Technologic parameters for Czech style beer

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Nurmberg: 12.11.2018

Type of beer

According to color

- Light beer
- Semi dark beer
- Dark beer

According the fermentation

- Bottom fermentation
- Top fermentation

According the original gravity

- non alcoholic beer
- Low energy beer
- Light beer
- Lager beer
- Hight gravity beer

Czech style beer

- Light beer
- Original gravity 10 – 12 %
- Bottom fermentation beer
- Lager type of beer
- Beer without off-flavours
- Beer with golden colour
- Beer with high bitterness
- Beer with high fullness
- Beer with high foam creating and foam stability

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Basic influence of Czech style beer

- Raw materials
- Technology
- Equipment

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Raw materials

- Water
- Malt
- Unmalted raw materials
- Hop
- Yeast
- Subsidiary materials

Water

- Sort of water
  - Soft — 0 – 8 °G
  - Middle hard — 9 – 18 °G
  - Hard — 19 – 30 °G.
  - Very hard — up to 30 °G

- Hardness
  - Carbonated — $CaHCO_3$, $MgHCO_3$
  - Un carbonated — $CaSO_4$, $MgSO_4$, $CaCl_2$, $MgCl_2$,
  - Total

Malt

- Type of barley – spring barley
- Basic analytical parameters
  - Colour 3,5 – 4 u EBC
  - pH 5,8 – 6
  - Saccharification 10 – 15 min
  - Extractivity 80 – 82 %
  - Malt grinding difference 0,8 – 2 %
  - Extract 45 °C 35 – 40 %
  - Proteins 9,5 – 11 %
  - Kolbach Nr. 36 – 42
  - Level of attenuation 79 – 82 %

Unmalted materials

- Sugars type
  - Sugar (saccharose)
  - Sugar syrups (starch hydrolyses of wheat, corn)
- Starch
  - Barley
  - Rice
  - Corn
  - Wheat

Hop

- Full aromatic hop less 5 % of alpha acids
- Semi aromatic hop 8 – 10 %
- Bitter hop 12 %
- High bitter hop 15 %

- Original
- Granuleted (G 90, G 45)
- Hop extract

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Technology and equipment

- Wort production
- Primary fermentation and maduration
- Filtration
- Filling and packaging

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Malt grinding

- Dry grinding
  - Two rolls grinder
  - Four rolls grinder
  - Six rolls grinder
- Conditioning grinding
  - Conditioning by hot water
  - Conditioning by steam
- Wet grinding
- Hammer mill grinding

Mashing

- Thick mashing
  - High gravity brewing system
  - Better extract balance
  - Changes of taste profile
- Optimal mashing
  - Malt : water ratio - from 1 : 3,5 till 1 : 4,0
- Thin mashing
  - Beer with low original gravity
  - Faster fermentation processes
  - Lower extract balance

Mashing

Temperature of mashing

- Cold mashing 19 °C
  - Low level of malt degradation
  - High energy loses
  - Long time of mashing process
- Middle temperature mashing 37 °C
  - Optimal temperature for Czech style beer mashing
  - Energy balance without loses
- Warm mashing 52 °C
  - High level of malt degradation
  - Usually with external enzymes addition
  - High quantity of brews
- Hot mashing 63 °C
  - only for special type of beer

Mashing

- Full automatic system
- Mixing malt and water directly in premash equipment before mash kettle
- Water temperature regulation
- Time of mashing – less then 20 minutes
- Separate mashing of basic mash and first mash

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Mashing system

- Infusion mashing
- Single mash decoction mashing
- Double mash decoction mashing
- Triple mash decoction mashing

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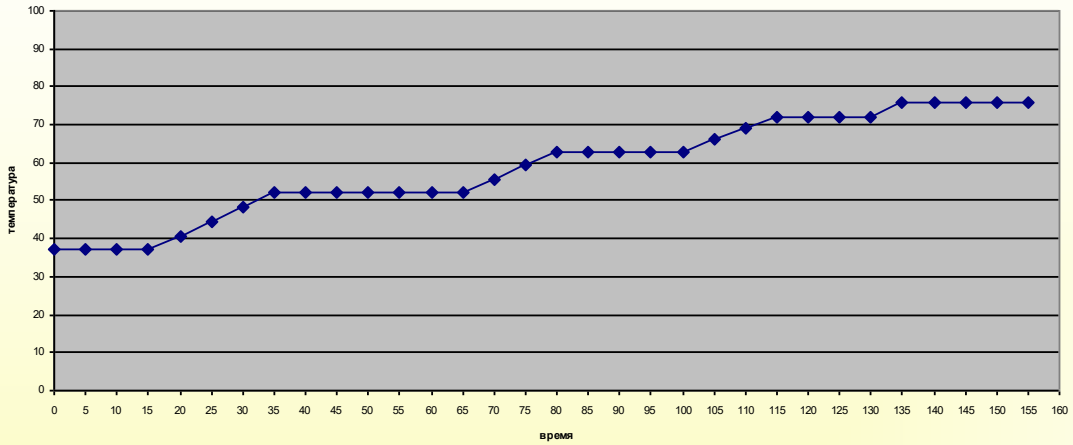
Infusion mashing

