APC & Optimization on Chemical Recovery Island

Bhattacharya Jaideep
Honeywell Automation India limited, Pune

ABSTRACT

Model based predictive control has been around for over 20 years and is widely used in the industries. Over the years, APC has decisively demonstrated its value. Many leading companies have successfully applied APC to their most important process units.
APC plays an important role in achieving the control and optimization benefits from the Recovery Block of Pulp and Paper plant, which typically consists of the Evaporator and the Recovery Boiler.
Evaporator APC solution will produce liquor of improved quality, with less variation in the final dry solid content. With advanced control it also will be possible to increase the dry solids content target value, as result of a more even liquor quality and of a more stable coordinated process. Energy consumption can be reduced as result of the optimization.
Recovery boiler APC will optimize the recovery boiler combustion controls continually monitoring the boiler operating conditions, calculating the optimum control parameters. The benefits of operating as an "ideal boiler" throughout the boiler load range include Stable operations. Increased production capacity, increased steam production, improved boiler efficiencies, decreased chemical usage and decreased flue gas emissions.

Introduction

Advanced Process control and optimization is key to running process plants reliably, efficiently and responsively. It has been around for over 20 years and is widely used in the industries.Over the years, APC has decisively demonstrated its value. Many leading companies have successfully applied APC to their most important process units.

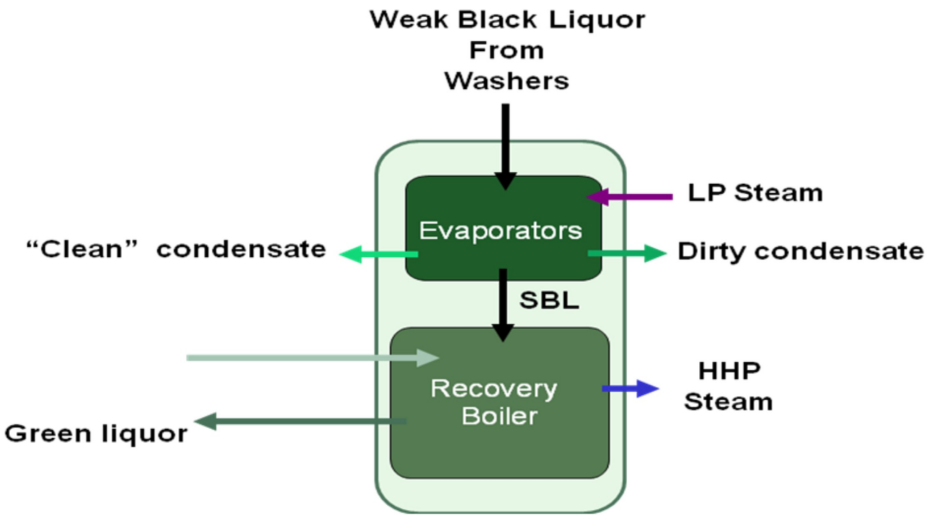
Recovery Island of a Pulp mill is a good candidate for implementing Advance Process Control because of the multivariate nature of the process and huge potential for utilities optimization.

Current industry trends like lack of experienced workforce, increasing raw material and energy cost, increasingly stringent environment compliance requirements have increased the need for APC applications in process industries including paper.

Here we will be looking into the evaporation and Recovery boiler units of the recovery island and discuss the scope of Advanced Process control and optimization in these units.

Evaporator Advance Process Control and Optimization

Evaporator and recovery Boiler Overall Process:



The objective of the Evaporator Advanced Process Control and Optimization is to provide a strong liquor production of stable and desired quality. The target value for dry solids content is dependent on the overall pulp mill production capacity and target values. With optimized control, the evaporation process will produce liquor of improved quality, with less variation in the final dry solid content. With advanced control it also will be possible to increase the dry solids content target value, as result of a more even liquor quality and of a more stable coordinated process. Energy consumption can be reduced as result of the optimization.

