

Impact of different fermentation tank outlets on product quality



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Introduction

- Conventional fermentation tank outlets are constructed with more or less long pipes connecting the tank with the valve block or a pipe fence. Tuchenhagen Brewery Systems has recently developed a new system called ECO-MATRIX®. In this system the valves are connected directly with the tank only with a short outlet.
- It is the aim of this study to investigate technological effects arising from different piping systems and especially different pipe lengths. As a primary task the processes taking place in the pipe and in the tank during main fermentation had to be determined. It is commonly stated that systems with long connecting pipes might be disadvantageous because of remaining product and uncontrolled process conditions in the pipework.
- Courses of main fermentation were monitored in two different breweries to examine the differences between the different tank connections. Both breweries were equipped with both piping systems (conventional and ECO-MATRIX®) to compare them under the same conditions. The results presented here are an excerpt of this study.

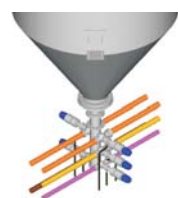
Material and methods

- Process course:** After filling of the fermentation vessels fermentation started at 15°C and proceeded until diacetyl reduction was completed (typ. 12 days). Approx. 18 hours after filling 1 hl of cold trub was removed and sampling was started.
- Sampling:** Samples were taken out of the tank and out of the pipe to determine the process course in the line in comparison to the tank. Tank samples were taken out of the regular tank sampling point above the cone. Samples out of the line were taken at the end of the pipe directly before the valve block. The pipe samples from the ECO-MATRIX® tanks were taken from the small outlet right above the valves.

Tank connections



- Conventional pipe connections** are in the majority of cases neither insulated nor temperature controlled. Thus undefined fermentation processes might take place.
- The content in the horizontal pipe does not take part in mass transfer with the content of the fermenter, and the static pressure in the pipe is at maximum.
- Yeast cells trapped in this area are subjected to increased stress.
- CO₂ can remain in the horizontal section of the pipe leading to encrusted yeast.

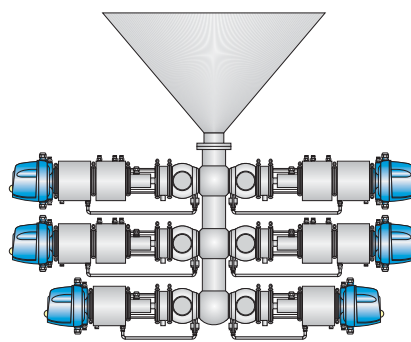


- The ECO-MATRIX® piping connection** is reduced to a vertical stem.
- All parts of the stem can take part in mass transfer with the tank.
- All pipes connected with the tank can be cleaned individually at any time.

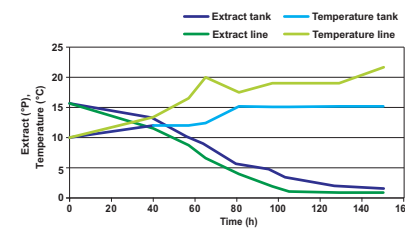
Temperature distribution during fermentation



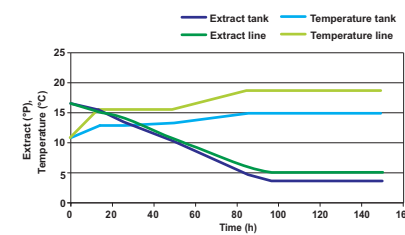
Because of the constantly higher temperature in the uncooled pipeline the fermentation proceeds much faster. In essence, two different processes take place in the tank and in the pipe in the conventional tank connection system.



Course of fermentation: extract and temperature

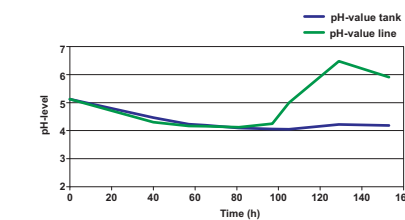


- Process course in a tank connected with a conventional pipe. Because of the constantly higher temperature in the line the fermentation proceeds much faster. In essence, two different processes take place in the tank and in the line.

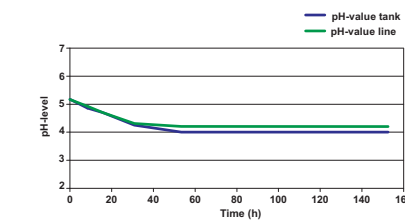


- This chart depicts the same parameters for a tank equipped with ECO-MATRIX®. In this analysis also a small difference can be observed in the course for the temperature, but the effect for the decrease of extract and temperature are much less pronounced compared to the conventional system.

pH-level in tanks and connecting lines

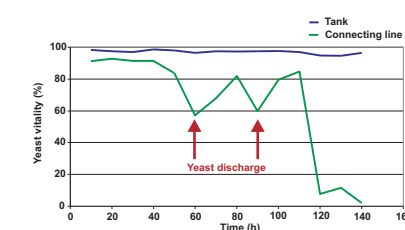


- The development of the pH-level in the conventional setup also shows a different behaviour in the tank compared to the line. After almost 4 days of fermentation the pH-level starts to rise in the line samples. The reason may be the excretion of basic amino acids by the yeast. The effect can be observed in yeast with bad viability starting to autolyze. The yeast quality in the line is decreasing.

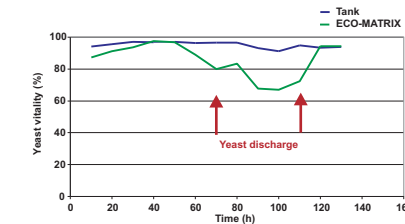


- In comparison, the massive increase in the pH-value could not be observed in tanks with ECO-MATRIX®.

Yeast deterioration in the line



- The line samples show a fast decrease in yeast viability due to a lack of extract. Yeast viability (measured using methylene blue staining) is reduced to below 5% in the worst case. Yeast cells with such low viability tend to autolyze and excrete basic amino acids, fatty acids and proteinases which influence beer quality negatively.



- Yeast vitality during fermentation in tank and ECO-MATRIX®. Inactive and dead cells settle in the tank outlet stem. However, deterioration of yeast viability occurs much earlier in the conventionally connected tanks and continues to much lower values over the course of fermentation.

Conclusion

- This study shows that two different processes take place in the line and in the tank. Due to uncontrolled conditions in the line (temperature, ratio: yeast to extract) an undefined fermentation process takes place. Yeast viability decreases and the yeast starts to autolyze with all its negative side effects. This affects the quality of the green beer remaining in the line extremely negatively.
- To avoid quality loss in the finished beer, the remaining line volume should be discarded and the line should be flushed.
- In comparison, the ECO-MATRIX® concept seems to be advantageous due to its very short pipe connection and the fact, that the connecting line can be cleaned independently. The volume in the very short connecting stem is very small compared to the large volumes in the lines of conventional connections. If such lines are discarded larger product losses are inevitable.
- In conclusion, wort/yeast/green beer residues remaining in the lines during main fermentation are undergoing a different process than in the tank. Systems where lines are short and vertical should be preferred to maintain beer quality, reduce product losses and to maintain a high hygienic status in the lines.