

# German Brewing Techniques

American Homebrewers Assoc.

2008 Conference

[steveholle@aol.com](mailto:steveholle@aol.com)

# Overview of Today's Presentation

- Topics
  - Overview of the Reinheitsgebot
  - Overview of common brewing methods
  - Examples of some commercial beer recipes
- Information Sources
  - Text Books – Kunze, Narziss,
  - Interviews with German brewers
  - Tours of German Breweries

# German Brewers

vs

# American Brewers

| German    | American        |
|-----------|-----------------|
| Tradition | Innovation      |
| Balance   | Extreme Flavors |
| Freshness | Variety         |
| Science   | Art             |

# Reinheitsgebot or Purity Law

- Written in 1516 (oldest food law still in force)
- 1516 Law is not the same as provisions defining Purity Law in Biersteuergesetz (“beer tax law”)
- 1516 Law does not include the modern requirements for labeling a beer as “brewed according to the Reinheitsgebot”
- Modern innovations have required ongoing interpretation about what is permissible

# German Reinheitsgebot applies to

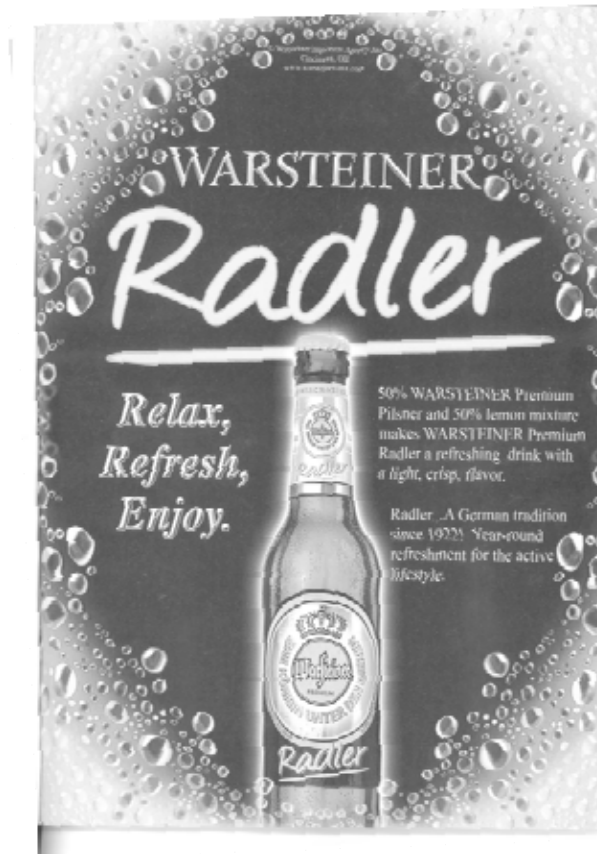
- All beer brewed in Germany and sold in Germany
- All beer brewed in Bavaria and Baden Württemberg and sold in or outside Germany

# Exceptions to Reinheitsgebot

- Beers brewed outside Germany and imported (EU ruled in 1987 law was restraint of trade between EU members)
- Beer brewed in Germany and exported (except Bavaria and Baden Württemberg)
- Malt beverages not labeled as “beer”
- Beer cocktails mixed in taverns — Examples: Berliner Weisse, Russ’n, Radler
- Experimental beer
- Homebrew

# Just Don't Call it Beer!

“Radler” is a mixed beer drink of 50% Helles Bier and 50% Sprite/7UP. The Brits call this a “Shandy”. It is usually mixed at the bar; however, Warsteiner is selling this concoction in a beer bottle, but the bottle is labeled “Mischbiergetraenk” and not “Beer”. Therefore, the Reinheitsgebot does not apply.



# Malt



- Malt only, no adjuncts (loophole: Spitzmalz)
- Lager beer can only use barley malt
- Ales may use any malted grain (wheat, rye, spelt)
- Malt must be milled on site (i.e., no malt extract)
- No coloring (loophole: Farbebier, aka “colored beer”)

# Water Treatment

Kloster Brauerei Ettal, Ettal



# Water

- Normal public water treatment allowed by “Trinkwasserverordnung”: chlorine, ozone, UV
- Treatments allowed: filtration, reverse osmosis, ion exchange, slaked lime
- Salts permitted: Gypsum and CaCl, if added to water only
- Cleaning and disinfectantsolutions allowed
  - with assumption that they are rinsed

