Evolution of a Mash Tun

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Briggs of Burton plc

Conference organised and hosted by
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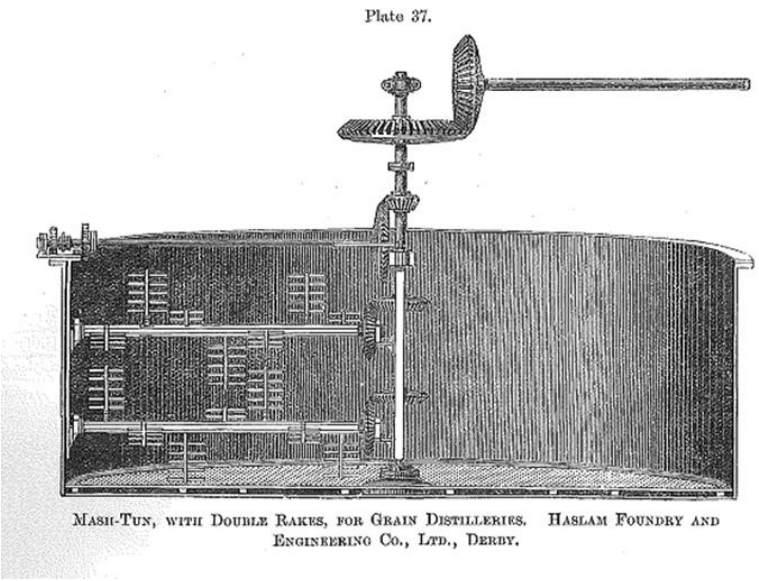
Talk Overview

- Mashing and Lautering processes
- Mash Tun design evolution

Overview of a Distillery Mash Tun's operation

Inputs

- Water
- Malt / Grist
- Electricity
  - Motor / pumps
- Steam
  - Heat
- Physical (Labour)