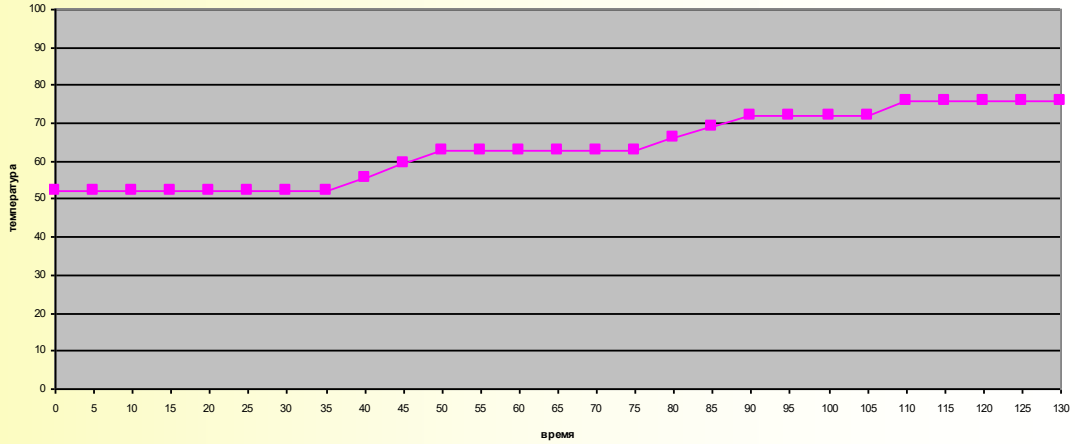
- Fast process – high quantity of brews
- Until 11 brews per day only one mash kettle is used
- Low energy consumption
- Low colour of beer
- Low colloidal stability of beer
- Low fullness of beer taste
- High consumption of enzymes and other substances
- Do not use for Czech type beer