# Acidification

- Prohibited
  - Addition of industrially/non-biologically produced acid
- Permitted
  - Acid rest
    - mash in at 45°C and let mash stand overnight – no longer commercially practiced (too slow, too variable)
  - Sauermalz
    - Regular pilsner malt sprayed with Sauergut
  - Sauergut, aka, sour wort
    - Wort is inoculated with cultured lactic bacteria or from wort that has been subjected to an acid rest

# Sour Wort

## via lactic bacteria (Sauergut)

Wochinger Braeu, Woching



# Hops

- Pellets allowed
- Extracts allowed if derived by natural solvents like ethanol, CO<sub>2</sub>
- Isomerized extracts not allowed
- Hops allowed in kettle only (i.e., no dry hopping)



# Yeast

- No nutrients or additives
  - Oops! Is that a zinc pipe
  - Macerated and heat deactivated yeast
- No acid washing
- Lager yeast in wheat beer bottle conditioning permitted (barley kräusen can't exceed 15%/v)
- Brewers not as focused on strain of yeast
  - Strain 34/70 = WY2206 & WLP830

# Yeast Transfer Tub

Brauerei Greifenklau, Bamberg



# Mashing Regimes

- Single temperature infusion
  - Almost unheard of in Germany
  - For a Braumeister, much too simple to make good beer
- Decoction – losing popularity due to time & \$
  - dark beers – caramel & phenols (fuller, rounder flavor)
  - wheat beers – denature proteins to improve viscosity
  - small traditional breweries
  - Increase fermentability
- Step infusion mash – most common

# German Mashing Regimes Require Sophisticated Equipment

- Mash agitator
  - Mixing during step infusion
  - Mixing for decoction
- Lauter tun rakes
  - Decoction and pumping deaerates mash so it won't "float" as in British-style single temperature infusion
- Mash pump

# Mash Tun

note the 2 agitator arms and copper chain to prevent scorching



# Classic Mash Temperatures

| Tem  | Purpose  |
|------|--|
| 35°C | (optional) starting point for mash in, especially triple decoction             |
| 45°C | (optional) degrade $\beta$ -glucans & produce ferulic acid _ 4 VG in Weissbier |
| 50°C | protein rest & degrade $\beta$ -glucans  |
| 62°C | gelatinization/liquefaction (beta amylase)                                     |
| 72°C | saccharification (alpha amylase)   |
| 78°C | mash off   |

# Water:Grist Ratios

(wt/wt, 1liter = 1kg, 1qt 2 lb)

- Mash more liquid than English infusion mashes because German mashes are stirred and pumped
- Water grist ratios are adjusted for beer type
  - 3.0 to 3.5 : 1 dark and/or malty beers (Maerzen)
  - 4.0 to 5 : 1 pale and delicate beers (Pils)
- Lower water : grist ratio requires more sparging: \_efficiency \_\_ phenols \_\_ fermentability
- Higher water: grist ratio requires less sparging : \_ efficiency \_\_ phenols \_\_ fermentability

# Lautering

- Continuous sparging is probably more common in larger breweries
- Batch sparging with 2 or 3 sparge water additions (“Nachgüsse”)
- Less common to heat kettle intensely while filling
  - convert starch to dextrins @ 75°C, start heating at kettle full
  - Consistent flavor and stability from consistent boiling parameters, i.e. time and temperature

# Lauter Tun

Brauerei Greifenklau, Bamberg



# Hops

- 1 to 4 additions depending on style
- Aroma hops are usually boiled 5 to 10 minutes to remove grassy flavors
- No dry hopping, but hops are sometimes added right before whirlpool, but not in whirlpool
- No bittering or hop oil extract can be added after kettle

# Knockout

- Aerate in-line between chiller and fermenter with sterile air (not oxygen)
- Knockout colder than fermentation temp.
- Flotation tanks for lagers when fermented in flat bottom fermenters
  - Can't remove trub in flat bottom fermenter
  - Can't harvest yeast if flat bottom filled with trub

# Coolship at Bavarian Farm Brewery



# Top Fermentation (ales)

- Open fermenters still common for Weissbier, brewpubs, and traditional Bavarian lager breweries
  - Skim and remove trub first +/- 2 days
  - Then harvest yeast by skimming
- Pitching rates
  - Weizen - 5 to 10MM cells/ml
    - Yeast cells double more times at warm temps
    - Yeast growth promotes higher ester production
  - Perhaps higher rate for cool fermented Alt and Koelsch due to colder temp and lower ester profile

