Fouling mitigation strategies while processing aluminous food products in micro structured devices

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Cargill Deutschland GmbH, a branch of the US based company Cargill Inc., is processing plant based raw materials, e.g. corn, wheat, cocoa, soy, to ingredients for food and feed applications. These resources and energy demanding processes require continuous optimization to reduce costs and environmental impact. Micro and milli reactor technology is currently under investigation at Cargill to increase process efficiency by valorizing side streams from various production processes. The protein, carbohydrate or cellulose containing streams are quite reactive, especially at elevated temperatures, and could therefore cause fouling in micro and milli channels thus limiting the process efficiency. However, the lack of in-situ measurement for the formation of layers in micro and milli channels indicates the need to develop systems to determine fouling. These tools would allow to determine the fouling progress in order to initiate cleaning procedures to restore the production performance of micro and milli reactors and to maintain required product quality.

The detection and observation of fouling processes in general can be performed by using a variety of suitable methods. The direct optical observation is one of the easiest methods. Therefore the Institute for Micro Process Engineering (KIT) developed and manufactured a series of micro reactors with transparent reactor covers. To ensure the optical accessibility of the micro reactor a micro structured stainless steel foil with parallel micro channels is clamped between a stainless steel housing for setting a temperature and a PMMA housing for optical observation. The materials have been chosen to enable both a homogenous temperature field via the metallic heating passage and a cheap optical window, which still is temperature resistant enough to enable fouling experiments. Furthermore customized flow distributors were developed to minimize the influence of inhomogeneous flow distributions and guarantee equal residence time for each micro channel during

experiments with micro structured foils containing different numbers of micro channels.

To increase the basic knowledge of fouling mechanisms in micro components the Institute for Chemical and Thermal Process Engineering (TU Braunschweig) systematically analyzes the impact of different parameters in relation to the occurrence of fouling in micro components. Therefore β-lactoglobulin, one of the major whey proteins, was chosen as a model system to determine its fouling characteristics in the described micro reactor designed by Institute for Micro Process Engineering (KIT). To quantify the fouling progress as well as the cleaning performance several indicators like pressure drop, integral thermal fouling resistance and optical methods are used. The modular construction of the micro reactor allows a comparison between experiments in single channel and experiments in multi-channel operation.

This contribution presents the experience and results of all three research partners in terms of fouling detection and fouling reduction in micro components in its current state.