

The effect of optimizing the operating parameters of the washers on the washer's efficiency and the overall economy of a mill

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Contents of the presentation

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- Why to control/monitor BSW
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Fiber Laboratory

Andritz corporation and Fiber Laboratory have had successful co-operation in development of chemical mixing technology since 2005. One important tool in these studies has been the mill size (6000 t/day) MC-loop, update going on to 10000 adt/d.

Our latest studies mainly considering BSW and O₂ delignification.

For example:

Kopra et al. ABTCP and TAPPI PEERS 2018 (BSW)

Käyhkö et al. ABTCP and TAPPI PEERS 2018 (O₂)

Kopra et al. TAPPI PEERS 2022 (BSW)

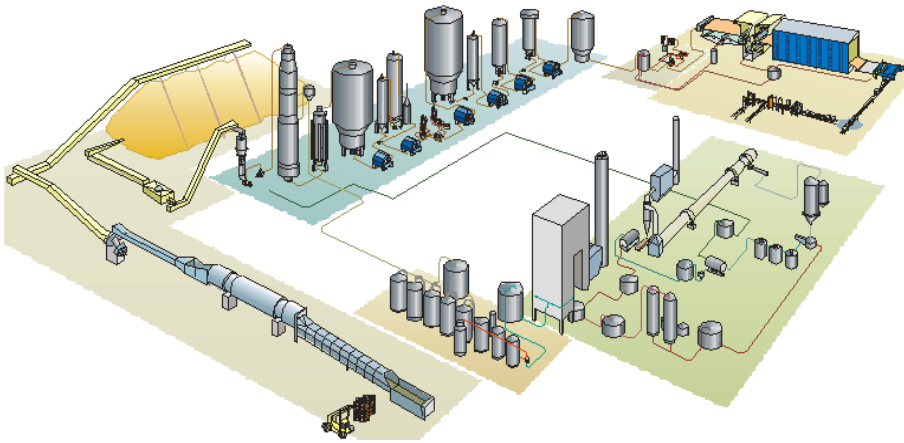
Käyhkö et al. TAPPI PEERS 2022 (O₂)





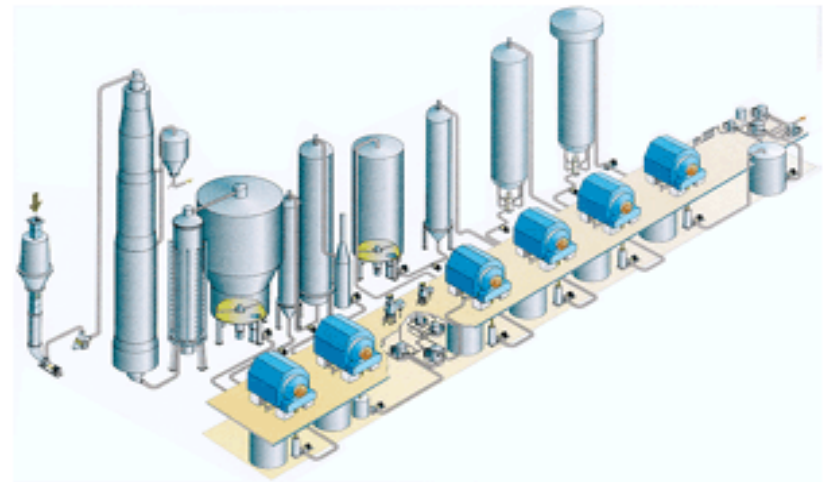
Brownstock Washing

Series of investigations to find solutions that minimize washing loss and **consume less energy**, water and chemicals



BSW can be regarded as the crossroads of the fiber line and the recovery cycle, which operations affect the performance and the economic viability of the pulp mill.

Brown stock washing is notable sub-process in chemical pulping, because it has effects on the followed treatments of pulp and other hand it's first step in chemical recovery cycle.





Objectives of the work

- Explain, why brownstock washing is so important, and which are the targets of boosting fiberline?
- Results:
- Optimizing DD-washers cake washing consistency
- Study the effect of air/gas to washing utilizing online measurement
- Understand the importance of DF and washing effectiveness measuring in mill with limited evaporation





Why and how to boost DD-washing?

