyces</i> spp. (also leathery & sweaty flavours)</p>	<ol style="list-style-type: none"> 1. Good yeast health/quality, Correct yeast strain, Correct pitching rate,, 2. Minimise O₂ exposure 3. Good CIP especially on cold side, Do not use equipment which can't be sanitised, Avoid soft plastic items

3. Bitter

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Flavour, Mouthfeel & Aftertaste</p> <p>Hoppy bitterness (clean from humulones or coarse from co-humulones),</p>	<p>Yes</p>	<p>Pale Ales, Bitters, IPAs</p>	<p>1. High alpha-acid hops</p> <p>2. Long boil times</p>	<p>Store cold, away from atmosphere (vacuum)</p> <p>Weaker worts have higher 'perceived' bitterness</p> <p>Perception of bitterness increased by presence of high concentrations of sulphate (SO₄) and magnesium (Mg) ions</p> <p>Higher pH increases alpha acid extraction, lower pH (<5.2) increases resin extraction</p> <p>Copper boil times (1 – 2 hrs)</p> <p>High fermentation temperatures reduce bitterness</p> <p>Filtering (especially sterile) removes bitterness</p>

4. Butyric

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Baby sick, Butyric acid, Putrid, Rancid/ spoiled butter/milk, Vomit</p>	<p>Never</p>	<p>None</p>	<p>Bacterial infections During wort production or post packaging, (<i>Clostridium</i> spp.) More pronounced with lower pH values</p>	<p>Good CIP Minimise O₂ exposure, maintain mash temperature >32°C and not exposed to oxygen</p>

5. Chlorophenol

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma, Flavour & Mouthfeel</p> <p>Adhesive tape, Antiseptic, Sticking plasters, Disinfectant, 'Hospital-like', Medicinal, Mouthwash, Plastic, TCP,</p>	<p>Never</p>	<p>None</p>	<p>1. Chemical reactions between alcohols and chlorine based sanitisers</p> <p>2. Water polluted with chlorine compounds</p>	<p>1. Use chlorine based cleaners and sanitisers in correct concentrations, More isn't necessarily better! Thoroughly rinse brewing equipment and packaging, Treat water to remove chlorines,</p> <p>2. Don't use polluted water</p> <p>TASTE & RECORD WATER FLAVOUR BEFORE STARTING BREW!</p>

6. Diacetyl (Vicinal Diketones)

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma, Flavour & Mouthfeel</p> <p>Butter, Buttered Popcorn, Butterscotch, Honey, Milky, Toffee, Vanilla.</p> <p>Oily, Creamy mouthfeel</p>	<p>Dependent on beer style.</p> <p>Never in thin body beers or Lagers</p>	<p>Pale ales, Bitters, Porters, Stouts, Strong ales,</p>	<p>1. Yeast Fermentation byproduct Insufficient/excessive yeast growth, Underpitching, Slow/weak fermentation, Low wort O₂, High gravity wort, Premature/delayed yeast removal from wort, Incorrect fermentation temp for strain (low), Swings in fermentation temperature, Fermenter CO₂ levels, Adjunct levels, Yeast nutrient,</p> <p>2. Microbial infection <i>Lactobacillus</i> & <i>Pediococcus</i> spp, Wild yeast</p>	<p>1. Yeast strain Yeast health Pitching rate Insufficient/excessive yeast growth, Wort gravity & O₂, Yeast/wort contact time, Control fermentation temperature, Fermenter CO₂ levels,</p> <p>2. Good CIP</p>

7. DMS (Dimethyl Sulphate)

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Cooked – broccoli, sweet corn, cabbage, vegetables; parsnips, tomato juice/sauce; seaweed, shellfish;</p> <p>Oily, creamy mouthfeel</p>	Yes	Low levels in lagers, German pilsners	<p>1. Malting process SMM produced during germination SMM > DMSO > DMS during wort boil</p> <p>2. Maize adjunct</p> <p>3. Microbial infection <i>Zymomonas</i> & <i>O. Proteus</i> spp, Wild yeast</p>	<p>1. Pale Ale malt lower SMM levels than dark malt, Boil time & vigour, Low temperature sparging, Weak wort cut-off, Slow wort cooling, Long lag phase or sluggish fermentation</p> <p>2. Maize has high SMM levels</p> <p>3. Good CIP especially on cold side, Do not use equipment which can't be sanitised, Avoid soft plastic/wood items</p>

