Energy Saving in Ethanol Production During the Mashing Process

3. European Bioethanol Technology Meeting

Association of Cereal Research, Detmold (Germany)


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Energy Saving in Mashing Process

• High gravity mashing
  • DS% up to 35%
  • Less water to heat up

• STARGEN-Process
  • Maximum temperature of 59°C in mashing
  • No additional thermal energy during mashing if hot water or stillage backset is used
High Gravity Mashing

• Mashing Conditions
  • Stillage backset 25%; pH 5.0-5.2; 50°C; 30 min
    – Enzymes
      » Liquozyme + Viscozyme Wheat
  • Liquifaction at 85°C; 60 min
    » Start of saccharification and fermentation at 32-34°C
    – Enzymes
      » Spirizyme Fuel + Alcalase
  • Isostab 30 ml / m³ of mash
  • Urea 400g / m³, Phosphoric Acid 100g/m³
Use of thermostable Xylanase
Gammaxylanase HTL

Mash viscosity without Xylanase
Einsatz thermostabiler Xylanase
Gammaxylanase HTL

Mash viscosity using Xylanase
Dependency of EtOH Concentration on DS % in Mash

\[ y = 0.32x + 1.9557 \]

\[ R^2 = 0.9857 \]
Dependency of Ethanol Yield LA/100 kg Wheat on DS % in Mash

\[ y = -0.4564x + 53.446 \]

\[ R^2 = 0.8617 \]
High Gravity Mashing

- 350 kg Wheat or Triticale / 1000 L of mash
- Add thermostable Xylanases with liquifaction enzymes
- After Liquifaction rest pH is lowered to 4,0
- Dilute mash to ~ 1,6 m³
- Simultaneous saccharification and fermentation
High Gravity Mashing - Conclusion

- Fermentation efficiency drops, if the ethanol content in the fermented mashes exceeds 10%vol EtOH.
- Benefits can be used if mashes are diluted before fermentation – cooling !!
- Fermentation to 10%vol EtOH can be finished within 48 - 52 h.
- The process has to be tailored to each plant.
- Low viscosities lead to benefits in fermentation, cooling, pumping, stirring, destillation...
Mash Preparation „Genencor Standard“

• Stillage backset 25%; pH 5.7; 57-58°C; 30 min
  • Enzymes
    – Spezyme Ethyl + Optimash BG
• Liquifaction at 85°C; 60 min
• Start of saccharification and fermentation at 32-34°C
  • Enzymes
    – Fermenzyme L 400 + Protease GC 106
• Isostab 30 ml / m³ of mash
Mash Preparation „Hohenheim“

- Stillage backset 25%; pH 5.7
- Liquifaction at 85°C; 60 min
  - Enzymes
    - Liquozyme + Gammazyme HTL
- Start of saccharification and fermentation at 32-34°C
  - Enzymes
    - Gammaclast 2 OP + SAN Super 360 L (20%)
  - Isostab 30 ml/m³ of mash
Mash Preparation „STARGEN“

- Stillage backset 25%; pH 3,8-4,2; 56-57°C; 2h
  - Enzymes
    - GC 626 + Optimash BG
- Start of saccharification and fermentation at 31-32°C; pH at start 3,5-3,6
  - Enzymes
    - STARGEN 001 + GC 106
  - Isostab 30 ml/m³ of mash
Duration of Fermentations

![Graph showing two lines representing Genencor Standard and STARGEN with data points.](image.png)
STARGEN Fermentation time: 3h
STARGEN Fermentation time: 3h
STARGEN Fermentation time: 21h
STARGEN Fermentation time: 21h
STARGEN Fermentation time: 69h
STARGEN Process: "Extract Contents" from different mashes

Time h

Content g/L

Glycerol
Lactic acid
DP3
DP2
DP1

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Ethanol Yield from Triticale Using Different Enzyme Systems

<table>
<thead>
<tr>
<th>Enzymes</th>
<th>LA / 100 kg Grain</th>
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<tr>
<td>Genencor</td>
<td>41</td>
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<tr>
<td>Hohenheim</td>
<td>42</td>
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<td>Stargen</td>
<td>40</td>
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STARGEN Process

• Maximum temperature 59°C
• Simultaneous starch degradation from native granules, saccharification and fermentation
• It should be possible to finish fermentation within 60 h (max 10%vol EtOH)
• Fermentation was free from infections without problems although we used a traditional yeast mash
• Low temperature and viscosities lead to energy savings in cooling (water), pumping, stirring.....
Thank You Very Much for Your Attention