Runability Failure Analysis of a Continuous Digester

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Abstract: In this study the possibilities to predict the continuous digester runability failures are considered and a method for failure identification and prediction is introduced. Runability failures are detected from an industrial digester operation, process performance indices are developed to evaluate process runability, digester failure classes are defined from digester index data using clustering analysis and finally the runability failures are predicted from front-end indices with classification methods. The works relevance is in both fault analysis and control. From runability problem analysis point of view, it is of interest to figure out if causal relationships and root causes leading to problems at the digester can be detected by following the course of the chip flow. In addition, if it is possible to predict future runability problems from the front-end indices, it would be possible to avoid or remedy the possible problems at the digester by means of process manipulation and control.

Continuous cooking is a complex process by its nature. It consists of numerous process stages, with long residence times, and strong interdependencies between process stages and variables making essential process variables difficult or impossible to measure. These include the characteristics of the raw material, the state of the delignification and the behavior of the chip column along the process line. The state of the process is not always easy to observe based only on the distributed control system (DCS) measurements, even by an experienced process engineer or operator. Therefore, interest towards intelligent process monitoring methods and operator support systems is continuously increasing.

Runability disturbances were detected systematically from an industrial continuous digester production. A set of 47 failure cases was used for analysis, consisting of 8 hours of 1 minute data. Runability indices were developed to describe specific disturbances in continuous cooking. Each index was designed to describe a specific disturbance and the tools for index development included process statistics, mass and energy balances, fluid mechanics, pulping kinetics and process dynamics. For data analysis the acquired set of data was divided into two parts, the front-end index and the digester index data. The clustering analysis was performed with digester index data to derive runability failure classes. Class information together with front-end index data was further applied using classification methods to predict the digester class from front-end index data.

Keywords: Pulp industry, fault identification, classification, monitoring.