The upgrade of a lauter tun to a Lauterstar

COMPARING LAUTER SYSTEMS | In Spring 2005 a Dutch brewer decided to invest in the upgrade of their existing two lauter tuns. The existing systems were equipped with two-zone ring type wort collection. It was the aim of this project to improve extract yield without slowing down process time. This article investigates the results and improvements of this upgrade.

THE LAUTERSTAR upgrade package from Huppmann AG, Kitzingen/Germany included the exchange of the existing cutting knives with double shoe knives, the fitting of bottom mash inlet pipes and the retrofit of the existing wort run-off system. These changes were carried out in very short operational down times. The original situation can be described as follows: The brewery is equipped with two brewing lines. Equipment from both lines can be combined with each other from the mash vessels down to wort cooling. The existing lauter tuns are of identical make with a diameter of 7.1 metres. They were built in the nineties at the same time as the rest of the two brew-lines. The lauter tuns are fitted with ring type run-off systems. Wort flow from the two collection areas is controlled separately by two inline density-metres. With flow metres, in-line density and turbidity measurement the system offers the possibility to follow changes very accurately.

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Side by side comparison of two lauter systems

In order to accurately determine the performance improvements, only lauter tun no. 2 has been upgraded. Lauter tun no. 3 which is identical could thus be used as a reference point. On both lines the same brands are produced. This parallel operation eliminates variation of raw material differences during lauter tun performance trials. The grist for both lines was prepared from one 6-roller dry mill. The same principle was used for wort boiling: only the kettle from Line 2 was used. Thus variations of the in-line control systems for density and volume could be eliminated.

Extract yield has been determined using the following three different analysis procedures:

1. Calculation of yield according to the brewhouse yield formula in DIN 8777 (Munich Agreements)
2. Total extract balance with volume and extract data capturing using in-line measurement systems. The data was computed using the process control system brewmaxx.
3. Spent grains remaining extract analysis (analytical approach)

EXTRACT LEVELS OF FINAL RUNNINGS

lautering areas	extract value at end of lautering lauter tun 3	extract value at end of lautering lauter tun 2 (Lauterstar)
inner ring	1.79%	1.29%
outer ring	1.84%	1.62%

Table 1

SPENT GRAINS ANALYSIS

indicator	measured value lt 3 (brew 236)	measured value lt 3 (brew 244)	measured value lt 2 (Lauterstar) (brew 237)	measured value lt 2 (Lauterstar) (brew 245)
soluble extract wet spent grains (80%)	0.7%	0.9%	0.3%	0.3%
digestible extract spent grains (80%)	0.6%	0.6%	0.5%	0.6%
Total extract losses	1.30%	1.50%	0.8%	0.9%

Table 2

Fig. 1a Uneven spent grains bed with the old side inlet

Fig. 1b Even spent grains bed with mashing off from below

Results

After fine-tuning of all lautering parameters to the Lauterstar conditions, a total of 38 brews were made to compare the two lauter tun systems.

Turbidity

The two lautering diagrams (Fig. 2) show typical turbidity curves. Mashing off from below into the lauter tun enhances uniform bed formation. Figure 1a and 1b highlight the difference in spent grains bed formation of the old side inlet (Fig. 1a) and the bottom inlet of the Lauterstar (Fig. 1b). In Fig. 1a wort ponds in the area below the rake knives, an indication of the uneven height of the bed.

The optimised bottom mash inlets in combination with flow-optimised cutting knives and the geometry of the wort run off system improved turbidity levels significantly.

A clear sign of this is the quick drop of the turbidity curve at the beginning of lautering in case of the upgraded lauter tun 2 compared to lauter tun 3 (see Fig. 2).

TOTAL MASS OF EXTRACT COLLECTED PER BREW

∅ extract mass, lauter tun 3	∅ extract mass, lauter tun 2 (Lauterstar)	∅ extract gain
6107 kg	6319 kg	212 kg

Table 3

Extract concentration in the last runnings

Due to the more intensive cutting, the more even spent grains bed and the improved run off geometry the extract concentration in the last runnings at end of lautering could be reduced by 0.2 to 0.5 percentage points. Table 1 presents the average values of all 39 brews.

