Packo Pumps

We optimize your flow

Improve your mash applications with Packo Pumps

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

A study in cooperation with KULeuven

A **VERDER** COMPANY

Introduction

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.

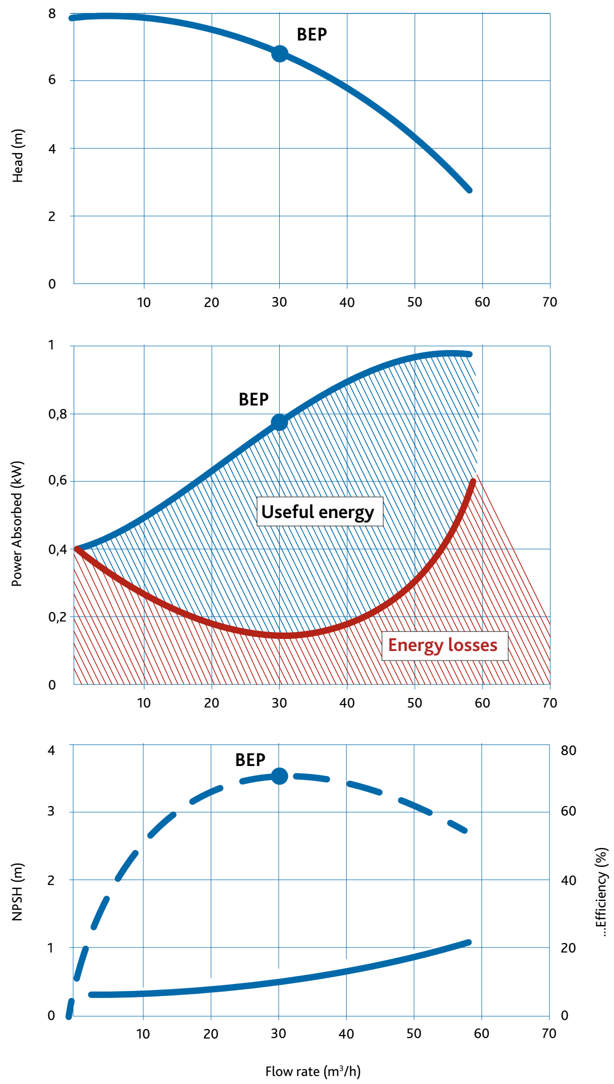
However, in order to achieve the targets of flow, filtration pressure and low rotation speed, the transfer pump is mostly too large and operates far from the BEP (Best Efficiency Point). The peripheral speed/velocity at the outside diameter of the impeller is defining the pressure. To achieve a certain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

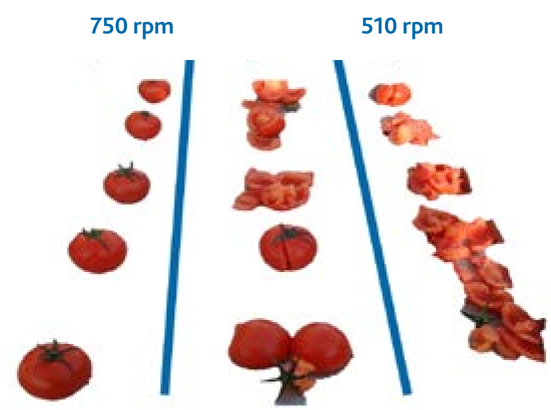
A part of the absorbed energy at the pump shaft is useful energy (pressure x flow rate).The rest is lost energy caused by shear and impact energy in the pump, since the flow rate does not match with the flow rate for which the pump has been designed. So lowest shear and related product damage will be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





High speed
High efficiency
Low cost energy

Low speed
Low efficiency
High cost energy

Trials at pilot scale

Experimental setup

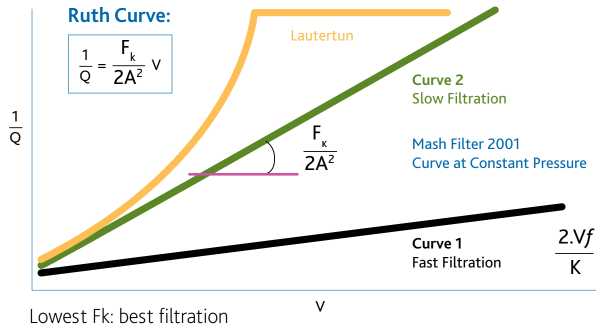
- 87 kg pilsner malt
- 192.6 l Brewing water (R.O. water)
- Mashing-in at 63°C –pH 5.3 (with lactic acid)
- 63°C – 30 min
- 72°C – 20 min
- 78°C – 1 min
- Heating at 2°C/min with direct steam injection