- **The targets of the boosting fiberline are:**

- Reduce water consumption through intelligent wash water usage, so black liquor dry solids can be maximized to evaporation, which means energy savings.
- Reduce mills' own energy consumption, leading to more energy for sale (requires integration with the local municipality).
- Optimize inlet/outlet consistency to reach full potential from the equipment.
- Improve the yield of the fiber line (oxygen delignification and bleaching). Optimize the O₂ stage to achieve maximum benefit from oxygen delignification. Can achieve a significant cost-benefit.
- Save cooking and bleaching chemicals by minimizing carry over to bleaching through effective washing. 1kg COD = 0,6 – 0,8 kg ClO₂
- Minimize also wastewater load to wastewater treatment plant.
- Optimize critical quality features, above all the strength of pulp.



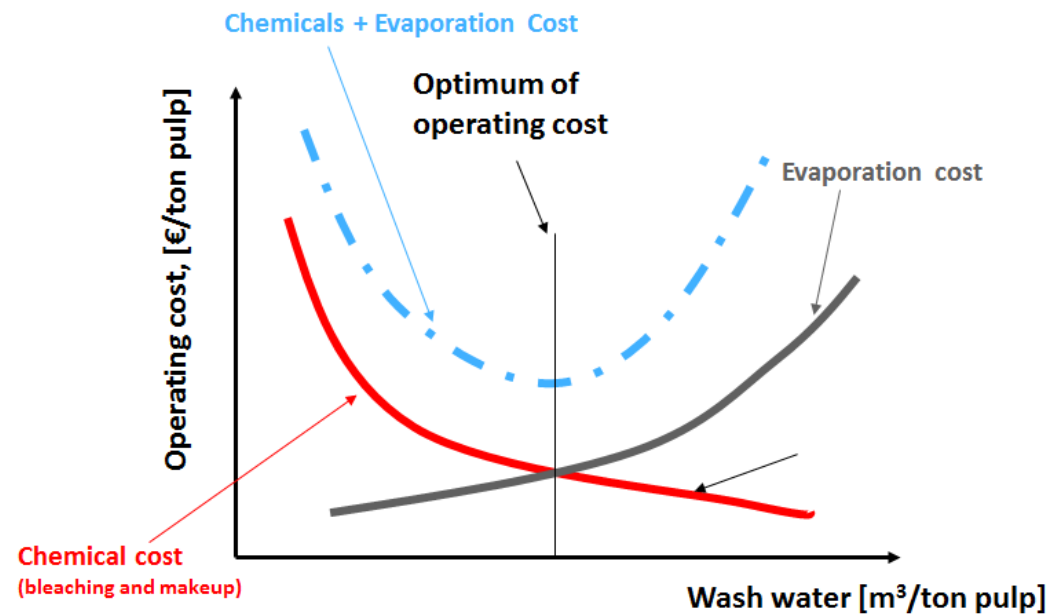
Effects of the washing result to different sub-processes of the pulp mill

- The performance of brown stock washing has an effect on many sub-processes like evaporation, oxygen delignification, bleaching and wastewater treatment.
- Since a washing filtrate from brown stock washing is finally introduced via an evaporation step into the recovery boiler, it has a great effect on the energy balance of chemical pulping.
- It is important to find the optimal operating point for washing, because without effective washing of kraft pulp production is not economically viable.



Need for continuous wash loss measurements or at least for regular checking based on of-line sampling

- The performance of the washing is mainly monitored via the level variations of the conductivity measurements and by measuring and controlling the wash water amount.



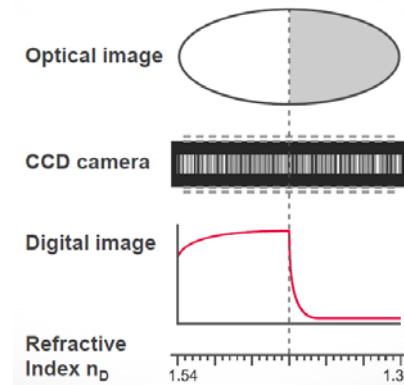
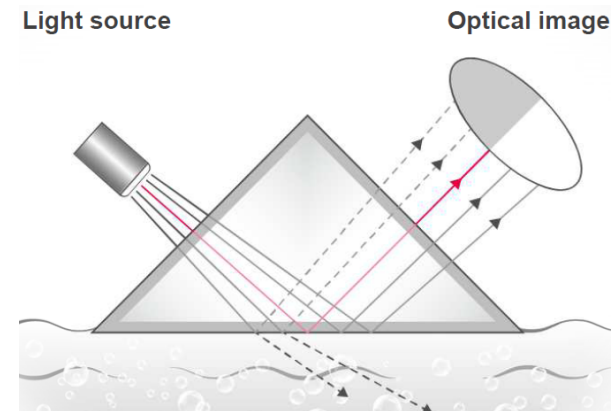