Infusion mashing



Microbrewery – 5 brews per day

Industrial brewery - 9 brews per day



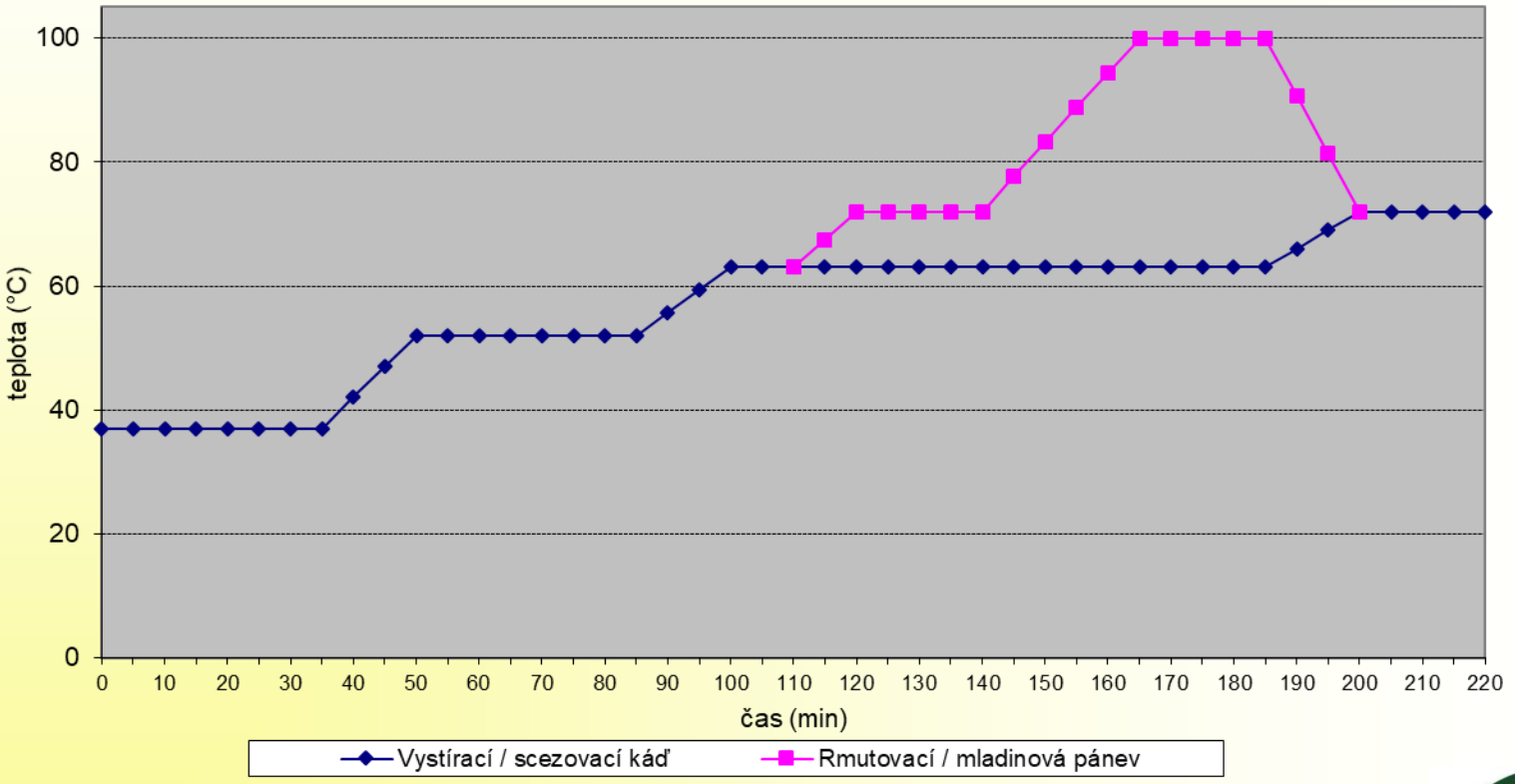
Microbrewery - 6 brews per day

Industrial brewery - 11 brews per day

Single mash decoction system

- It is used only in microbrewery scale for Czech type beer
- Separate mashing in increases quantity of brews per day
- Positive influence (compare to infusion) for fullness and other parameters of beer

Single mash decoction system



Microbrewery - 3 brews per day

Industrial brewery – 9 brews per day

Double mash decoction system

- Basic technology for Czech type beer
- Better sensory and colloidal stability
- Better fullness of beer
- Darker colour of beer
- Without using external enzymes
- Maximum quantity is 8 brews per day (separate process of mashing in)

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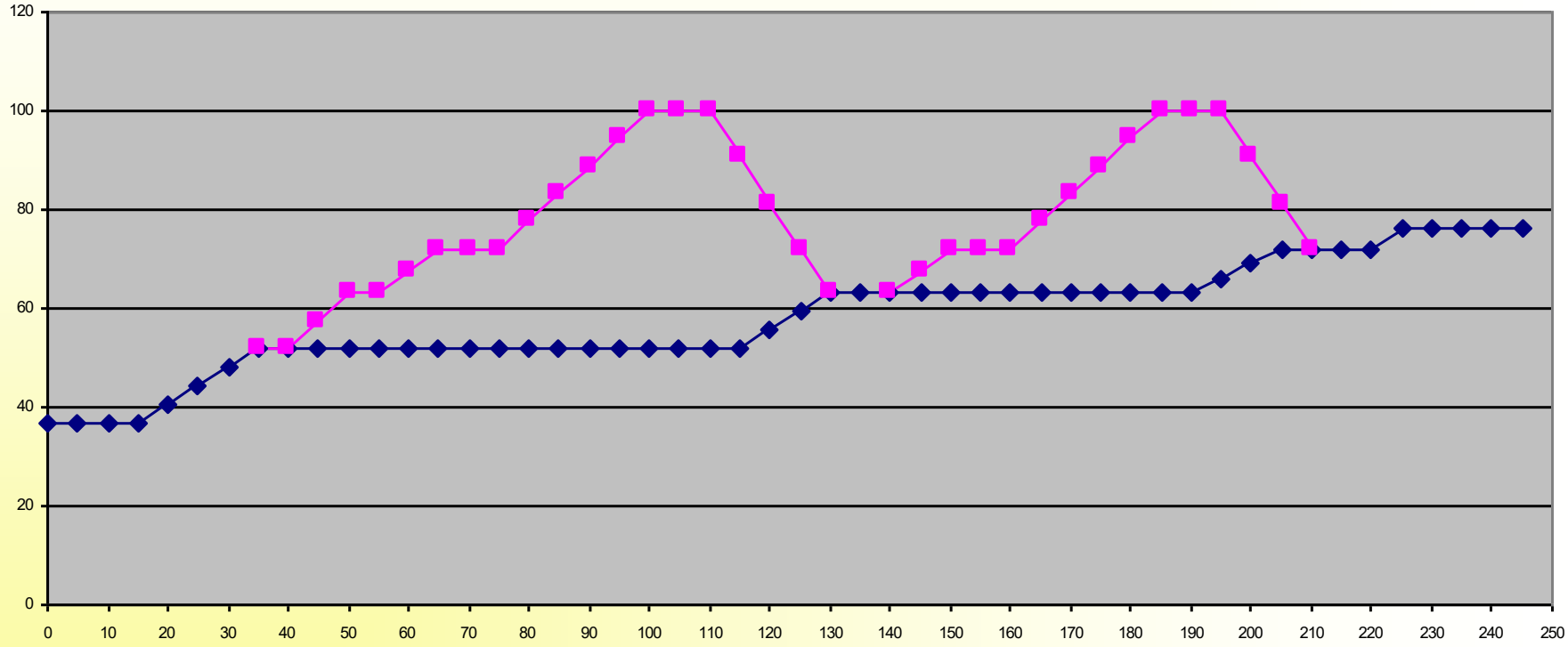
Double mash decoction system