Spent grains analysis

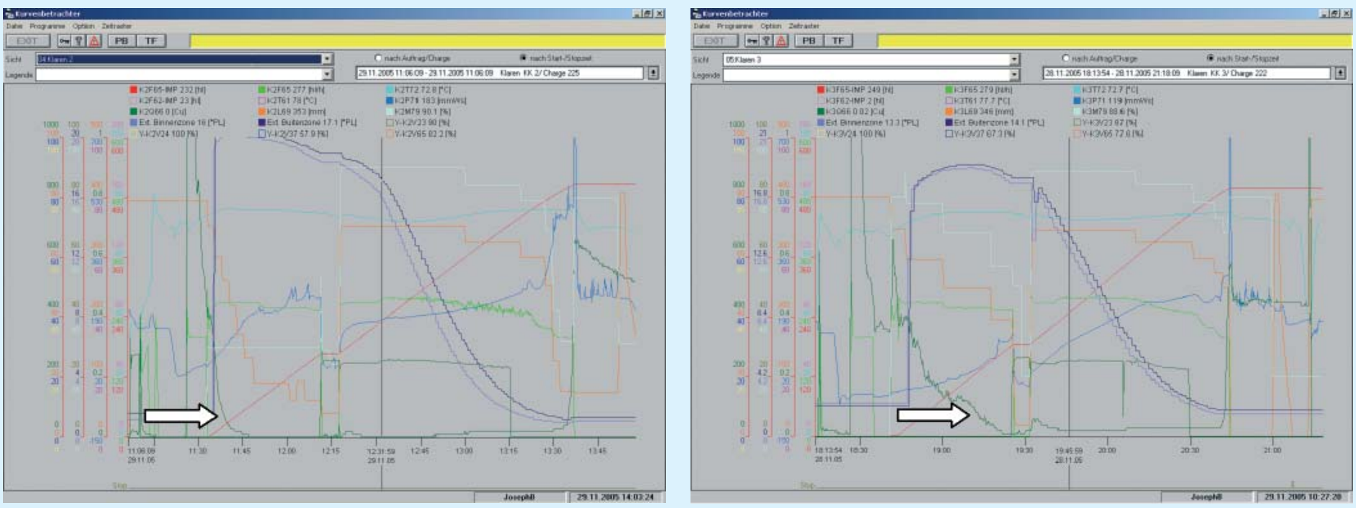
Spent grains analyses were carried out from four brews. The results in Table 2 show that the parameter "soluble extract", could be improved by 0.5 percentage points, on average. As to expect, the "convertible extract", an indicator for mashing and malt milling, did not change.

Total amount of extract collected

From wort volume and extract content data measured in line, the total mass of extract was calculated by integration of the data. Table 3 shows the average values of all 38 brews. The increase which can be associated to the lauter tun upgrade amounts to 3.5%. This increase is higher than all other analyses applied here. It has to be noted that in addition to better extraction the effect of the total wort volume collected per brew (see next paragraph) plays a role here.

Total wort volume collected

The total wort volume per brew was also measured and evaluated by the process control system: Per brew an additional 10 hl of wort can be collected in the upgraded



lauter tun 2 (Lauterstar) | lauter tun 3

Fig. 2 Turbidity curves in the lautering diagram (green lines with arrow)

TOTAL LAUTERED WORT VOLUME PER BREW

∅ total wort volume lauter tun 3	∅ total wort volume lauter tun 2 (Lauterstar)	∅ gain in volume
500 hl	510 hl	10 hl

Table 4

EXTRACT YIELD OF BOTH BREWING LINES

average values calculated from 7 brews, 100% barley malt

	lauter tun 3	lauter tun 2 (Lauterstar)	increase in extract yield
Overall brewhouse yield (OBY) (cold)	97.5%	98.7%	1.2%
brewhouse yield (cold)	75.3%	76.3%	1.0%

Table 5

lautering system. Both lauter tun processes had the same upper set-point determining "end of lautering": 50 EBC in turbidity and/or a maximum differential pressure of 700 mm water column. Turbidity and differential pressure could be kept longer below the upper set-point with the Lauterstar. This reflects a significant capacity increase. It is important to mention that total lautering time was constant for both systems.

Brewhouse yield

From the collected process data the brewhouse yield for both lauter tun systems could be calculated. The results are compiled in Table 4. As already demonstrated by Miedaner [1] the accuracy of the analysis in comparison to spent grains analysis is clearly not as good. However, in routine operation it is a simple way of monitoring the extract yield development in the brewhouse, at no additional expense.

The following equations were applied for calculation:

$$OBY = \frac{(V_{CW} \times E_{CW} \times \rho)}{E_{malt}} \times 100\%$$

Eq. 1: OBY-calculation

$$A = \frac{V_{CW} \times P \times \rho \times 0{,}96}{S} \times 100\%$$

Eq. 2: brewhouse-yield

OBY: Overall brewhouse yield
V_{CW}: Volume of cold wort [hl]
E_{CW}: Extract content of the cold wort [°P]
ρ: Density [kg/l]
E_{malt}: Malt extract mass [kg]
A: brewhouse yield
V_{CW}: hot cast wort [hl]
P: Original extract [GG%]
S: Malt throw [dt]

Conclusion

The results presented here demonstrate that a clearly defined project for a lauter tun optimisation could achieve significantly better extract yield. Considerable savings could be achieved which lead to a pay back time for this investment of approximately 1.5 years.

The compontents of the Lauterstar upgrade package can be combined individually, depending on the application. The individual requirements of a brewer such as extract yield, wort quality or processing time will be taken into account. Operational down-times for the upgrade can be kept very short.

Mash transfer into the lauter tun with bottom inlet valves resulted in a significant improvement of the spent grains bed. The evenly distributed spent grains layer has positive impact on turbidity and homogenous extraction throughout the bed. The example demonstrated that even a relatively modern lautering system built in the nineties had significant potential for improvement. An analysis of the spent grains for extract losses should be carried out to determine the need of a lauter tun upgrade. ■

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1. Miedaner, H.: Critical remarks on determination of brewhouse yield, *Brauwelt International* (2004), No. VI, pp. 418-421.

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