Outputs

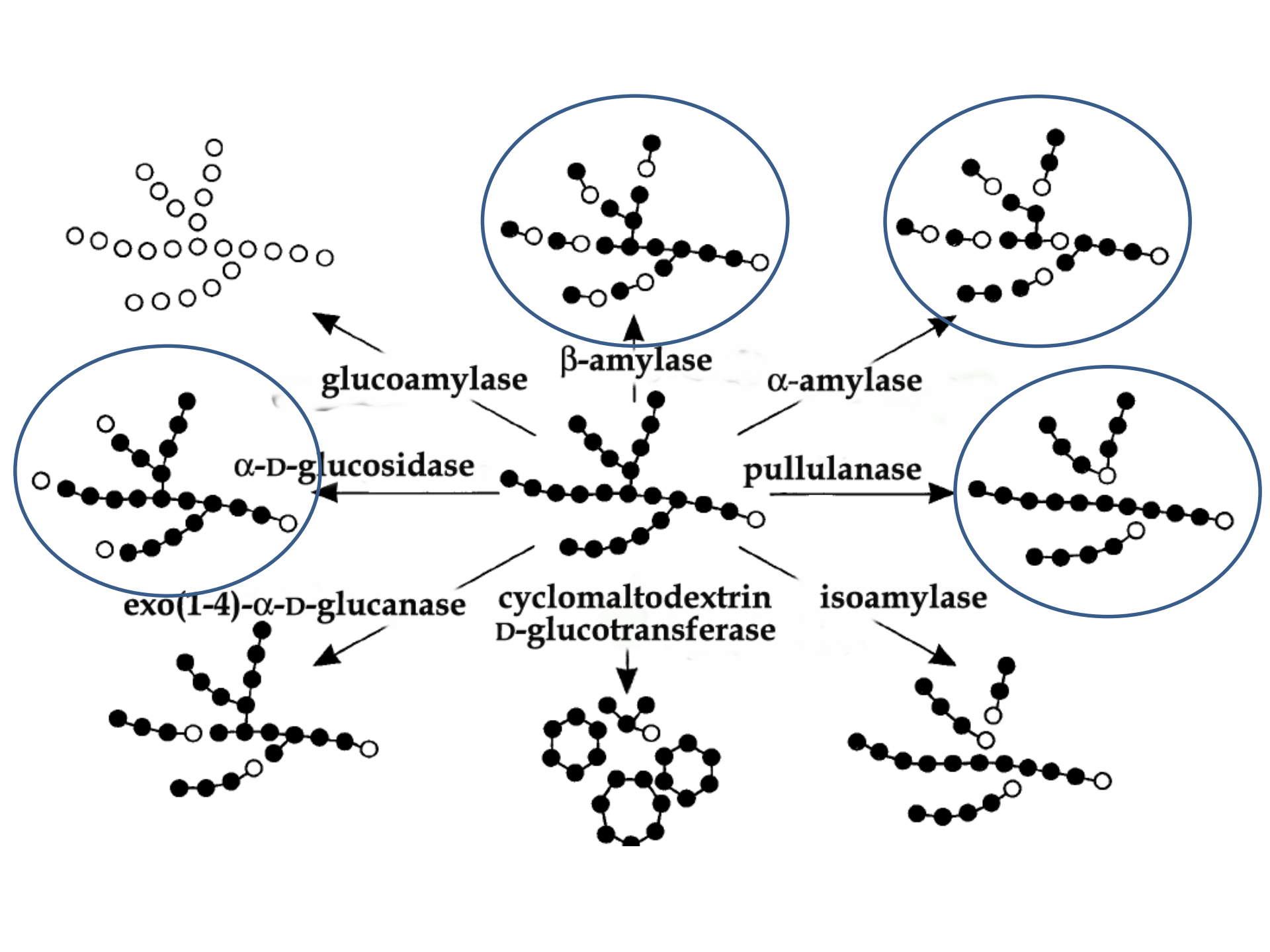
- Wort
- Spent grains / Draff

Inefficiencies

- Evaporation
- Soiling

Mashing and Mash Separation

- Mashing
  - Mixing of malt grist with water
  - Breakdown of proteins
  - Starch gelatinisation & liquefaction
  - Conversion of starch into lower molecular weight fermentable sugars
- Mash Separation / Lautering
  - Filtration of Mash
    - Separation of Wort from grain bed
  - Sparging
    - Leaching of remaining extract from grain bed using hot sparge water
  - Separation of Draff from Wort (draff) for disposal
    - By-product


glucoamylase
β-amylase
α-amylase
α-D-glucosidase
pullulanase
exo(1-4)-α-D-glucanase
cyclomaltodextrin
D-glucotransferase
isoamylase