Microbrewery – 3 brews per day

Industrial brewery - 7 brews per day

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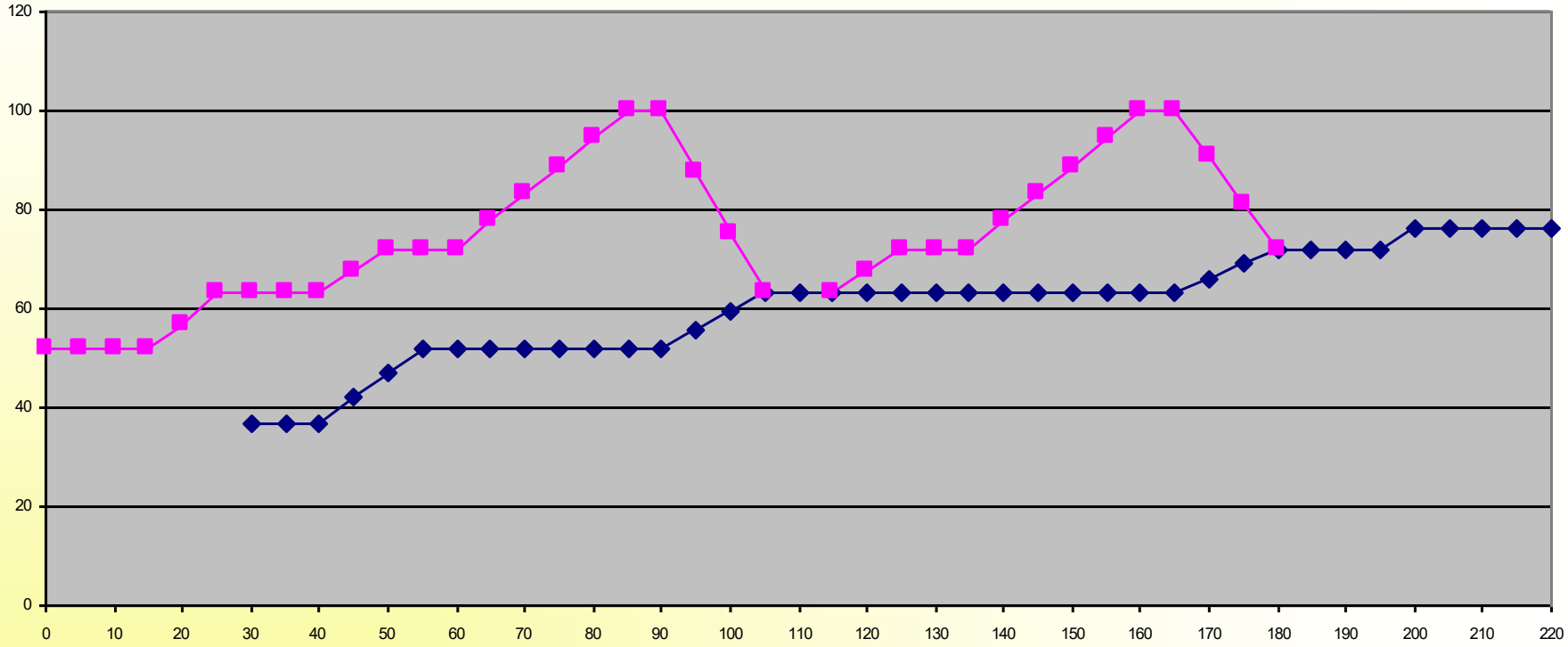
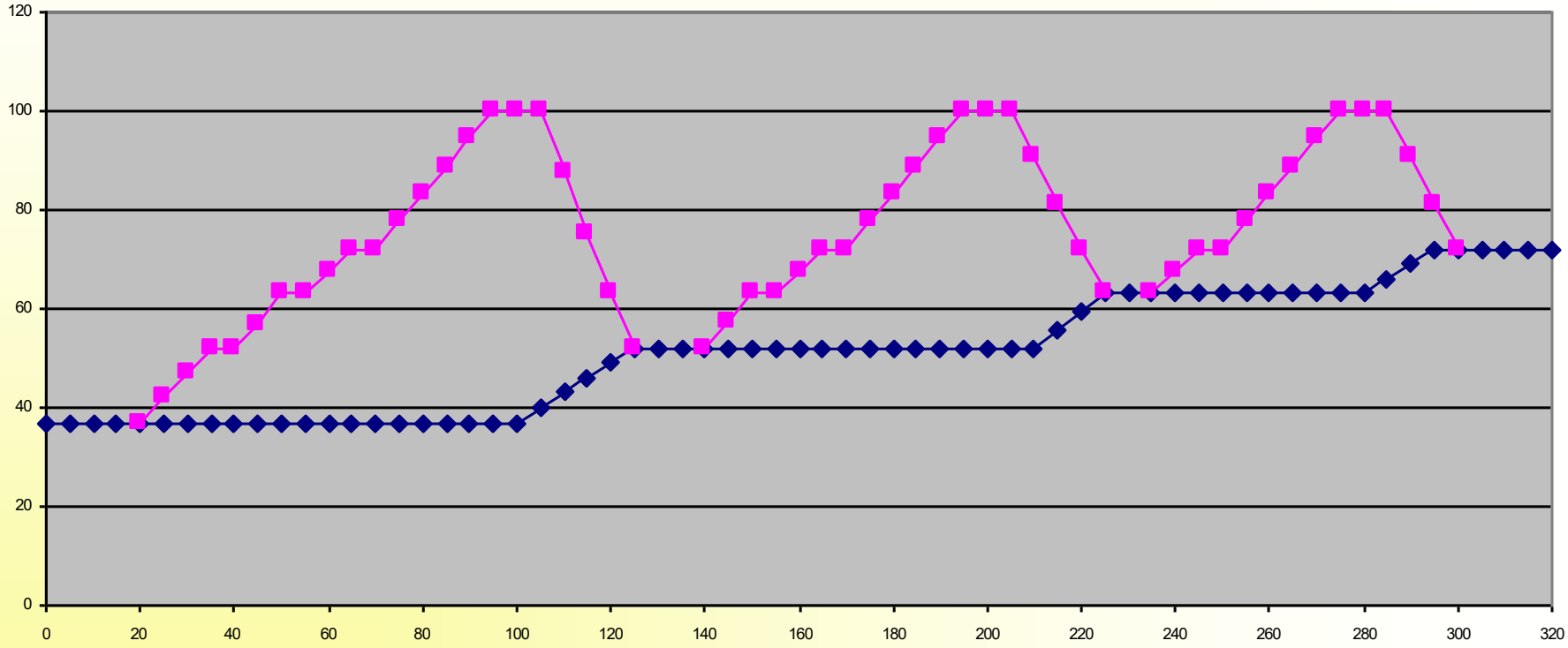
Double mash decoction system



