Improve your mash applications with Packo Pumps

Improved lauter performance for thin bed filtration combined with decreased energy consumption

A study in cooperation with KU Leuven
It is generally accepted that shear force during mashing, transferring and lautering should be avoided, especially in the case of thin bed filtration, using a fine milled grist. Therefore pump rotation speed is limited up to 1000 rpm during thin bed filter operations.

However, in order to achieve the targets of flow, filtration pressure and low rotation speed, the transfer pump is mostly too large and operates far from the BEP (Best Efficiency Point). The peripheral speed/velocity at the outside diameter of the impeller is defining the pressure. To achieve a certain pressure a corresponding peripheral speed is needed. A lower speed of rotation results in a larger impeller diameter to achieve the same peripheral speed and related pressure.

A part of the absorbed energy at the pump shaft is useful energy (pressure x flow rate). The rest is lost energy caused by shear and impact energy in the pump, since the flow rate does not match with the flow rate for which the pump has been designed. So lowest shear and related product damage will be achieved when the lost energy is the lowest.

By consequence it means that a pump with the highest efficiency will lead to a reduced amount of product damage. In a first stage this has been proved when pumping tomatoes.

While transferring tomatoes, it shows that the pump efficiency is a more important factor than the rotation speed. The same conclusion was held with other shear sensitive products such as milk containing a high content of cream.

In this study the phenomenon has been tested for mash transfer during thin bed filtration. Tested on pilot scale and industrial scale.
Trials at pilot scale

Experimental setup
- 87 kg pilsner malt
- 192.6 l Brewing water (R.O. water)
- Mashing-in at 63°C – pH 5.3 (with lactic acid)
- 63°C – 30 min
- 72°C – 20 min
- 78°C – 1 min
- Heating at 2°C/min with direct steam injection

Transfer to pilot membrane assisted thin bed filter (Meura 2001) with reference pump MWP2/40-160/ (3K-160) equipped with channel impeller and a new pump FP/63-25/114 (O-132) equipped with open impeller.

Follow-up during mash filtration at 0.65 bar: flow, pressure, filtered volume, extract.

Each trial in triplicate

<table>
<thead>
<tr>
<th>Reference pump (1)</th>
<th>New pump (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pump with channel impeller operating at low speed</td>
<td>smaller pump with open impeller operating at higher speed</td>
</tr>
<tr>
<td>MWP2/40-160/116 (3K-160)</td>
<td>FP/63-25/114 (O-132)</td>
</tr>
<tr>
<td>rpm</td>
<td>Q (l/h)</td>
</tr>
<tr>
<td>Filling</td>
<td>495</td>
</tr>
<tr>
<td>Lost energy (W/m³)</td>
<td>21.288</td>
</tr>
<tr>
<td>Filtration</td>
<td>1158</td>
</tr>
<tr>
<td>Lost energy (W/m³)</td>
<td>321.93</td>
</tr>
<tr>
<td>End filtration</td>
<td>1277</td>
</tr>
<tr>
<td>Lost energy (W/m³)</td>
<td>1107.70</td>
</tr>
<tr>
<td>β-glucan (ppm) first wort</td>
<td>165</td>
</tr>
</tbody>
</table>

Reference pump (1) is a pump with channel impeller operating at low speed
New pump (2) is a smaller pump with open impeller operating at higher speed

Fk new pump < Fk reference pump
- Improved filtration performance with new pump

Higher rotation speed
- no higher extraction of β-glucan content
- no negative influence on filtration performance

Higher efficiency or lower energy losses
- lower β-glucan content
- improved filtration performance

Ruth curve — filtration coefficient
Trials at industrial scale

Experimental setup
- 8.5 ton pilsner malt
- 212 hl Brewing water (R.O. water)
- Mashing-in at 63°C – pH 5.3 (with lactic acid)
- 63°C – 30 min
- 72°C – 20 min
- 78°C – 1 min
- Heating at 1°C/min

Transfer to pilot membrane assisted thin bed filter (Meura 2001) with reference pump and 2 other pumps:
- P1: MCP2/65-250/1104 ("open/semi-open impeller")
- P3: IFF2/80-200/1104 ("vortex impeller")
- P4: ICP3/80-200/1104 ("channel impeller")

Follow-up during mash filtration at 0.65 bar: flow, pressure, filtered volume, extract.

Each trial in duplicate

<table>
<thead>
<tr>
<th>P1 = MCP2/65-250/1104 (&quot;open/semi-open impeller&quot;)</th>
<th>P3 = IFF2/80-200/1104 (&quot;vortex impeller&quot;)</th>
<th>P4 = ICP3/80-200/1104 (&quot;channel impeller&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>rpm</td>
<td>Q (l/h)</td>
<td>HMT (m)</td>
</tr>
<tr>
<td>Filling</td>
<td>444</td>
<td>11679</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filtration</td>
<td>651</td>
<td>25000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β-glucan (ppm) first wort</td>
<td>152.0</td>
<td>β-glucan (ppm) first wort</td>
</tr>
</tbody>
</table>

Higher rotation speed
- no influence on β-glucan content
- no influence on filtration performance

Higher efficiency or lower energy losses
- lower β-glucan content
Conclusion

It is generally accepted that rotation speed should be limited to 1000 rpm for mash transfer in mash filter operations in order to minimize shear force.

However to achieve the targets of flow, filtration pressure and low rotation speed, the transfer pump is mostly too large and operates far from the BEP (Best Efficiency Point).

Since a certain pressure is necessary for operation, the impeller will be larger for low rotation speed in order to obtain sufficient peripheral speed/velocity and the related pressure.

This could increase shear. At pilot scale it is clearly demonstrated that a higher rotation speed does not result in higher extraction of β-glucan.

At the contrary, the higher rotation speed of the new pump, but with a much better efficiency, resulted in a somewhat faster wort filtration. At industrial scale, the same conclusions could be found.

However, the pumps are still too large and the test needs repetition with pumps that keep the lost energy as low as possible in order to minimize shear force.

Electricity consumption can decrease and the cost reduction of a smaller pump could be up to 50%.
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