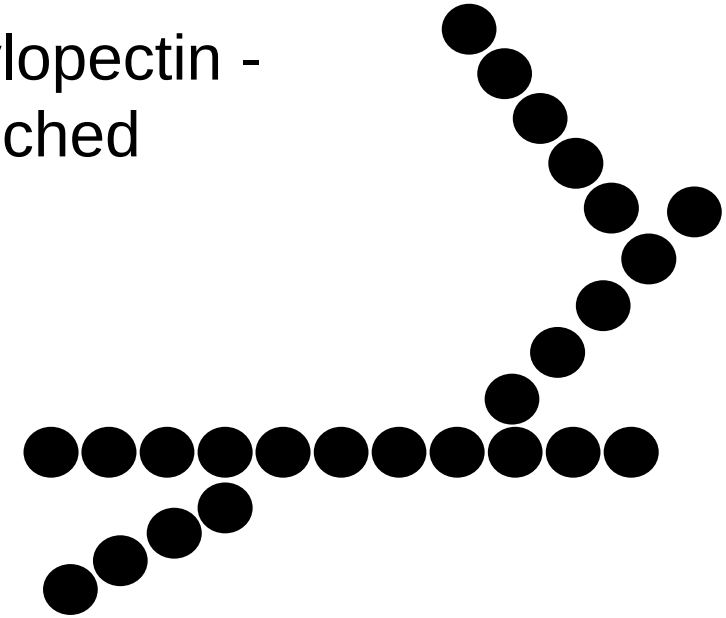
Amylose - unbranched

α-amylase – random >3 length oligomers

α-glucosidase – terminal glucose from reducing end

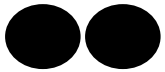
β-amylase – maltose from reducing

Amylopectin - branched



Limit dextrinase – hydrolyse 1,6 branches releasing maltose

maltotriose



maltose

glucose

http://www.chem.qmul.ac.uk/iubmb/enzyme/EC3/2/1/

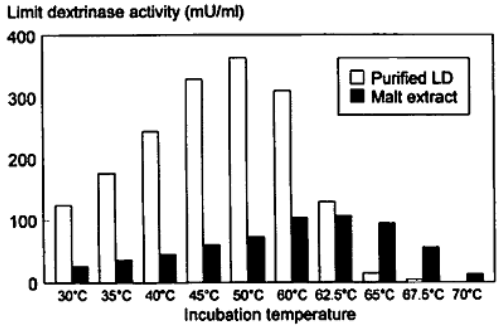
Limit dextrinase activity

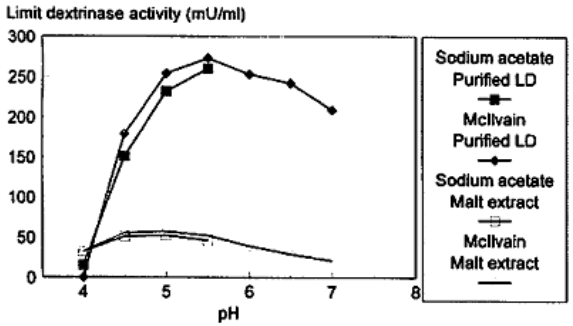
Optimum conditions

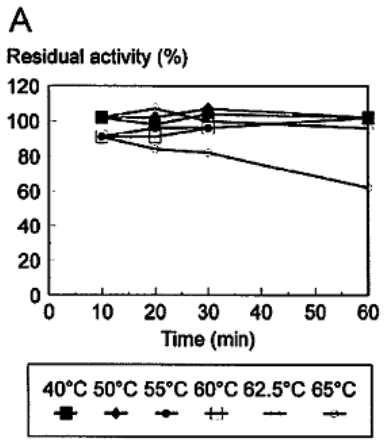
- Temperature: 62.5°C
- pH: 5.5

Drop in activity at T > 65°C

and t = 10 min







Stenholm, Katharina, and Silja Home. 'A New Approach to Limit Dextrinase and Its Role in Mashing*'. *Journal of the Institute of Brewing* 105, no. 4 (1 January 1999): 205–10. doi:10.1002/j.2050-0416.1999.tb00020.x.

Mash Conversion

Lab mill setting

- 2 = Fine (Used in Semi-Lauter Tuns)
- 7 = Coarse

78.06/76.15 = 102.5%

TABLE II. Analyses of Malts Used in RG/FG Fermentability Comparison

Barley Variety	SE 2 dwb %	SE 7 dwb %	2/7 difference %	F(FG) %	FE dwb %
Golden Promise	78.06 ± 0.62	76.15 ± 0.7	1.91 ± 0.62	87.42 ± 0.63	66.57 ± 0.91
Natasha	80.62 ± 0.95	79.23 ± 0.65	1.39 ± 0.50	87.77 ± 0.33	69.54 ± 0.67
Triumph	79.64 ± 0.50	78.43 ± 0.55	1.21 ± 0.44	87.87 ± 0.46	68.92 ± 0.57
All	79.27 ± 1.26	77.7 ± 1.59	1.57 ± 0.62	87.64 ± 0.55	68.10 ± 1.58

Results are mean ± 2SD.

Dolan, T. C. S. 'Scotch Malt Whisky Distillers' Malted Barley Specifications the Concept of Fermentable Extract — Ten Years On'. *Journal of the Institute of Brewing* 97, no. 1 (2 January 1991): 27–31. doi:10.1002/j.2050-0416.1991.tb01049.x.

Practical Obstacles in Mash Tun Benchmarking

- Distillery and Brewing analytical methods
  - Laboratory based extract recovery yields
  - >100% yield achievable
  - Extraction in last worts using 85 – 90°C sparge water
  - Only 60°C in EBC method
  - Comparable?
- Heterogeneity of raw materials?
- Extract Yield / Timeframe
- Extract / Fermentable yield?

Key Distillery Wort parameters

- Haze
  - Clear / Cloudy
- Extract
  - Yield / Fermentable sugars
  - SG
- Chemistry
  - Free Amino Nitrogen
  - Lipids
  - Polyphenols
  - pH
- Dextrinase enzyme activity

Early Distillery Mash Tun Technology

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Spurtle?

Scots kitchen tool for mixing porridge

Mash Tun
(with Stirrer Gear)

- Roller milled / Steeles mashed @ 4:1 grist ratio
- Plate loading circa 250 to 300 kg/m2
- Cycle time circa 6-8 hours
- Poor Draff out
- Flat bottom / no under plate clean
- Difficult to clean
- Cloudy worts

Traditional Mash Tuns

Semi-lauter using fixed knives

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Semi-Lauter Tun

- Roller milled / Steeles mashed @ 4:1 grist ratio
- Plate loading 250 kg/m2
- Cycle time circa 5-6 hours
- Balanced non-pressure run-off
- Fixed rake height – cloudy worts or slower run-off
- Limited rake efficiency / potential bed channelling
- Swinging feet Draff out - slow
- Usually flat bottom / poor under plate clean
- Good above plate clean

Lateral Technology Transfer

What can Distillers borrow from Brewers?

