Suggested project and master thesis topics at Frövi/Rockhammar

Introduction

Frövi/Rockhammar[1] (a part of Billerudkorsnäs) comprises a pulp and paper mill producing cartonboard and liquid packaging board. This list contain some initial information on suggested specialization projects, which can be continued into a master thesis. Projects 1-8 cover pulp and energy topics while projects 9-10 cover board production. The supervisors from Frövi/Rockhammar will be Eva Antilla (board production) and Andreas B. Volden (pulp and energy). The topics range from process modeling and simulation studies to more hands-on projects. Apart from using standard tools like MATLAB, it will also be applicable to get acquainted in more specialized software for modeling, MPC development, control systems and such. The initial idea for most of the projects is to focus on modeling during the project and partly during the thesis, and for the latter part focusing on control and optimization. During the specialization project an initial mill visit will be applicable. For the thesis work, a longer stay at a suitable time is desirable.

For interested students further information is available from Eva[2] and Andreas[3] by email.

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Project 1: Modeling and MPC development for TCF bleaching of chemical pulp

Bleaching of pulp is necessary to lower residual lignin content and to increase the end brightness. At Frövi, the bleaching plant comprises a TCF (totally chlorine free) bleaching sequence consisting of four stages. At each stage a number of parameters play a vital role, for instance chemical dosing and retention time. The process is dead-time dominating and multivariable, emphasizing the need for MPC. The aim for the project will be to gain process knowledge and eventually model the process, and further - if time allows - to continue on MPC development based on an existing application and findings in the project.

Project 2: Optimal control of a white water system at a CTMP mill

Rockhammar is a chemi-thermomechanical pulp (CTMP) mill. White water from the process originates from a number of sub-processes, and it's necessary for the mill to run. The white water system serves unit operations throughout the mill, but is also used to balance the mill in total. Hence, the function of the system is important, and especially during disturbances and shutdown/start-up. The task will be to identify bottlenecks and workarounds on current system, but also to investigate opportunities for further improvements. This could for instance be: new control strategies, improving current control structure and so on.

Project 3: Evaluating a steam network in search for enhanced performance

Steam production at Rockhammar comprises two systems: a steam boiler and heat recovery by reboilers. The steam producers may vary, and additionally steam demand may abruptly change due to process variations. This cause disturbances over the network and decrease steam reliability. The main objective of this project is to investigate steam network dynamics for modeling purposes, and to evaluate today's operation of the network. Further, an ana-

lysis of the control loops involved and alternative solutions is of significant interest.

Project 4: Increasing pulp yield by stabilizing level control and wood chips treatment

Prior to pulping, the wood logs are cut into chips. The chips are then fed into the process, which prior to pulping, consists of several pretreatment steps. These steps have two major purposes: increase chip temperature as much as possible and treatment with chemicals to lay a best possible foundation for high quality and even pulping. For a successful pretreatment the keywords are even retention time, tight level control and accurate chemical dosing. This task will investigate how to attain tight level control of dead-time influenced control loops, and to simultaneously minimize chemical dosing.

Project 5: Lime kiln modeling and optimization

A part of the recovery cycle at chemical pulp mills include the lime cycle. Recovered lime mud from the recaustisizing process is burned to hot lime (or quick lime), where the hot lime is reused in preparation of white liquor. The conversion from lime mud to hot lime takes place in a rotary tube-oven (lime kiln) at temperatures ranging from 1250 to 600 °C. This projects aims to develop a model of the kiln, where the target eventually is to evaluate suitability of current control structure and an MPC solution for control. However, the MPC part is secondary in this work, as we will focus primarily on the modeling and existing control structure perspective.

Project 6: Optimizing control of a black liquor evaporation train

Black liquor from the chemical pulping process contains mostly water. To recover the pulping chemicals, which comprises the inorganic part of black liquor, the black liquor is incinerated in a recovery boiler at 75% dryness. To achieve this level of dryness, a large portion of water needs to be removed from the black liquor in an evaporation train. The evaporation train consists

of several evaporators (effects) and end thickeners, and the operation is a major steam consumer at the mill. To achieve operation closer to optimum presents multiple advantages, a vital part off course being able to lower steam consumption while maintaining throughput. This project focuses on control structure evaluation and moving towards more optimal control, i.e., reducing back-off while maintaining acceptable robustness.

Project 7: Optimal operation of surplus energy to external district heating network

The heating applications at the mill can be seen as three different layers; steam network for process heating, internal district heating within the mill, and external district heating. Via the external district heating network, the mill provides excess heat to the neighbouring communities. Excess heat is the surplus energy not necessary for the mill to run, although still present as a byproduct during normal operation, and it's fed to the external district heating network. This project aims to investigate improvements in operation, and how to maximize throughput to the network at all operating ranges. This is especially important during winter when both mill and district heating network demands considerable energy.

Project 8: Advancing in control of debarking wood logs

The very first step in making pulp or paper from virgin fibres is to debark the wood logs. To make the debarking operation as efficient as possible, a defined temperature between the bark and wood core is desirable, which is where the adhesive forces between bark and wood is at minimum. This temperature is achieved by a temperature controlled watering of the logs prior to debarking. The key of this project is to make a model for prediction of incoming logs temperature between bark and wood, and investigate how to control the water temperature based on said prediction. This will ensure not only an efficient debarking, but will also enable energy savings, and narrow the operating window around the optimal point where both wood loss and residual bark is at minimum.

Project 9: Optimal operation of a heat exchanger network on a board machine drying section

More information to come.

Project 10: Improved control of board profiling on wet-end section on a board machine

More information to come.