Industrial brewery - 8 brews per day

Triple mash decoction system



Microbrewery – 2 brews per day

Industrial brewery - 4,5 brews per day

Wort filtration

- Gravitation lauter tun
  till 6 brews per day
- Lauter tun with wort pump
  6 - 12 brews per day
- Mash filter
  10 – 22 brews per day

Wort filtration

- Main parameter
  - Brightness of wort
- Changed parameters
  - Flow of wort
  - Rotation speed of stirrer
  - Position of stirrer
- Auxiliary parameters
  - Pressure difference above and below of sieves
  - Quantity of filtered wort

Wort collector

- Without wort collector
- Wort collector without heating
  - Heating in the wort kettle
  - Heating during the pumping from wort collector till wort kettle
- Wort collector with heating

Wort boiling

- Atmospheric wort boiling
  100 °C, 75 - 90 minutes
- Wort boiling under low pressure
  103 – 105 °C, 60 - 70 minutes
- Wort boiling under low pressure
  106 – 108 °C, 50 - 60 minutes

Hop dosage for Czech type beer

- Minimum 50 % of aromatic hop
- Total dosage

  100 mg alpha acids for one litre of beer
  (beer has around 30 mg per litre – 30 u. EBC)
- Three portion
  - 1 dosage 50 % hop
    bitter or semi aromatic hop – granulated or extract
    in the start of wort boiling
  - 2 dosage 30 % hop
    semi aromatic or aromatic hop – granulated
    in the middle of wort boiling
  - 3 dosage 20 % hop
    aromatic hop – granulated
    in the end of wort boiling

Analytical parameters wort for Czech type beer

• pH	5,2 – 5,5
• Colour	10 – 15 EBC u.
• Bitterness	35 – 55 EBC u.
• Total soluble nitrogen	900 – 1000 mg/l
• Amino nitrogen	210 – 240 mg/l
• Coagulated nitrogen	15 – 20 mg/l
• Total attenuation	80 – 82 %
• Total polyphenol compounds	250 – 300

Energy balance

Energy consuption

- Heat
  - 60 – 300 MJ/hl
  - brewhouse more than half
- Electrical energy
  - 8 – 20 kWh/гл
  - Colling system around 50 %
  - Pressured air around 10 %
- Water
  - 3,5 – 8 hl of water for one hl of beer

Capacity of brewhouse for Czech type beer

2 vessels – 15 brews per week

1. Mash kettle and wort kettle

2. Mashing in and lauter tun

- Usually for microbrewery
- Unspecialized vessels

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Capacity of brewhouse for Czech type beer

4 vessels– 35 brew per week

2 mashing in and mash kettle

Gravitation of lauter tun

Wort kettle (+ whirlpool)

- Minimal variant for indrustrial brewery

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Capacity of brewhouse for Czech type beer

5 vesels – 50 brews per week

2 mashing in and mash kettle

Lauter tun with pump

Wort collector

Wort kettle (+ whirlpool)

- Optimal variant for industrial breweriesw

Capacity of brewhouse for Czech type beer

Till 100 brew per week

One system of grinding

Two brewhouses lines each for 5 vessels

One system of cooling

- Adventage is possibility different production capacity (working one line only and in the sesone both lines work
- Almost continual process of wort production
- Optimal about energy consuption