Process refractometer measurement

- We have done several mill studies using refractometers as wash loss measurement units
- Refractometer indicates total dissolved solids (TDS) in solution, both organic and inorganic
- TDS can be measured both from filtrates and from filtrate part of the pulp flow.

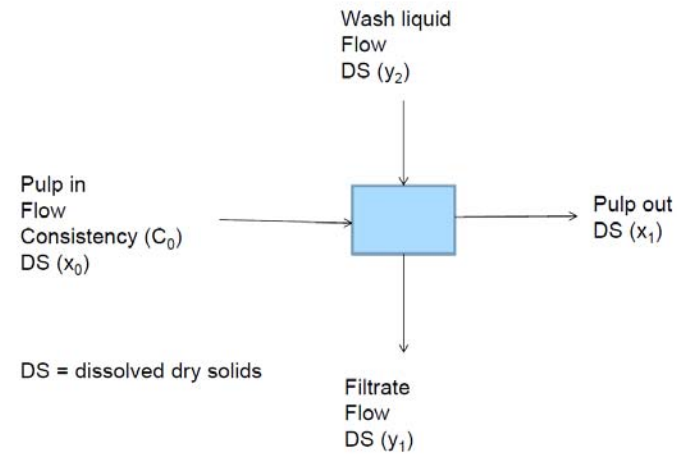
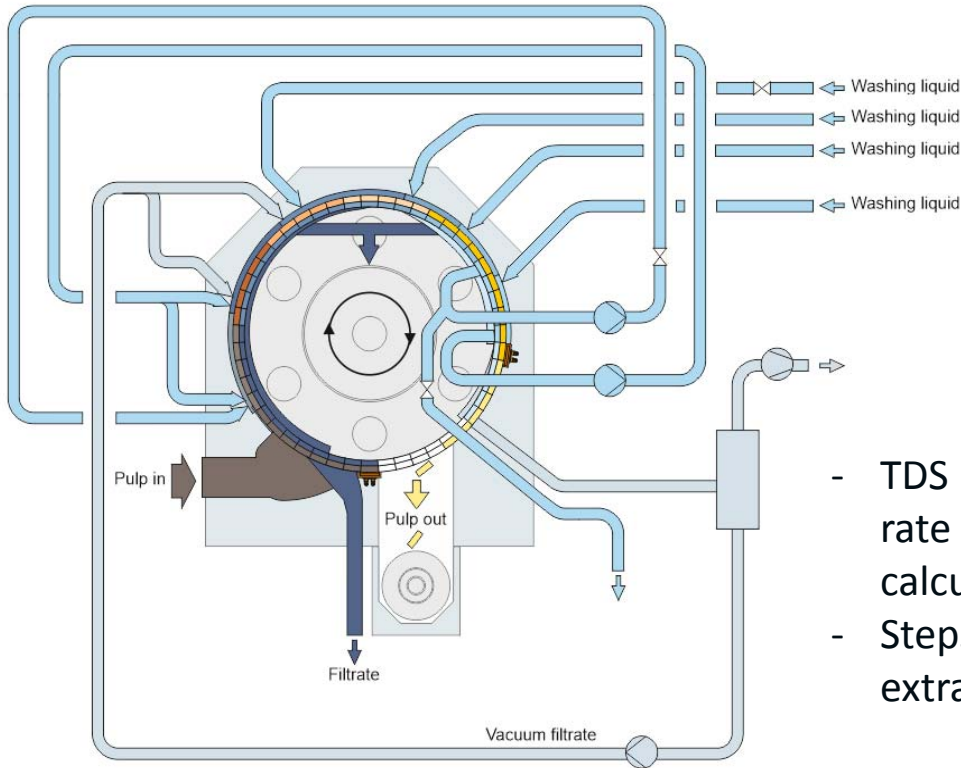