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Technology Selection Considerations

Process

- Recipe Variation
  - Grist Charge
  - Mash / Sparge Ratio
- Wort Clarity
  - Cloudy / Clear
- Yield
  - Washback Conversion
  - Weak Worts
- Spirit Character
  - Spirit Type
  - Mill Type / Compression

Physical

- Real Estate
  - Equipment Footprint
  - Separate Conversion Vessel for Mash Filter
- Thermal Shock
  - High Temperature Sparging
  - Mash Filter Membrane Temperature Limitations

Mash Separation Technologies

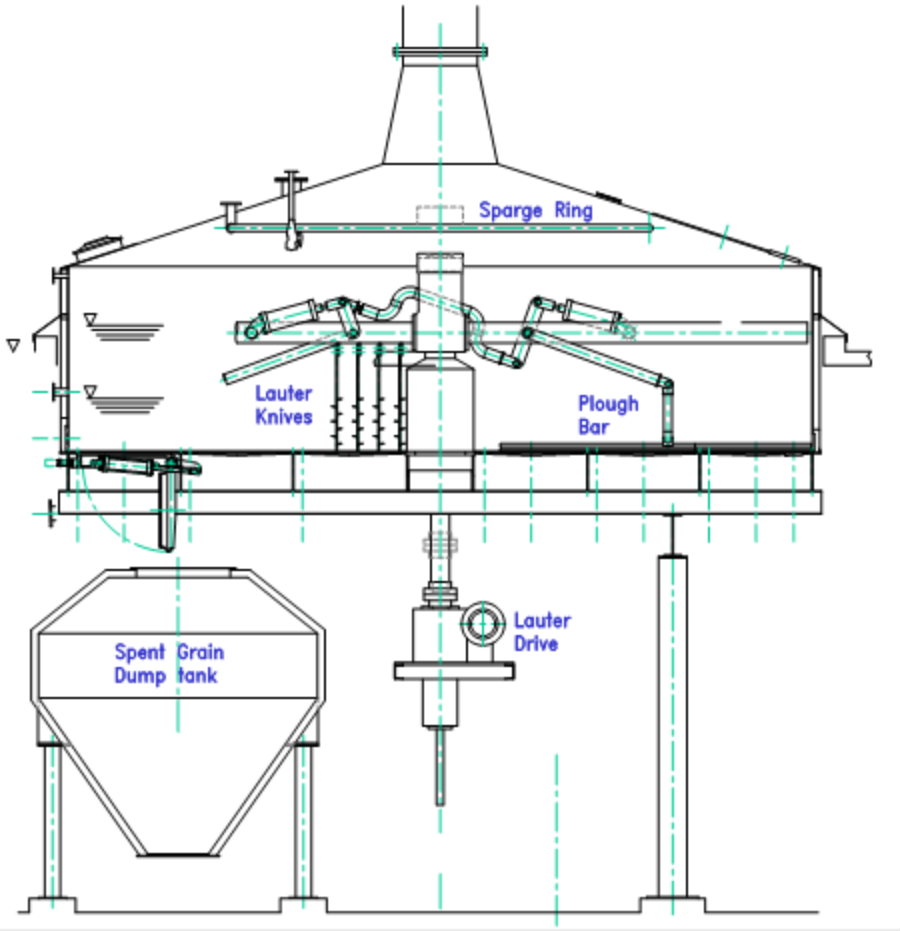
Lauter Tun

Mash Filter

Technology Comparison

	Mash Tun (Full Lauter)	Mash Filter
Throughput	Mod. – High 3.0-5.0h TAT	High 2.0h TAT
Extract Efficiency	High 101 to 102%	High Max 103%
Flexibility	Good 40 to 100%	Poor 80 to 110%
CIP	OK	Inefficient 4 to 8 hrs
Complexity	Complex	Complex
Cost	Moderate	High
Spirit Yield	416 L/Te	Comparable

