UNDERSTANDING AND REDUCING FOULING IN WHEY EVAPORATORS

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ABSTRACT

Fouling in whey evaporators results in an increased energy consumption, product losses and reduced runtimes. The fouling layers are usually mineral-based, mainly containing calcium phosphate and calcium citrate. Additionally, the fouling layers can contain lactose and whey proteins.

Optimization of evaporators with respect to fouling will lead to an increase in runtime and production capacity. Unfortunately optimization processes are often trial-and-error based because the exact mechanism and rate of fouling are not known. This makes the optimization process inefficient and results are often sub-optimal. In order to improve the optimization process a predictive model was developed that describes mineral fouling in whey evaporators. This model describes the fouling process as a three stage event: formation of calcium containing particles, transport of the particles to the evaporator wall and adherence of the particles to the wall.

To test and validate the model, NIZO has developed an analysis device that enables to do experiments on-site with actual industrial process streams. With the analysis device the formation and composition of the fouling layer can be monitored as a function of time. The analysis device was first tested and validated at a site of one of the collaborating industrial dairy partners and then used to determine the fouling behavior under different conditions.

Experimental results show that the build-up of fouling is initiated by one of the components present in the process stream, after which, at a critical amount of this deposit, different calcium and other salts are being deposited on the evaporator surface. Experiments at various conditions indicate that the amount and composition of fouling can be influenced by process parameters such as product temperature, temperature of the evaporator wall, pH and additives.

The knowledge obtained in this project resulted in several strategies to decrease the fouling in the evaporator, resulting in an expected 20% cost reduction due to increased capacity of the evaporator. Furthermore, because the composition of the fouling layer was determined, an improved strategy to valorize the fouling layer waste stream was proposed.

It is expected that he NIZO fouling analysis device can also be applied in other (food) industries were mineral fouling is a problem in heat exchangers and in the investigation of strategies to decrease phosphate fouling in the dairy and food industry.