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OPTIMIZATION OF THE PERFORMANCE OF A FILTER PRESS BY STATISTICAL DESIGN OF EXPERIMENTS AND EMPIRICAL MODELLING

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ABSTRACT

Automatic vertical filter presses can be successfully used for dewatering and washing of various products in industrial processes. Due to the differences between the material properties, filtration and washing characteristics of different suspensions need to be experimentally determined for each new application. This often requires a large number of tests to be performed. The operation cycle in a vertical automatic filter press consists of several stages which all have an influence on the filter cake properties and therefore also on each other. For this reason, theoretical optimization of the whole operation cycle of a filter press is difficult.

This paper presents a method that can be utilized for optimizing the performance of the vertical automatic filter press for a given suspension and, at the same time, for reducing the amount of test work required. The method relies on statistical design of experiments and on empirical modelling which have proved to be very suitable tools for this kind of studies. By using these techniques, the influence of a large number of process variables on several product characteristics can be reliably and objectively determined with a small amount of test runs. In addition, possible interactions between the studied process variables can also be detected and taken into account in the optimization of the process.

The method developed was applied for optimizing the operating conditions of a vertical automatic filter press for dewatering and washing of wheat starch. Five different variables of the filtration, pressing, cake washing and air drying stages were considered in the tests that were carried out by a pilot-scale (0.1 m^2) filter press according to the basic principles of factorial designs. The examined product characteristics were the overall capacity of the filter, the cake moisture content and the purity of the cake.

The results obtained from the tests were used for creating different kinds of regression models for all of the studied responses and the created models clearly showed that the influence of the process variables on the studied responses could be reliably predicted in all cases. By comparing the different experimental designs and models, it could be shown that it is possible to significantly reduce the amount of experimental work by using statistical design of experiments and still obtain fairly accurate correlations. Relative importance of the studied process variables on the studied responses could also be easily estimated by examining the statistical parameters of the models.

Keywords: Cake filtration, Washing, Vertical automatic filter press, Starch, Design of experiments, Modelling