Full Lauter – Development
Technology Transfer from Brewery Lauter Tuns



Low profile valley bottom

Auto programmed lautering vs DP

Enhanced lift Knives – extract & cycle time

Plough Draff discharge

Draff dump tank

Electro-mechanical fully variable drive

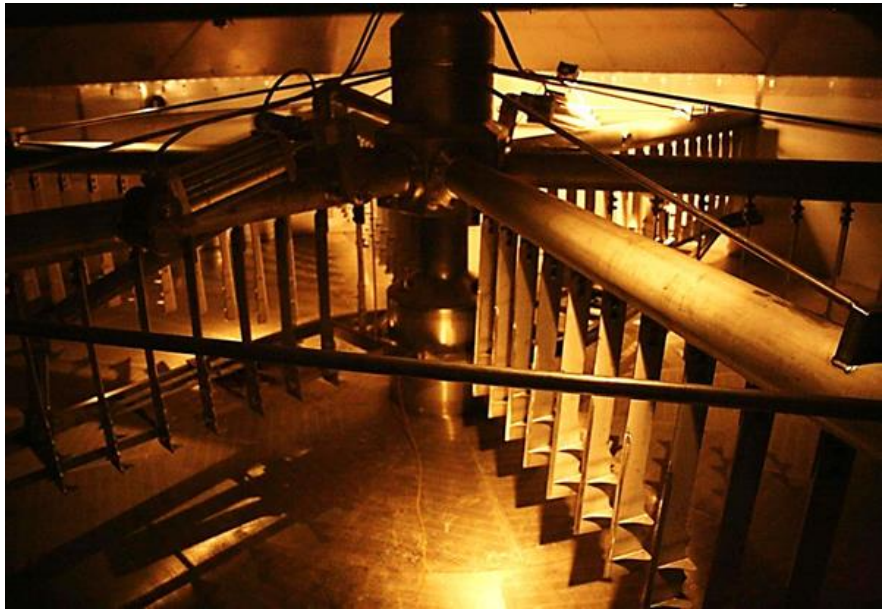
- Rotation – Lauter & discharge
- Raise / lower

Large diameter - low extract loss Draff valves

Maximise Wort collection time

Continuous profiled sparging

Distillery Full Lauter Tun – Latest



- 6 Roll milled / Steeles mashed @ 3.8:1 grist ratio
- Plate loading 160 to 175 kg/m2
- Cycle time 3 to 4 hours
- Controlled pumped run-off
- Valley bottom / effective under plate clean
- Good over plate clean
- Automated lautering vs volume & DP
- Clear wort capability without time or extract penalty
- Rapid Draff out

Full Lauter –
Distillery Mash Tun Development

- VSD Steeles Masher
  - enhanced wort clarity
- Distillery knives – flight pitching
- Automated distillery run-off profile
  - Wort to Washback
  - Weak Worts
- Integrated Volume & DP lautering
- Distillery continuous sparge profile
- Multi-zone underplate flushing

Mash Tun Flexibility

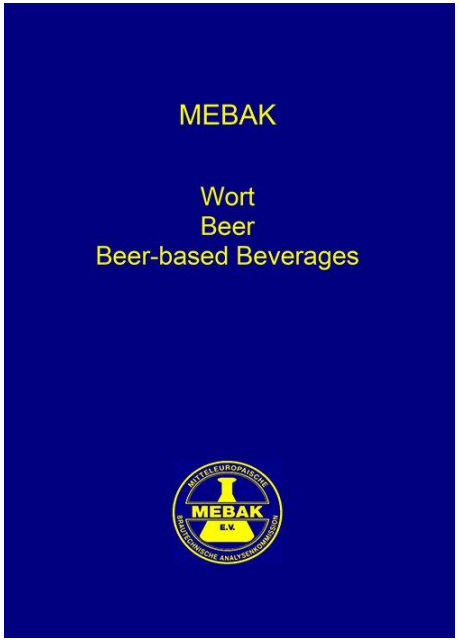
- Traditional Distillery Mash Tun
  - Limited mechanical variation
  - Fixed knives and batch size
- Modern Briggs Distillery Mash Tun
  - Full-Lauter
  - Responds to filter bed structure and wort run off
  - Automatically performs deep rake when run off rate stopped
  - Can be tuned to produce Cloudy or Clear Wort dependent on the Distillers requirements

Malted Barley

Flexibility in a Lauter Tun

- Access to new varieties / lower cost malts?
- Access to low Diastatic power malt using more extensive milling
- Reduce particle size to improve starch accessibility
- Different specifications

