

Controlling Off-flavours

Kevin Mutch
Peripatetic Brewer
25th October 2017

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, Vinegary</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>	<p>1. Good yeast health/quality, Correct yeast strain, Correct pitching rate,,</p> <p>2. Minimise O₂ exposure</p> <p>3. Good CIP especially on cold side, Do not use equipment which can't be sanitised, Avoid soft plastic items</p>

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>	<p>Yes</p>	<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>	Never	None	<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>		