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

Theory of Mash Filtration



Lowest Fk: best filtration

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

	Reference pump (1) pump with channel impeller operating at low speed MWP2/40-160/116 (3K-160)					New pump (2) smaller pump with open impeller operating at higher speed FP/63-25/114 (O-132) D09S18KEB Y55S5019--M2				
	rpm	Q (l/h)	HMT (m)	η (%)	Pabs (W)	rpm	Q (l/h)	HMT (m)	η (%)	Pabs (W)
Filling	495	500	1.03326	11.3	12	588	500	1.03326	30	5
			Lost energy (W/m³)		21.288			Lost energy (W/m³)		7
Filtration	**1158**	442	5.70792	**4.5**	149	**1382**	601	5.70792	**17.6**	53
			Lost energy (W/m³)		**321.93**			Lost energy (W/m³)		**72.66**
End filtration	1277	175	6.5473	1.6	197	1617	177	6.55094	3.6	76
			Lost energy (W/m³)		1107.70			Lost energy (W/m³)		576.88
β-glucan (ppm) first wort					165	β-glucan (ppm) first wort				149

Fk new pump < Fk reference pump

- Improved filtration performance with new pump

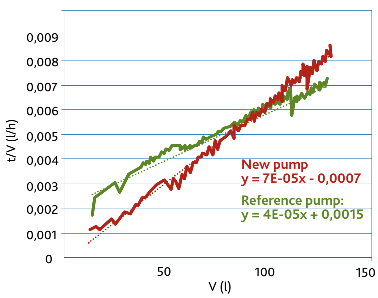
Higher rotation speed

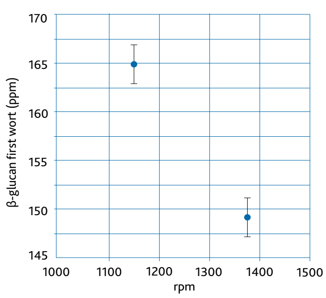
- no higher extraction of β-glucan content
- no negative influence on filtration performance

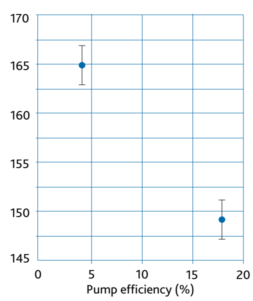
Higher efficiency or lower energy losses

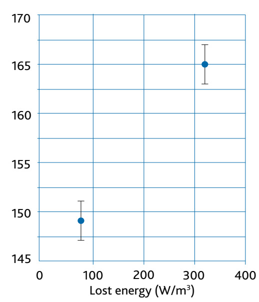
- lower β-glucan content
- improved filtration performance

Ruth curve — filtration coefficient









Trials at industrial scale

Experimental setup

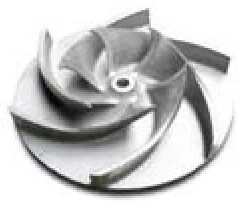
- 8,5 ton pilsner malt
- 212 hl Brewing water (R.O. water)
- Mashing-in at 63°C –pH 5.3 (with lactic acid)
- 63°C – 30 min
- 72°C – 20 min
- 78°C – 1 min
- Heating at 1°C/min

Transfer to pilot membrane assisted thin bed filter (Meura 2001) with reference pump and 2 other pumps:

- **P1:** MCP2/65-250/1104 (O-260) ("open/semi-open impeller")
- **P3:** IFF2/80-200/1104 (VO-220) ("vortex impeller")
- **P4:** ICP3/80-200/1104 (4K-200) ("channel impeller").