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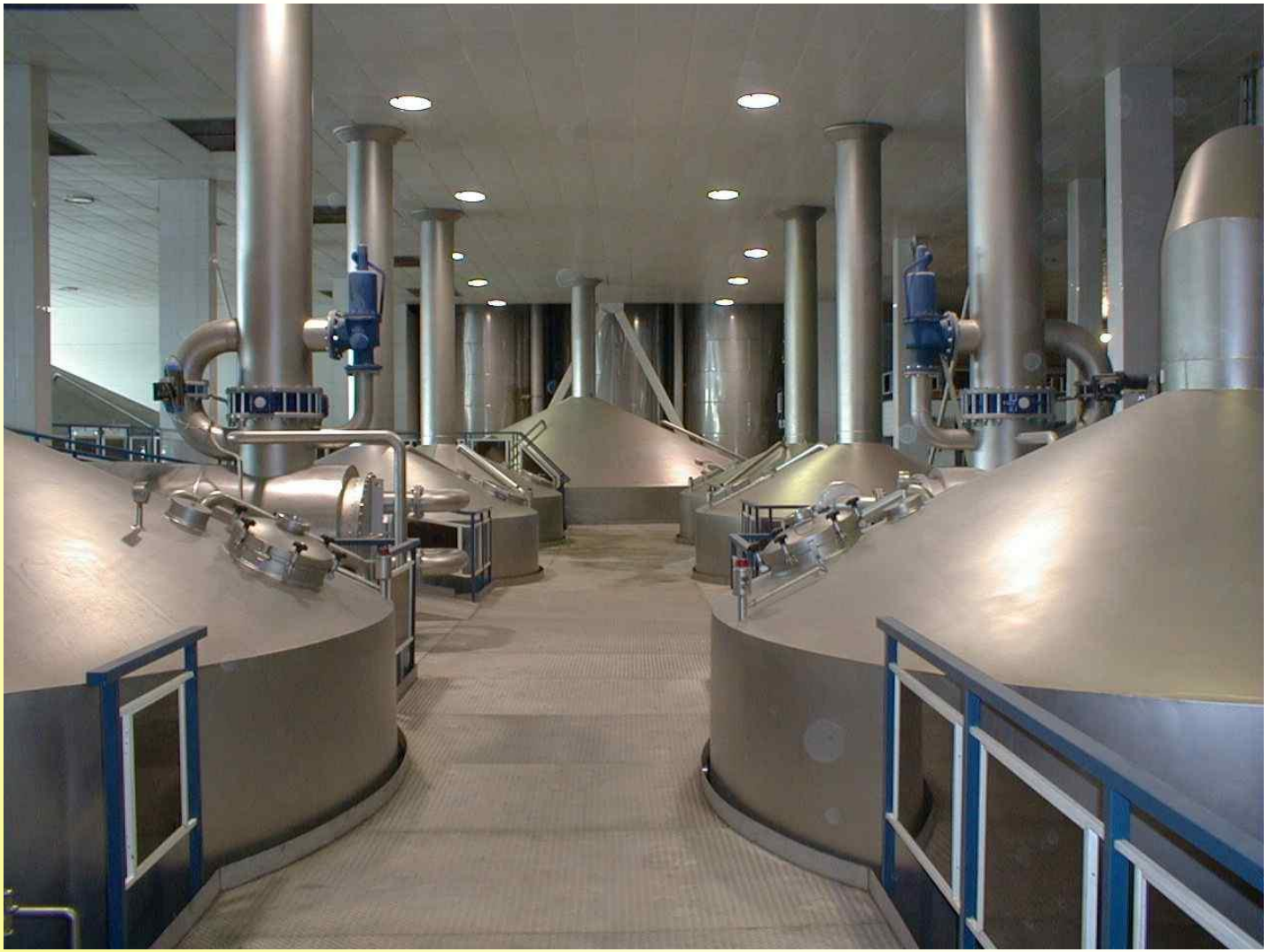

Summary of wort production for Czech type beer

- Soft water
- Raw materials is only malt and hop
- Without unmalted raw materials
- Minimum 50 % aromatic hop
- Without enzymes and other auxilary materials
- Temperature of mashing in 37 °C
- Double decoction system of mashing
- Atmospheric wort boiling – 90 minutes

Basic parameters for start of fermentation

- Strain of yeast — bottom fermentation
- Beginning temperature for fermentation — 7,5 °C
- Dosage of yeast — 0,7 l per hl
  (15 million yeast cells for ml)
- Wort aeration — 7 mg O_2/l
- Maximum generation number
  - Classical technology — 6 - 8
  - CCT technology — 3 - 4

Yeast strains

From Research Institute Brewing and Malting from Prague

Yeast collection contains more than 120 yeast strains

The most used yeast strains

- Yeast strain 2
- Yeast strain 7
- Yeast strain 95
- Yeast strain 96

Yeast strain 2 - Budweiser

There is used in several breweries in Czech Republic.