8 & 9. Ethyl Acetate/Ethyl Hexanoate

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Acetate Ripe apples, Pears, Pear drops</p> <p>Hexanoate Aniseed, Apple, Fruity, Banana, Pineapple Honey, Rum, Sherry, Brandy, Wine-like</p>	Yes	<p>Ales</p> <p>German wheat & rye beers, Belgian Ales</p>	<p>1. Fermentation by products</p> <p>2. Wild yeast infection</p>	<p>1. Yeast strain, Yeast management, Trub levels Insufficient/excessive yeast growth, Mineral deficiency (Zn, Ca etc), Correct fermentation temperature for yeast strain, High temperature fermentation, Green beer aeration, Wort oxygenation, Ethanol concs.,</p> <p>2. Good CIP</p>

10. Hydrogen Sulphide (H₂S)

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Rotten eggs, Drains, Putrid, Sewers, Fresh beer</p>	<p>Yes - low concs.</p> <p>No – high concs.</p>	<p>Light lagers, Pale hoppy Ales</p>	<p>1. Brewing by products Formed during wort boil</p> <p>2. Fermentation / Conditioning / Packaging by products Autolysed yeast, Sulphite preservatives in isinglass Aluminium contact</p> <p>3. Yeast strain (lager < ale yeasts)</p> <p>4. Microbial infection <i>Zymomonas, Pectinatus</i> etc. spp.</p>	<p>1. Cu ion concentrations</p> <p>2. Yeast management, Wort oxygenation, Pitching rates, Mineral deficiency (Zn), High temp fermentation, Ventilated fermentation, Sufficient conditioning time, Minimise H₂S fining use</p> <p>3. Incorrect fermentation temperature for yeast strain</p> <p>4. Good CIP</p>

11. Isovaleric Acid

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Blue cheese, Rochefort, Old hops, Rancid,</p> <p>Dirty/sweaty feet/socks, stale cheese, Putrid</p>	<p>Never</p>	<p>None</p>	<p>1.Hops Alpha acid oxidation during storage</p> <p>2. Aging</p> <p>3. Bacterial infections</p>	<p>1. Hop freshness, vacuum sealed, oxygen-free, low temperature storage, green hops/pellets</p> <p>2. Aging decreases intensity</p> <p>3. Good CIP</p>

12. Lightstruck

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Catty, Farty, Faecal, Mercaptan, Sulphury, Sunstruck</p>	<p>Never</p>	<p>None</p> <p>Common in green or flint bottles, especially lagers – some drinkers consider flavour as true beer flavour</p>	<p>1. Mishandling Photochemical reaction where visible or UV light reacts with riboflavin (from sun or artificial light)</p> <p>2. Bittering hop levels</p>	<p>1. Store fermenting & finished beer in light-blocking containers Amber bottles – 5% UV & 5-30% of all light pass, Green bottles – 80% UV & 50-80% of all light pass, Flint/Clear – 90% of UV & all light pass</p> <p>2. Reduce level of bittering hops</p>

13. Mercaptan

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Catty, Drains, Farty, Faecal, Leeks, Rotten vegetables, Sulphury</p>	<p>Never</p>	<p>None</p>	<p>1. Yeast Fermentation by product</p> <p>2. Bacterial infection <i>Pectinatus</i> and other spp.</p>	<p>1. Yeast strain, Yeast autolysis Remove beer from yeast</p> <p>2. Good CIP</p>