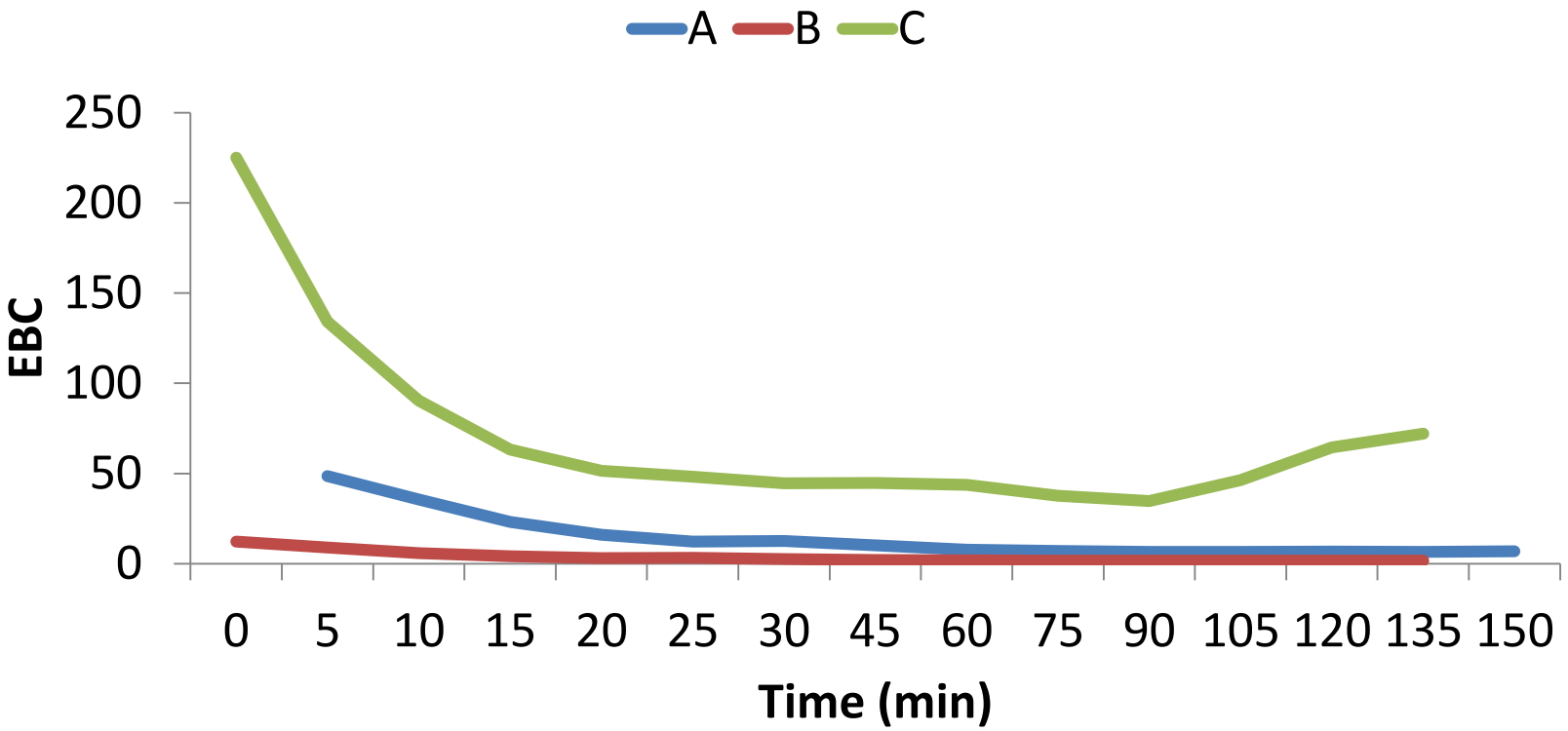
Wort Clarity



Clear Worts capability without Cycle Time or Extract penalty

- ≤10 EBC clarity for 70% of run-off volume to washback
- ≤20 EBC average clarity for 100% of run-off volume to washback
- ≤40 EBC average clarity for WW waters
- *Ref - MEBAK <40 EBC for more than 60% of run-off time*

Mashing Trial Results



Trial	Details
A	Raking regime for normal production Rake height determined by DP
B	Raking regime more aggressive Normal production (lower heights used)
C	Raking regime – rake height set at 100mm for bulk of run

Conclusions

- Rake operation influences bed filterability
- The requirement for clear or cloudy wort is specific to the distillery
- Full Lauter mechanism in a Distillery Mash Tun provides the capacity to the vary extent of wort clarity
- Future trials to be performed

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