Typical objectives that can be achieved by evaporator APC are:

Production rate control

The production rate can be defined strong liquor flow [t/day] leaving the evaporator.

Production rate is controlled/maximized to an operator specified value keeping into account the plant constraints like tank levels, evaporator effect delta temperatures, control valve openings etc.

Steam control

Steam flow is manipulated based on production rate and strong liquor dry solids content at target. Steam flow is related to evaporated liquid flow and therefore related to evaporation load or production rate. Variations of feed liquor density and evaporation effects efficiency can disturb the dry solids content control function, therefore steam flow is used for compensation.

APC will try to minimize the steam consumption while maintaining the strong liquor dry solids content at target. This is achieved due to significant reduction in variation (standard deviation) of key controlling variables which allows the plant to move close to optimum.

Strong liquor dry solids control

The main objective of APC is to keep the desired content of dry solids in final strong liquor on target and with minimal variations. Accurate and reliable measurement of density or dry solids content is very important for this function.

Evaporator Effect Delta temperature

The main objective of APC will be to minimize the effect delta temperature for the evaporators as this will result in maximum heat utilization from the heating medium (steam or vapor)

Recovery boiler Advance Process Control and Optimization

The recovery boiler in a pulp mill is a dynamic process and sensitive to disturbances and instability caused by a variety of reasons, such as the varying quality of black liquor, load changes, and different operating methods. The objective of the Advanced Process Control in Recovery Boiler is to stabilize boiler operations by continually monitoring the operating conditions. The solution pushes the boiler to its limits to maximize throughput of black-liquor solids. It thus reduces boiler-burn production bottlenecks and increases mill production.

The control solution includes features that increase operator confidence and improve boiler safety.

Typical objectives that can be achieved by evaporator APC are:

Recovery boiler Load control

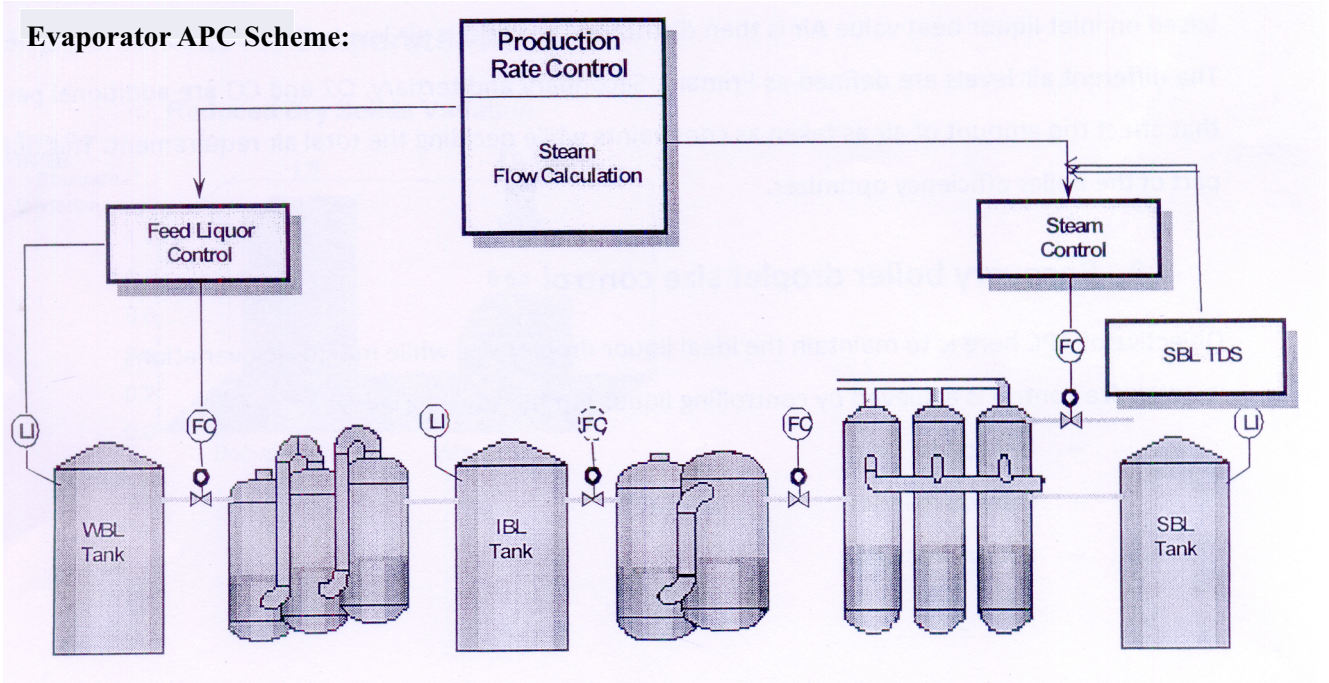
As part of this objective, APC will stabilize combustion conditions during load changes or liquor quality changes at fixed load. Desired set point for the Boiler load (Organic Dry solids) is given by operator as a target in APC. Heat value of liquor is calculated continuously based on RI, flow, temperature % solids. Liquor flow is manipulated based on heat value to meet boiler load