# Weissbier Fermenter

Schneider



# Open Brewpub Fermenters

## Fliegerbraeu, Munich



# Bottom Fermentation (lager)

- Pitch 15 to 30MM cells/ml
- Knockout colder than fermentation temperature @ 6 to 8°C
  - Oxygen solubility \_
  - Protection against invading microbes
  - Reduces fruity/spicy higher alcohols and esters
- Free rise to 9 to 10°C, achieve about 80 - 90% of attenuation limit in 1 week
- Drop to lagering temperature (0 to 2°C) by 1°C/day (DON'T CRASH!!!!!!)
- Condition for 3 or more weeks (diacetyl rest sometimes used by larger brewers up to 20\_C)
- Tank is bunged and remaining extract (1 – 2% remaining fermentable extract) or added kraeusen (10%) carbonates beer

# Open Lager Fermenter

(Kloster Brauerei Ettal, Ettal)



# Open Lager Fermenter

(Kloster Brauerei Ettal, Ettal)



# Open Lager Tank

Brauerei Greifenklau, Bamberg



# Clarification/Filtration

- **Not Permitted** — these are not inert, can't be fully removed
  - Irish moss
  - Isinglass
  - Forced carbonation from CO<sub>2</sub>, if not produced by fermentation
- **Permitted** — inert ingredients that can be removed by filtration or sedimentation
  - PVPP (plastic flakes that adsorb tannin)
  - Silica gel
  - DE and cellulose filters
  - Carbonation by spunding (bunging) and kräusen
  - Forced carbonation from CO<sub>2</sub> captured from fermentation  
OK

# Spundapparat

pressure-relief valve for carbonation



# German Brewers Are Very Mindful of pH thorough out entire process

- 5.4 to 5.6 pH in the mash
- 5.1 to 5.4 at end of boil
- 4.2 to 4.4 at end of fermentation ( 4.6 bacteria active and taste affected)
- Focus on the beer pH, not the mash!!!!!!
- Homebrew pH is often too high!

# German Lagers may have higher levels of SO<sub>2</sub> (sulfur dioxide) than American lagers

- SO<sub>2</sub> should not to be confused with:
  - DMS – inadequate boil (should never be found in German lager)
  - H<sub>2</sub>SO – stressed yeast / unwanted microbes
- Lager yeast naturally produce more SO<sub>2</sub> than ale
  - German brewing techniques produce/trap more SO<sub>2</sub>
  - Cold fermentation, cold lagering
  - Natural carbonation (forced carbonation scrubs SO<sub>2</sub>)

# Factors contributing to increased SO<sub>2</sub>

Dr. Greg Casey, Coors Brewing

- Lager yeast strain produces more SO<sub>2</sub> than ale
- Spunding and kraeusen (trapped CO<sub>2</sub>)
- Sulfates in water
- Cold temperature (Miller – beer fermented at 10°C 2x more SO<sub>2</sub> than at 15°C)
- Suntory of Japan noted more SO<sub>2</sub> with all malt beers than with adjunct beers

# Factors contributing to decreased SO<sub>2</sub>

- Ale yeast
- Pasteurization
- Higher beer storage temps
- Increased tank venting
- CO<sub>2</sub> release purges SO<sub>4</sub> from beer
- Fast fermentations
- Non-pressurized fermentation/conditioning

# Beer from the Lager Tank

Taste the freshness and SO<sub>2</sub>

Paulaner Braeuhaus, Munich



# Appendix

- Typical Grain Bills – a lot of a little
- Actual German Brewery Recipes
  - Munich Dunkel
  - Weizen
    - Hell
    - Dunkel
    - Helles
    - Pils
    - Koelsch
    - Alt

# Malt Color

- Use a lot of low color malt instead of a little of a high color malt
  - 100% vienna or munich malt can be used
  - Cara malts are usually less than 5% of grain bill
  - Dark/Roasted malts are usually less than 1%
- Roasty flavor rarely acceptable, except a hint in Schwarzbier. Ways to add color, but no roast flavor
  - Fardebier (colored beer)
  - Dehusked roasted malt (carafa)

# Malt Bill for Various Beers

*(Source: Narziss, Brauwelt, 6, (1990), p. 178-184.)*

| Beer Type | Malt Type   | Malt EBC | % of Grist |
|-----------|-------------|----------|------------|
|           |             |          |            |
| Pils      | pilsner     | 3        | 100        |
|           | pilsner     | 3        | 95         |
|           | cara-pils   | 4        | 5          |
| Hell      | helles      | 3.5      | 95         |
|           | cara-hell   | 25       | 5          |
| Export    | helles      | 3.5      | 100        |
| Export    | pilsner     | 3        | 99         |
|           | cara-munich | 120      | 1          |