Level of atenuation is middle deep.

Sedimentation is very good

Low production of diacetyle

Middle production of ester and high alcoholic compounds

Better for classical technology

Yeast strain 7 - Pilsner

There is used in several breweries in Czech Republic.

Level of atenuation is middle.

Sedimentation is very good

Middle production of diacetyle

Very low production of ester and high alcoholic compounds

Better for classical technology

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Yeast strain 95

There is the most used in Czech Republic.

Level of atenuation is deep.

Sedimentation is good

Low production of diacetyle

Low production of ester and high alcoholic compounds

Can be used for classical and CCT technology

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Yeast strain 96

There is the sometimes used in Czech Republic.

Level of atenuation is very deep.

Sedimentation is good

Low production of diacetyle

Low production of ester and high alcoholic compounds

Better to used for CCT technology

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Basic parameters for primary fermentation

- Beginning temperature of fermentation 7,5 °C
- Maximum temperature of fermentation 10,5 – 12 °C
- Extract control during the fermentation
- Yeast cells concentration during fermentation
- Diacetyle control at the end of fermentation

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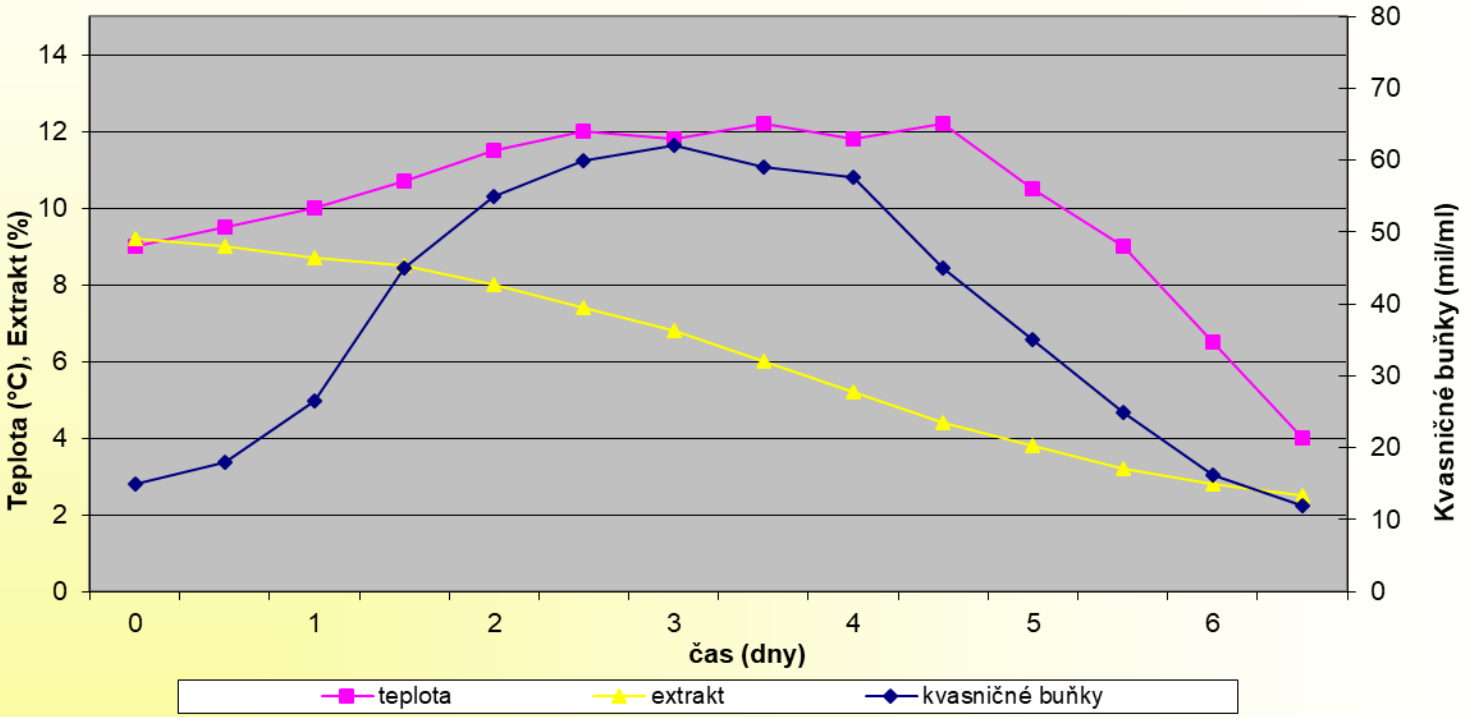
Diagram of fermentation



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Primary fermentation and madutation technology

- Traditional technology – different fermenting and maturation plant
  - Open fermentation vessels + horizontal lager tanks
  - Close fermentation tanks + horizontal lager tanks
- Present technology
  - CCT + horizontal lager tanks
  - CCT + CCT double phases fermenting technology
  - CCT single phases fermenting technology
- Future technology
  - Technology of yeast cells immobilization
  - Technology of enzymes immobilization

