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Novel Tools for Improving the Energy Efficiency and Process Control of Vacuum Filtration

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Vacuum filtration is applied in solid-liquid separation in a wide variety of industrial processes for instance in the mining, chemical, and paper industries. The target of the project introduced here was to test and validate a new concept for forming and controlling vacuum level in industrial vacuum filtration applications by applying an innovative energy-efficient procedure. The main focus of the new concept is on vacuum filters where the CAPEX- and OPEX- costs originating from the production of vacuum currently play a significant role. Typically, the vacuum in these processes is created by using large liquid ring vacuum pumps which operate at constant rotational speed and the techniques used for controlling the vacuum level are fairly simple. The method that was created in this project relies on advanced and high dynamic performance process control, which enables significant savings in energy consumption in vacuum filtration processes.

The specific energy consumption of vacuum filtration operations typically depends on the properties of the feed suspension, the filtration conditions applied and the characteristics of the cake dewatering process. Operating a vacuum filter at high pressure difference requires a high air flow rate and thus results in high energy consumption. By taking into account the solids content of the filtered suspension together with the power demand and energy consumed at a certain pressure difference level, it is possible to investigate the specific power demand and energy consumption relative to the solids content of the filtered cake. When the mother liquor in the void space of the filter cake is replaced by air, the flow rate of air through the cake increases, which has a dramatic influence on the specific energy consumption. The results obtained in this project demonstrate clearly that both the air flow rate and the specific energy processes could be operated in a way that increases the energy and resource efficiency and eventually also reduces the carbon footprint related to these processes.

The applicability of a data-driven soft sensor method to estimate the filter cake solids content after vacuum dewatering was also studied. In addition to this, several other measurements, such as air humidity and thermographic camera were applied in the pilot unit and it is demonstrated that the results obtained from these measurements provide a lot of relevant data that can be utilized for controlling the vacuum

filtration processes. The methods applied in this study offer new means to control and optimize the energy consumption of vacuum filtration and subsequent drying stage as well as the properties of the final product.