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

Each trial in duplicate

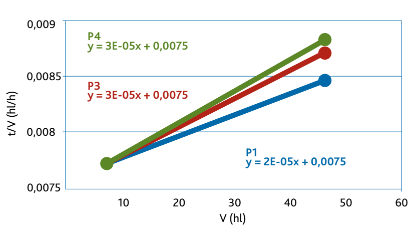


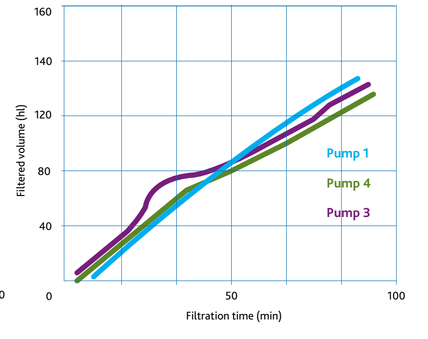
P1: open/semi-open impeller

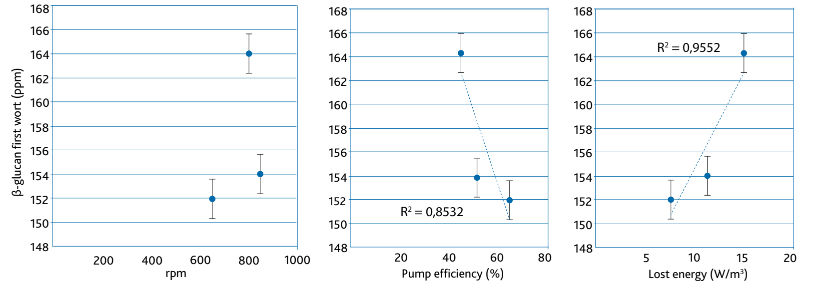
P3: vortex impeller

P4: channel impeller

Ruth curve — filtration coefficient







	P1 = MCP2/65-250/1104 (O-260) ("open / semi-open impeller")					**P3** = IFF2/80-200/1104 (VO-220) ("vortex impeller")				
	rpm	Q (l/h)	HMT (m)	η (%)	Pabs (W)	rpm	Q (l/h)	HMT (m)	η (%)	Pabs (W)
Filling	444	11679	2.25	56.4	138	503	11670	1.92	42.3	148
			Lost energy (W/m³)		5.15			Lost energy (W/m³)		7.31
Filtration	**651**	25000	5	**66.8**	516	**799**	25000	5	**48.6**	726
			Lost energy (W/m³)		**6.85**			Lost energy (W/m³)		**14.92**
β-glucan(ppm) first wort					152.0	β-glucan(ppm) first wort				164.5

	P4 = ICP3/80-200/1104 (4K-200) ("channel impeller")				
	rpm	Q (l/h)	HMT (m)	η (%)	Pabs (W)
Filling	533	11810	1.86	50.8	122
	Lost energy (W/m³)				5.08
Filtration	**858**	25000	5	**57.4**	601
	lost energy (W/m³)				**10.24**
	β-glucan (ppm) first wort				154.0

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).

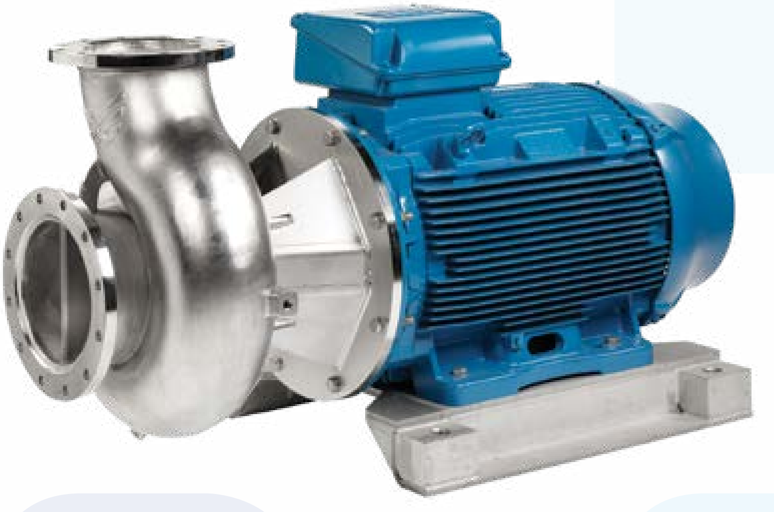
Since a certain pressure is necessary for operation, the impeller will be larger for low rotation speed in order to obtain sufficient peripheral speed/velocity and the related pressure.

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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