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Open fermenting vessels + horizontal lager tanks

- Traditional technology for Czech type beer
- The best quality of beer
- Big influence of staff
- Big of work difficulty
- Long term process conditions (work time consumption and brewery capacity)
- Less economic production parameters

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CCT + horizontal lager tanks

- Present technology
- Can be used for Czech type beer production
- Middle work time consuption
- Better possibility to control process and its automation
- Less investment cost during changing the classical technology

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Bohemia Brewing Centre

CCT + CCT
double phases technology

- Present technology
- Can be used for Czech type beer production
- Less work time consuption
- Better possibility to control process and its automation
- Better economic cost production

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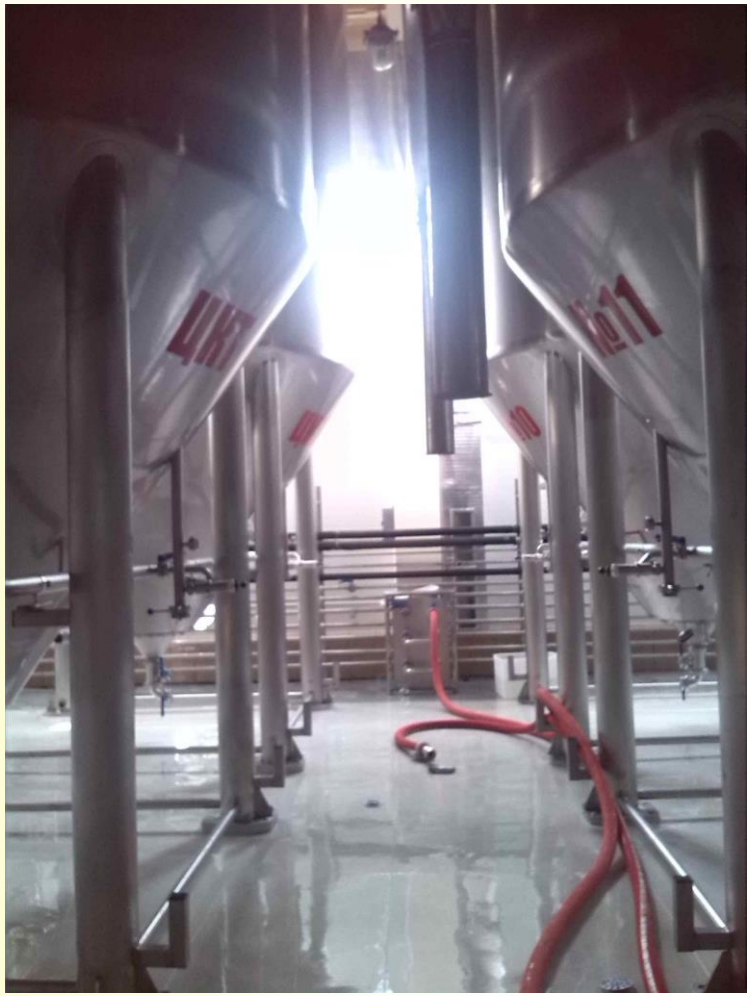

Beer filtration

- Single stage filter
- Double stage filter

- Filters
  - Frames filter
  - Plates filter
  - Kandles filter
  - Cross flow filter (non kieselgugh filter)
- Centrifuges

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Optimal analytical parameters of Czech type beer

- Apparent extract 2,5 – 3,5 % w/w
- Total attenuation extract 2,0 – 3,0 % w/w
- Extract difference AE and TAE 0,5 – 1,0 % w/w
- Alcohol 4,5 – 5,0 % v/v
- pH 4,1 – 4,8
- Color 8 – 15 EBC u
- Bitterness 25 – 40 EBC u
- Foam 5 min
  5 cm
- Saturation 0,45 – 0,5

Optimal analytical parameters of Czech type beer

• Total soluble nitrogen	800 – 1000 mg/l
• Amino acids	0,2 – 2 mg/l
• Amin nitrogen	80 – 150 mg/l
• Coagulated nitrogen	8 – 14 mg/l
• Total polyphenol compounds	120 – 250 mg/l
• Anthocyanogenes	35 – 60 mg/l
• Filterpossibility (Esser)	120 – 200 ml
• Natural colloidal stability	2- 3 months

Optimal senzory parameters of Czech type beer

Sensory quality (EBC scheme)

• Total aroma	middle
• Off flavours (aroma)	hoppy, yeasty
• Saturation	middle or high
• Fullness	high
• Intensity of bitterness	high
• Aftertaste of bitterness	medium long
• Off flavours (taste)	without off-flavours

Summary of Czech type beer

- Bottom yeast strain
- Low fermentation temperature
- Long term maturation
- Classical technology or double phases CCT technology
- Golden colour of beer
- High fullness of beer
- High bitterness and foam stability
- Beer without off-flavours

Thank you for atention

Miloš Hrabák