# Malt Bill for Various Beers

(Continued)

| Beer Type | Malt Type    | Malt EBC | % of Grist |
|-----------|--------------|----------|------------|
| Dunkel    | munich       | 15       | 90         |
|           | helles       | 3.5      | 9          |
|           | black        | Na       | 1          |
| Dunkel    | munich light | 15       | 40         |
|           | dark         | 25       | 40         |
|           | helles       | 3.5      | 14         |
|           | cara-munich  | 128      | 5          |
|           | black        | Na       | 1          |
| Dunkel    | munich       | 15       | 50         |
|           | melanoidin   | 35       | 30         |
|           | helles       | 3.5      | 19         |
|           | black        | Na       | 1          |

# Malt Bill for Various Beers

(Continued)

| Beer Type | Malt Type   | Malt EBC | % of Grist |
|-----------|-------------|----------|------------|
| Maerzen   | vienna      | 5.5      | 90         |
|           | helles      | 3.5      | 10         |
| Maerzen   | vienna      | 5.5      | 90         |
|           | cara-hell   | 25       | 10         |
| Maerzen   | munich      | 15       | 70         |
|           | helles      | 3.5      | 25-30      |
|           | cara-munich | 120      | 0-5        |
| Maerzen   | munich      | 15       | 50         |
|           | helles      | 3.5      | 30         |
|           | melanoidin  | 20       | 20         |
| Maerzen   | munich      | 15       | 100        |

# Malt Bill for Various Beers

(Continued)

| Beer Type     | Malt Type | Malt EBC | % of Grist |
|---------------|-----------|----------|------------|
| Helles Weizen | wheat     | Na       | 50-90      |
|               | helles    | 3.5      | 50-10      |
| Helles Weizen | wheat     | Na       | 70         |
|               | cara-hell | 25       | 5          |
|               | helles    | 3.5      | 25         |
| Helles Weizen | wheat     | Na       | 70         |
|               | munich    | 15       | 15         |
|               | helles    | 3.5      | 15         |

# Malt Bill for Various Beers

(Continued)

| Beer Type | Malt Type  | Malt EBC | % of Grist |
|-----------|------------|----------|------------|
| Weizen    | wheat      | Na       | 60         |
|           | munich     | 15       | 40         |
|           | black      | Na       | <0.5       |
|           | wheat      | Na       | 40         |
|           | dark wheat | Na       | 30         |
|           | munich     | 15       | 30         |
| Koelsch   | helles     | 3.5      | 95         |
|           | cara-hell  | 25       | 5          |
| Koelsch   | helles     | 3.5      | 85         |
|           | vienna     | 5.5      | 15         |
|           |            |          |            |
|           |            |          |            |

# Malt Bill for Various Beers

(Continued)

| Beer Type | Malt Type   | Malt EBC | % of Grist |
|-----------|-------------|----------|------------|
| Alt       | helles      | 3.5      | 99         |
|           | black       | Na       | 1          |
| Alt       | munich      | 15       | 90         |
|           | helles      | 3.5      | 10         |
| Alt       | helles      | 3.5      | 85         |
|           | cara-munich | 120      | 15         |
| Alt       | munich      | 15       | 50         |
|           | melanoidin  | 35       | 50         |

# Malt Bill for Various Beers

## *Notes:*

- *Black Dark malt is called Farbemalz (colored malt)*
- *Black malt has color of 1300 to 2500 EBC*
- *Melonoidin malt is also known as Bruhmalz*
- *Munich malt is also know as Dunkles Malz*

# German Bier Recipes

- Recipes from commercially brewed beers
- Note not only the grain, hops, and yeast, but also the process variables.

