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MULTI-CRITERIA OPTIMIZATION OF PRESSURE SCREEN SYSTEMS IN PAPER RECYCLING – BALANCING QUALITY, YIELD, ENERGY CONSUMPTION AND SYSTEM COMPLEXITY.

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Abstract: Paper for recycling is the most important raw material for the German paper industry. In 2016, 16.9 million tons of paper for recycling were used in Germany [1]. In addition to fibers and chemicals, the production of paper requires large amounts of process water and energy. The recycling material has a heterogeneous composition and needs to be purified before new paper can be produced. In particular tacky contaminants, so-called stickies, lead to problems in the papermaking process and reduce the quality of the product. For separating stickies from valuable fibres, fine screening systems are used. The fine screening system typically consists of multiple interconnected pressure screens. The design of such systems is highly complex, as many different system configurations are possible and conflicting objectives need to be considered. A mathematical optimization of the configuration and operational parameters was first done by Fügenschuh et al. [2] in 2014. A mixed-integer nonlinear program was used to optimize the configuration and operational parameters simultaneously. In this work, our goal is to extend this model and to provide practitioners with access to our optimization approach. We extend the model of Fügenschuh by: (i) The volume flow of the pulp suspensions is modeled to gain a more realistic representation and to be able to assess the energy consumption. (ii) More system configurations are considered by allowing a splitting of the connection between the different screens. (iii) The design parameters, e.g. slot width of a screen, are taken into account in a dimensionless screen model. Thus, they can be included in the optimization problem. Additional objectives, besides the quality and fibre yield, are the resource-consumption and complexity of the system. The resulting mixed-integer nonlinear program is solved to global optimality using exact methods. A software tool with graphical user interface is developed. It allows for a simple formulation and adaptation of the optimization problem as well as a graphical presentation of the results. Our tool can be seen as a decision support for engineers during planning and operation of such systems and comparable industrial separation processes.

Reference

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