14. Metallic

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Appearance, Aroma, Flavour & Mouthfeel</p> <p>Aluminium foil, Bitter, Blood-like, Coin-like, Inky, Harsh, Rusty, Tinny</p>	<p>Never</p>	<p>No</p>	<p>Contamination</p> <p>High levels of metallic ions in brewing liquor, leaching from equipment &/or supplies</p>	<p>Water treatment, Use of corrosive materials, Prolonged caustic chemical contact time, Stainless, food grade plastic, glass containers for fermenting and finished beer</p>

15. Musty - TCA

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Cellar-like, Damp, Dank, Fusty, Mouldy, Musty, 'Cork taint'</p>	<p>Never</p>	<p>None</p>	<p>Mould - On equipment stored wet or in damp conditions, Damp floors, Wooden barrels, Corks</p> <p>Improperly cleaned packaging materials</p>	<p>Good CIP and sanitising, Dry storage of wood & plastics, Humidity/dampness in plant especially packaging area,</p>

16. Papery

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Cardboard, Papery, Dull</p>	<p>Never</p>	<p>None</p>	<p>Aging Dissolved oxygen</p>	<p>Oxygen levels during process, All vessels 'quietly filled' Hot & cold break, Finished beer storage temperature, Final package fill levels, Packaged product storage temperatures</p>

17. 4 Vinyl-Guaiacol

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Phenolic, Cloves</p>	<p>Generally no</p>	<p>German wheat beers, Belgian ales</p>	<p>1. Fermentation by product Yeast</p> <p>2. Wild yeast infection <i>S. diasticus</i> sp</p> <p>3. Bacterial infection <i>Acetobacter</i> spp.</p>	<p>1. Good yeast health/quality, Correct yeast strain (hefeweizen yeast) Correct pitching rate, Correct fermentation temperatures, Longer fermentation/conditioning times,</p> <p>2. Good CIP</p> <p>3. Good CIP</p>

18. 4 – Ethyl Guaiacol

Description	Appropriate?	Beer styles where appropriate	Cause	Control measures
<p>Aroma & Flavour</p> <p>Phenol, Smoky, Ash-like,</p>	<p>Generally no</p>	<p>Subtle levels from smoked malt in Scotch ales</p>	<p>1. Malt Smoked malt Scorching wort/mash</p> <p>2. Process faults</p> <p>3. Contamination <i>Brettanomyces spp</i></p>	<p>1. Mash/boil temperatures, Direct fired /indirect heated equipment,</p> <p>2. Boil times, Good wort oxygenation Good yeast health/quality, Correct yeast strain, Correct pitching rate, Correct fermentation temperatures,</p> <p>3. Good CIP</p>

Common factors influencing off-flavour production

<p>Premises Clean (cleanable) & dry or damp & dirty</p>	<p>Copper Quiet fill Oxygen pick up Hop additions Boil - times, temperatures, vigour pH Trub levels - Hot break</p>	<p>Conditioning Quiet fill Correct oxygenation levels Pitching rate Temperatures, times, pressures pH Adjunct additions Speed of cooling Yeast removal from green beer Auxiliary fining addition Exposure to light</p>
<p>Equipment material choice Stainless or ferrous, wooden, plastic</p>		
<p>CIP & sanitation Correct materials (chemicals) for correct part of process Chemical concentrations, times, temperatures Cleaning/spray patterns Soak baths or dry</p>	<p>Wort cooling Trub levels - Cold break Speed of cooling</p>	<p>Packaging Quiet fill Correct oxygenation levels Packaging materials - aluminium, glass (colour) Exposure to light pH Fill levels</p>
<p>Water Taste and treat - document</p>	<p>Yeast handling Strain Storage, health, quality Nutrients</p>	
<p>Raw materials Storage conditions - cool, dry Grist choice & levels - malt, hops, adjuncts, yeast spp.</p>	<p>Fermentation Quiet fill Correct oxygenation levels Pitching rate Temperatures, times, pressures pH Adjunct additions Speed of cooling Yeast removal from green beer Auxiliary fining addition Exposure to light</p>	<p>Storage Temperature Exposure to light Time</p>
<p>Mash Temperatures Mineral salt additions Oxygen pick-up pH</p>		