Boiler constraints like excess O_2, CO is considered while increasing liquor flow.

Recovery boiler combustion air control

Objective of APC here is to have the right amount of air in the right place. Total air demand is calculated based on inlet liquor heat value. Air is then distributed to various air levels according

Evaporator APC Scheme:



to existing philosophies. The different air levels are defined as Primary, Secondary and tertiary. O_2 and CO are additional parameters that affect the amount of air as taken as constraints while deciding the total air requirement. This objective is part of the Boiler efficiency optimizer.

Recovery boiler droplet size control

Objective of APC here is to maintain the ideal liquor droplet size while minimizing variations

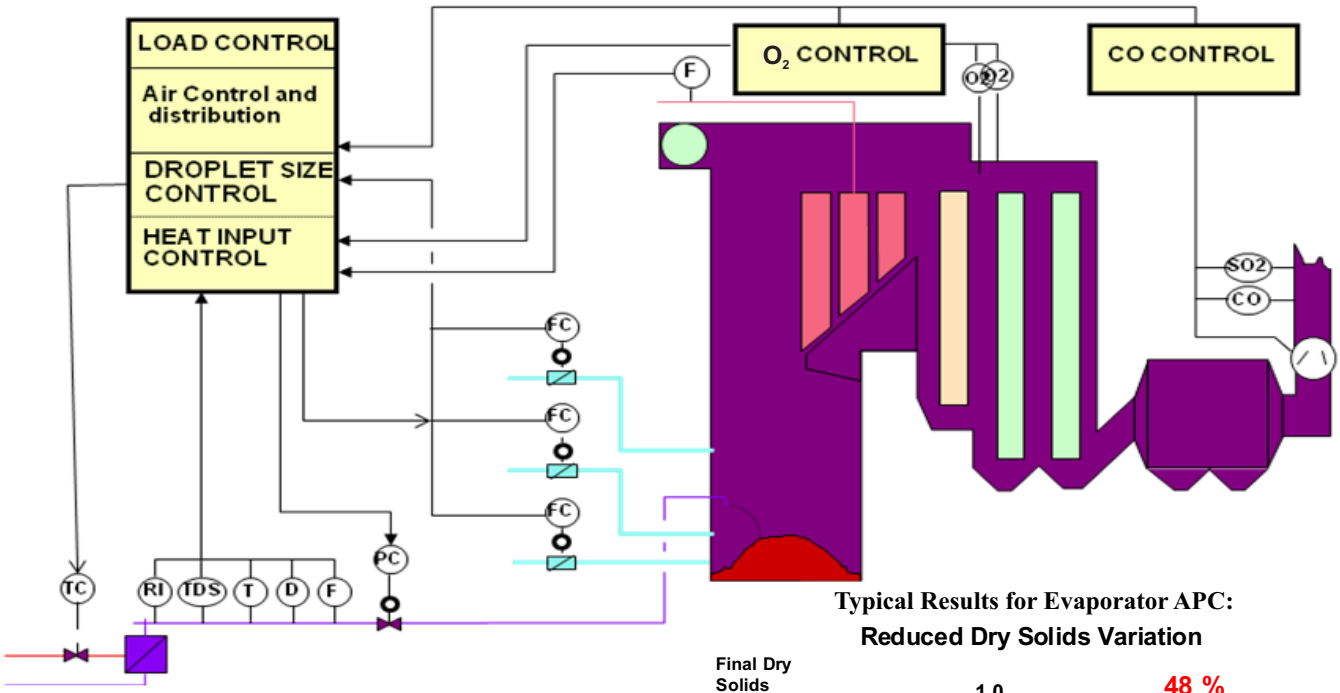
Droplet size control is achieved by controlling liquor temperature based on

