Rethink Beer Pasteurization – Safety, Sustainability and Quality

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Introduction

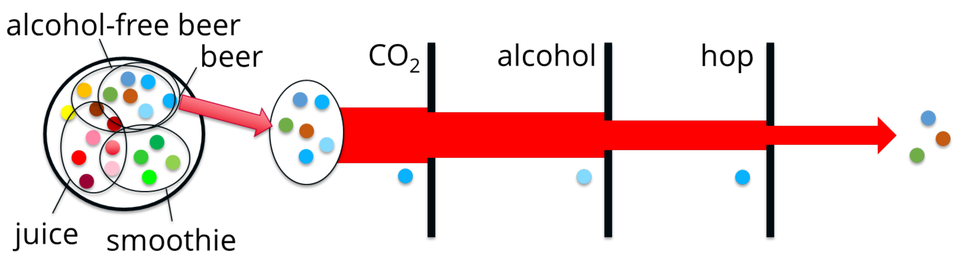
Common pasteurization methods often use simplified assumptions, but a more accurate treatment becomes increasingly interesting to the brewing industry since the market for mixed and alcohol-free beer is growing. Those products are often more vulnerable to microbial hazards one-hand side. On the other one, many of those kind of products are sensitive to chemical (e.g. vitamins) and organoleptic (e.g. color, taste, haze) deteriorations. We investigated some possibilities for more precise control in pasteurization processes.

PU_{set}

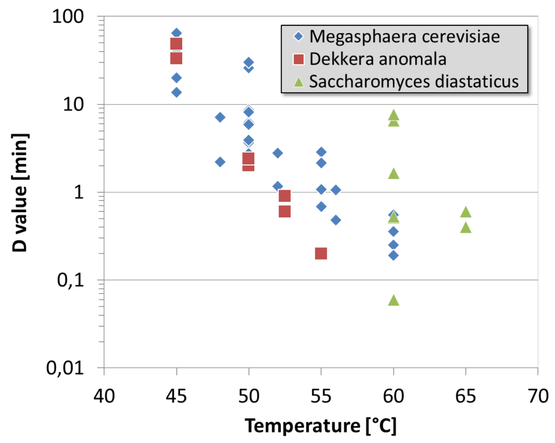
PROBLEM: For set parameter in pasteurization processes, often only generalized PU values are used. These values are not specific for one distinct beverage but for a class of beverages.

APPROACH: Using beverage specific information about hazardous microorganism and matrix specific death kintics for this species leads to product specific PU_{set} values.

RESULT:



Lists from hazardous microorganisms for individual beverage classes can be obtained by literature. The list can be reduced by chemical parameters such as pH that did not match the growing conditions of the species. This shortlist can be checked for relevant decimal reduction (D) values in the Lemgo D-and z-value database for food (https://www.th-owl.de/fb4/ldzbase), for example.



From the relevant D value, together with the desired security level the product specific PU_{set} value can be calculated.