# Monastery Weltenburg – Munich Dunkel

## 2008 World Beer Cup Gold Medal

|                     |  |
|---------------------|--|
| Malt:               | 75% Munich, 20% pale, 5% specialty (caramel and roasted)   |
| Water: Grist        | Ratio: 3 to 1  |
| Mash (2 decoctions) | Mash in @ 52°C, rest 10 min<br>Pull 1 <sup>st</sup> decoction (30%) & boil 20 min<br>Rest @ 63°C, rest 30 min<br>Pull decoction & boil 20 min<br>Mash off @ 74°C |
| Lautering           | Vorlauf – 5 to 10 min<br>First wort runs off in 1:15 hr<br>3 sparge water additions @76°C<br>Total lautering time = 2.5 to 3.0 hr                                |
| Boil                | 50 min @ 103°C (external calandria)  |
| Hops                | 3 additions: 1st @ boil start; 2nd after 25 min; 3rd at end<br>IBU - ??<br>(Probably Hallertau/Hallertau and/or Hallertau/Perle)                                 |
| Whirlpool           | 20 min stand   |
| Knockout            | 12.5°P @ 6°C w/ 2 stage counter flow wort chiller  |
| Aeration            | 6 mg of O <sub>2</sub> and pitch proprietary yeast @ 30MM cells/ml   |
| Flotation           | 2 hours  |
| Primary             | 7 days @ 9°C in flat-bottom enclosed fermenter – fully attenuated  |
| Conditioning        | 3 to 4 weeks @1°C w/kraeusen for natural carbonation   |
| Filtration          | DE   |

# Export Dunkel

## (small Bavarian brewer)

OG 12.8°P  
 BU na  
 Water no treatment, except water salts and sauergut  
 Malt 94% Munich malt, 6% caradunkel, 0.1% Farbemalz (black); Farbebier in kettle  
 Mashing (1 decoction)

| Temperature (°C) | Rest (min) | Comment  |
|------------------|------------|--|
| 50               | -          | Mash in  |
| 64               | 10         | Pull decoction to raise mash to next rest; boil 20 min |
| 72               | 20         | Saccharification rest                                  |
| 75               | --         | Mash off/Transfer to lauter tun                        |

Lautering 2:20 hr total; 1:00 first runnings, 1:20 for 2 sparge additions  
 Boil 1:45 hr  
 Hops 1<sup>st</sup> 45% Hallertau Perle 10 min after boil start  
 2<sup>nd</sup> 55% Hallertau Perle 30 min after boil start  
 Ferment Cool to 7°C in 65 min

# Schneider Weisse Original

## Kelheim

|                     |   |
|---------------------|---|
| Malt:               | 60% wheat malt, 40% pale barley malt (color comes from <1% carafa)  |
| Water: Grist        | Ratio: 5.5 to 1 (very liquid)   |
| Mash (2 decoctions) | 35°C, mash in<br>44°C, 10-15 min (ferulic acid _ 4VG)<br>52°C, protein rest<br>62°C, gelatinize<br>72°C, saccharification<br>Mash off   |
| Lautering           | 3.5 hr  |
| Boil                | 58 min @ ??°C with external calandria   |
| Hops                | 12 IBU  |
| Whirlpool           |   |
| Knockout            | 12.8°P @ 16°C   |
| Aeration            | 5 mg of O <sub>2</sub> in-line  |
| Yeast               | proprietary yeast @ 4-7MM cells/ml (don't reuse yeast – top crop)   |
| Primary             | ? Days @ 16-24°C in open fermenters – fully attenuated  |
| Bottle Conditioning | centrifuge to drop yeast count to 0.3 to 0.5MM cells/ml<br>cool beer to 2.5g CO <sub>2</sub> /L (8°C)<br>Mix Speise in tank for 6.5g CO <sub>2</sub> /L (3.2 CO <sub>2</sub> v/v)<br>Fob bottles after filling<br>1 week @ 20°C, then 2 week @ 10°C |

# Observations by Hans Peter Drexler (Schneider) on Weissbier

- Longer the rest at 44° C, the higher the 4-V-G (clove phenol)
- Low Kolbach index ( 38%) for wheat and barley needed for estery beer
- Removal of cold break creates neutral taste and is not necessary
- Open fermenters increase esters
- Bottle conditioning increases phenols
- O<sub>2</sub> reduction at bottling important

# Hefeweizen Beer

## Doemens Akademie

OG 12 to 13°P  
 BU 13  
 ADF 80%  
 C02 6g/L  
 Malt 60% Wheat, 38% Pale barley, 2% Sauermalz  
 Water: Grist 3.75:1

| Temperature | Rest      | Comment   |
|-------------|-----------|---|
| 45          | 20        | Precursor ferulic acid for 4VG formed               |
| 50          | 10        | by direct heat to mash tun                          |
| 62          | 10        | After 10 min. pull 1 <sup>st</sup> decoction        |
| decoction   | in 10 min | raise to 72°C, hold 15 min, then boiling for 15 min |
| 72          | 15        | Add decoction to raise main mash to 72°C            |
| 78          | --        | Transfer to lauter tun                              |