- dry solids
- refractive index
- liquor pressure

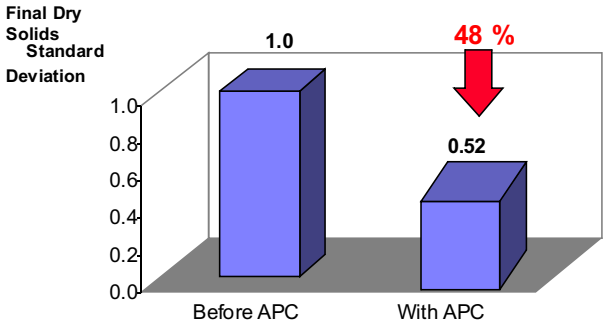
Typical Benefits

Apart from stable operations and improved plant efficiency, typical benefits achieved from Evaporator APC project is around 45 % reduction in strong black liquor variation while for recovery boiler APC typical benefits are Increased production capacity (2% to 5%), Improved chemical reduction performance (reduced reduction degree variation 15% to 50%), increased steam production, reduced Excess Oxygen (30% to 50%)

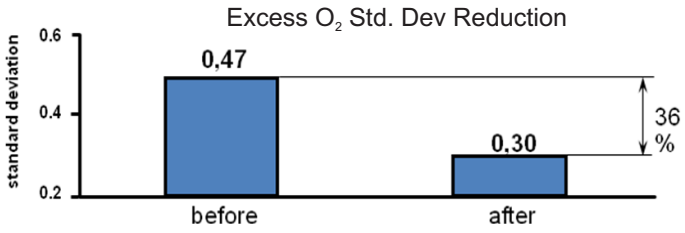
Recovery Boiler APC Scheme

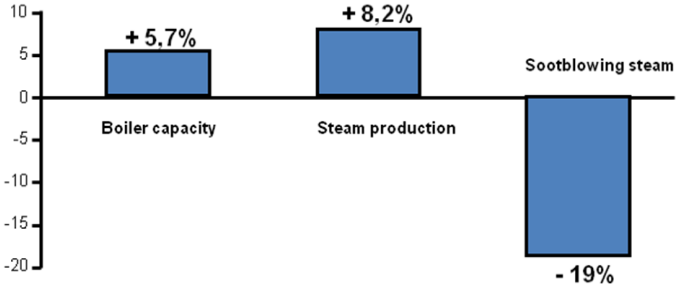


Typical Results for Evaporator APC: Reduced Dry Solids Variation



Typical Results for Recovery Boilers APC





Conclusion

Pulp and paper industry have to continuously deal with changing circumstances with respect to trained workforce, changing economic situations, increasingly stringent quality standards. Success of business depends on quickly adapting to the changing economic scenarios and also adopting latest technologies like Advance Process control to drive benefits.

The recovery block consisting of Evaporators and Recovery Boiler can be better controlled and optimized using APC that will add to the overall economics of the pulp mill.