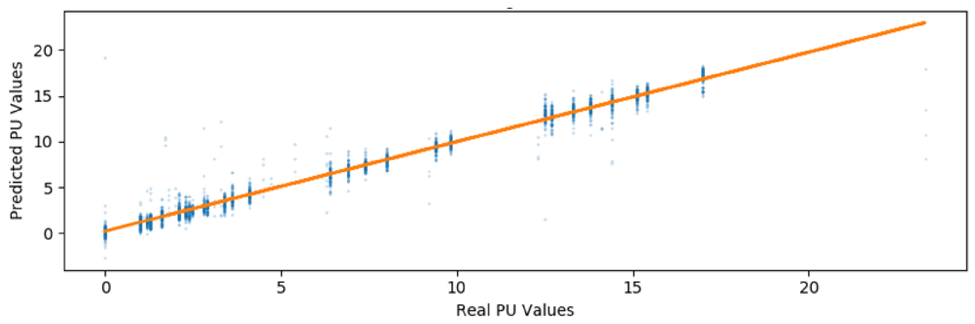
PU_{set}

Flash pasteurization

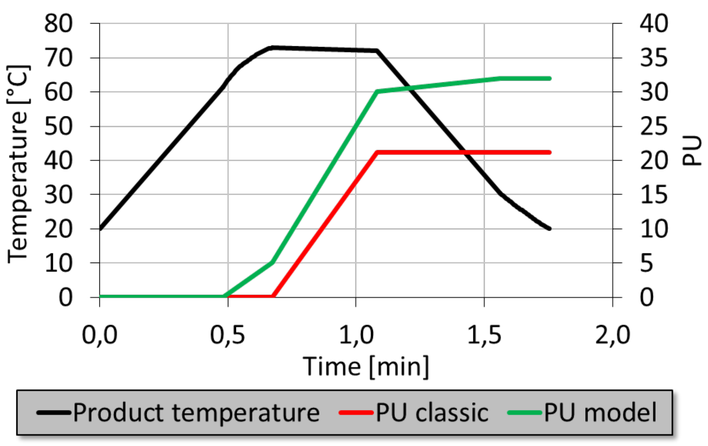
PROBLEM: PU calculation with a one point temperature measurement ignores several aspect such as ‘pasteurization in the heat exchanger’ or ‘dead spaces’.

APPROACH: (I) Determination of the heat impact by inline measurement of the chemical changes during pasteurization.
(II) Using of a model for the temperature curve over time.

RESULT:



(I) With near infrared spectroscopy in a laboratory scale a partial least squares regression (PLSR) model could predict the actual PU of one apple juice (±4 PU). Unfortunately for now, the model is to weak to predict PU in other apple juices.



(II) With a model of the temperature course in the flash pasteurizer, based on the temperature before and after each heating or cooling section and physical data of the heat exchanger, a more precise prediction of the heat impact is possible. The example to the left will show 21.1 PU with classical one point measurement and 31.9 PU (+51%) with the model.

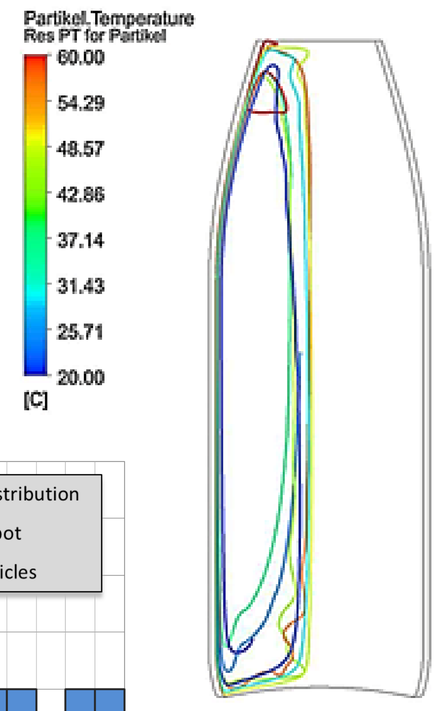
Tunnel pasteurization

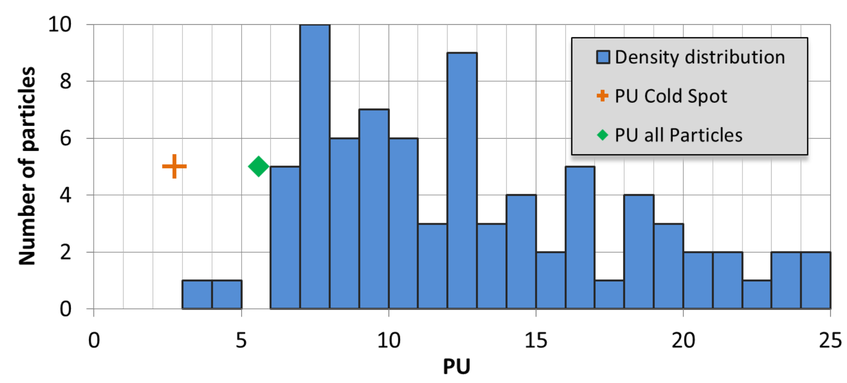
PROBLEM: PU calculation from cold spot measurement only ignores several aspect such as ‘temperature distribution’ or ‘particle movement’.

APPROACH: Calculating the survival probabilities for microorganisms by numerical simulation of the pasteurization process with particle tracing.

RESULT:

A simulation of a beer pasteurization shows that all particles are moving in circles. Heated on the outside and with constant temperature going down inside. On the right the path of one particle and its temperature is shown.
PU was calculated for all particles. The results are summarized in the graph below. Additionally, the PU classically calculated by the cold spot temperature (orange cross) and the overall PU calculated by the particle temperature (green diamond) is marked. Cold Spot measurement leads to underestimation of the pasteurization by about 50%.





Conclusion

Precise parameterization of pasteurization processes can prevent overpasteurization for improved quality and adequate safety against microbiological hazards.

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