Hops Hallertau Perle pellets, one addition 10 min after start of boil  
 Ferment at 20°C until fully attenuated,  
 Bottling add Speise held back from brew day, and condition at room temperature

# Hefeweizen

## (small Bavarian brewer)

|                            |   |
|----------------------------|---|
| OG                         | 12.4%   |
| BU                         | na  |
| H <sub>2</sub> O treatment | none  |
| Malt to Mashing            | 56% wheat, 28% pale barley, 12% Munich, 4% Caradunkel; Fardebier equal 1.5% added to kettle (1 decoction) |

| Temperature (°C) | Rest (min) | Comment  |
|------------------|------------|--|
| 45               | 15         | Mash in  |
| 52               | 5          | Optional, may begin heating immediately to next rest |
| 62               | 20         | Pull decoction, boil 20 min, add back for next rest  |
| 72               | 72         | Optional, add decoction to raise main mash to 72°C   |
| 75               | --         | Transfer to lauter tun                               |

|           |   |
|-----------|---|
| Lautering | 2:20 hr total; 1:00 first runnings, 1:20 for 2 sparge additions |
| Boil      | 1:45 hr   |
| Hops      | 1 addition of Hallertau Perle 10 min after boil start           |
| Ferment   | Cool to 16-17°C in 65 min.                                      |

# Export Hell

## (small Bavarian brewer)

|                            |  |
|----------------------------|--|
| OG                         | 12.3°P   |
| BU                         | na   |
| H <sub>2</sub> O treatment | sour wort - 1% of knockout volume added at mash in, 0.5% added in kettle |
| Salts                      | CaCl   |
| Malt                       | 96% pale barley, 2% carahell, 2% caradunkel                              |
| Water: Grist               | na   |
| Mashing                    | (1 decoction)  |

| Temperature (°C) | Rest (min) | Comment  |
|------------------|------------|--|
| 58               | 15         | Mash in  |
| 64               | 20         | Pull decoction to raise mash to next rest; boil 10 min |
| 72               | 25         | After 10 min. pull 1 <sup>st</sup> decoction           |
| 75               | --         | Transfer to lauter tun                                 |

|           |   |
|-----------|---|
| Lautering | 2:20 hr total; 1:00 first runnings, 1:20 for 2 sparge additions |
| Boil      | 1:30 hr   |
| Hops      | 1 <sup>st</sup> 30% Hallertau Perle 10 min after boil start     |
|           | 2 <sup>nd</sup> 30% Hallertau Perle 30 min after boil start     |
|           | 3 <sup>rd</sup> 20% Tettnang 60 min after boil start            |
|           | 4 <sup>th</sup> 20% at knockout                                 |
| Ferment   | Cool to 7°C in 65 min.  |

# Schoenramer Pils

## Brauerei Schoenram, Schoenram, Bavaria

- soft water, **low alkalinity**, chloride and sulfate ions enhances body and aroma respectively
- very pale barley variety with a lot of enzyme activity (we use the variety Barke, the palest available)
- intense mash, single-decoction best as it **boosts attenuation**. Rests vary according to year, but a long time around 65°C is necessary
- **high attenuation (>87% apparent)** enhances hop character (dryness) and at the same time, through the higher level of alcohol, **adds a sweetness** to balance out the bitterness
- I am a proponent of aroma hop varieties and **use only aroma varieties** for my Pils (as for all my beers), even for the bittering - 4 different varieties given 5 times, more than 50% as late hopping, all are Bavarian hop varieties from the Hallertau and Spalt (the varieties and combination a secret I'm not at liberty to give away)
- enough evaporation to drive out DMS ( > 5.5% )
- acidification of mash and wort to adjust pH (**lactic acid derived from the malt and propagated to around 1.5%**)
- hot trub separation with the whirlpool, **cold trub separation with flotation tank**
- fermentation in open vessels beginning around 7°C, max. temperature 9°C, pitching rate 18 million cells per ml (about 1 liter of thick yeast per hl)
- ferment close to final attenuation, cool to 3°C over 2 days (total fermentation time with cooling around 8 days) add 8% krausen beer when transferring to lagering
- **we skim our fermentation head almost daily**
- hold in tank at 3°C for 2 weeks until vigorous secondary fermentation begins to calm down, **gradually cool** to below 0°C (around minus one) over two weeks
- last two weeks below freezing, total lagering 6 weeks, 5 weeks is also OK, but not less
- ensure minimal oxygen take-up at bottling

# Prost!

