Model Based Refiner Optimisation

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1. Introduction

**AutomationX GmbH / Austria**

- Solution provider for integrated automation solutions
- Founded in 1992
- 70 employees
- Focus on: Processing plants
  - Production management / MES
  - Process optimisation

**Stora Enso Hylte / Sweden**

- Employees: 430
- Paper machines: 2
  - newsprint since 1972
- Pulp: TMP and DIP
- TMP plant: 2 main line refiners
  - 1 reject refiner
  - 3 low consistency refiner
- TMP production: 800 t/d
2. Reasons for Realising the Project

- There were two different projects at Hylte.

- Project 1 (Boost): With various tests we found out that our paper machines would run better with an amount of shives below a certain value.

- Project 2 (Tctrl): We installed a temperature-based control at the main line. At the refiner the hydraulic pressure is controlled by the temperature inside the refiner. This stabilises the refiner making it easier to control the quality.

- Tests showed that although energy is shifted between the main lines and the LC refiners we can keep the right quality to a certain degree.

- Good experience with AutomationX and eMPC after an installation of filler control at our paper machine.

- We wanted a system that automatically reduces the standard deviation of the quality and cuts down the energy consumption by shifting energy when possible.
3. Initial Situation

- We achieved to increase specific energy consumption at LC and to decrease energy consumption at the main refiner lines - but not as much as we wanted.

- Cascade control at the main lines was too slow and was stopped too often by limit violations.

- With testing, analysing and help from AutomationX we could calculate the savings for the installation of an MPC Control.

- Because of that we could draw on the central budget ‘Energy Efficiency Investments’ of Stora Enso.
4. Main Objectives

- Reduction of electrical energy consumption
- Reduction of the quality’s standard deviation (shives)
- Implementation of recipe and grade change management
5. Control Concept

Refiner 11 → Refiner 12
Refiner 21 → Refiner 22

Reject Refiner

LC Refiner 3 → LC Refiner 4 → LC Refiner 5

Temp. spec. energy

eMPC eMPC eMPC eMPC eMPC

ePO (overall Process Optimiser ➔ load shifting)

eMPC* Model Predictive Controller
ePO* Process Optimiser
6. Project Implementation

1. Installation of AutomationX APC server on site

2. Configuration of data monitoring (OPC interface to existing ABB DCS)

3. Data validation and process model development based on historical process information

4. Installation of MPC for each refiner line (main, reject and LC-refiners)

5. eMPC start-ups and acceptance / optimisation period

6. ePO development and start-up (overall process optimiser for load shifting based on quality parameters)

7. Implementation of recipe and grade change management

8. Optimisation period

9. Guarantee run and final acceptance
6.1 Modelling

- Data preparation (filtering, re-sampling and reconstruction of missing data)
- Data and correlation analysis
- Dynamic process model development
- Model validation
- Model transfer → eMPC
6.2 Main Refiner

- A dynamic model describes the general behaviour of the main refiners (temperature).

- Observing shives and MFL quality parameter in MPC Controller (related to production)

- Model adaption based on the real measurement (Kajaani MAP)

- Safety limits still exist in ABB DCS and MPC has limited allowance for set point
6.3 Main Refiner / Trends

- Trend values of the main refiner line. Actual values from the DCS are shown on the left side of the black line. Predicted MPC values are shown on the right side of the black line.
6.4 Reject Refiner

- Production related load management for reject refiner
- Moving set point for maximum energy achievement
6.5 LC Refiners

- Achieving final quality for shives and MFL
- Observing incoming quality to reduce variation
- Achieving energy savings based on incoming quality from main refiner line
6.6 ePO (overall Process Optimiser)

- ePO adjusts the shives set points of the main refiner line if the LCRs run on set point. (More shives reduce energy consumption of the main refiner.)

- The more shives are at the LCRs, the higher is energy consumption. Due to the fact that LCRs are more energy efficient than MRs energy savings can be achieved.

- Set point shifting will be stopped if the final quality behind the LCRs cannot be reached anymore.
### 6.7 Recipe Overview

- Integrated Recipe and Grade Change Management

![Recipe Overview Diagram]

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<th>Line 2</th>
<th>Reject Rollback EVL Line 1</th>
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Förbättring av Blivande: 0 min
## 7. Results - Energy Savings

### Specific Energy

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<th>Main Line [kWh/t]</th>
<th>LC Line [kWh/t]</th>
<th>Reject Refiner [kWh/t]</th>
<th>Total [kWh/t]</th>
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<td><strong>Savings [%]</strong></td>
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7.1. Results - Shives Quality improvement

![Graph showing Shives LC comparison between eTMP with ePO and manual methods. The manual method shows a higher value than eTMP with ePO.](image-url)
7.2. Results - Summary

- Energy savings: 4.2%
- Shives standard deviation: - 25%
- ROI: < 7 months
- Reduced operator workload
- Quality stability independent of operator → higher stability on paper machine
- Integrated recipe and grade change management
- Increased shive content because of stabilized pulp quality
8. Additional Installations in Hylte

- Ash content, strengths and opacity control on PM4 with AutomationX eMPC

- \( \rightarrow \) 1% more ash in raw paper (within defined paper quality ranges)
Thanks for your attention

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