- Free interchangeability of sensors
- Full range: 0-100 % b.w.
- Safe insertion and retraction
- Automatic prism cleaning with steam
- Retractable steam wash nozzle
- Easy installation
- Ethernet and remote access





Calculations



DS = dissolved dry solids

$$Y_{C_{0,st}} = 1 - \frac{L_{1,st}(x_{1,st} - y_2)}{L_{0,st}(x_{0,st} - y_2)} = 1 - \frac{L_1(x_1 - y_2)}{L_0(x_0 - y_1) + L_{0,st}(y_1 - y_2)}$$

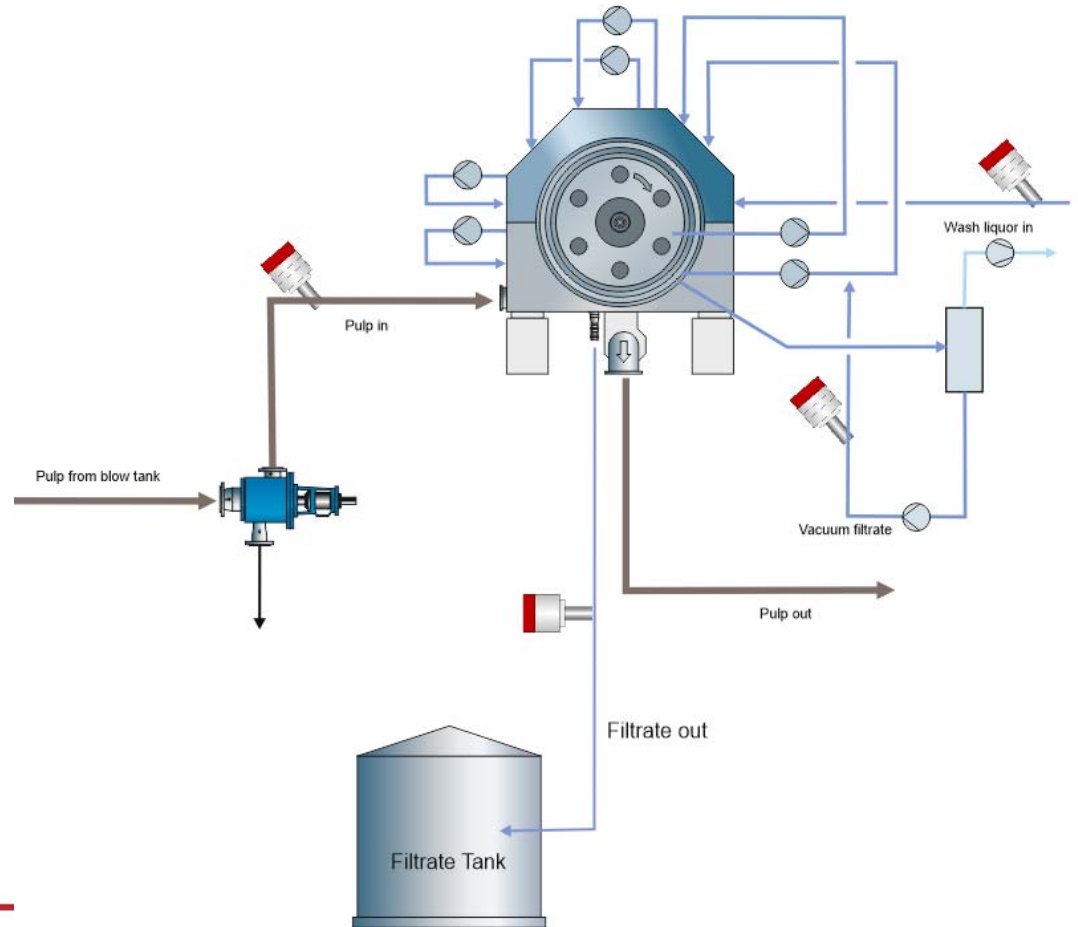
- TDS measurement together with consistency and flow rate measurements enables real time efficiency calculations.
- Steps with a DD-washer: thickening, displacement, extraction, discharge.





Measurement arrangements

- Mill A: softwood, batch cooking, 700 a.d. metric tons/day , 4-stage DD-washer after cooking, the kappa target after the digester was 50. (washing consistency exp.)
- Mill B softwood, (DF study)
- Mill C, swing mill. (Gas/air studies on the washer feed) “PEERS 2024” extensive BSW study.





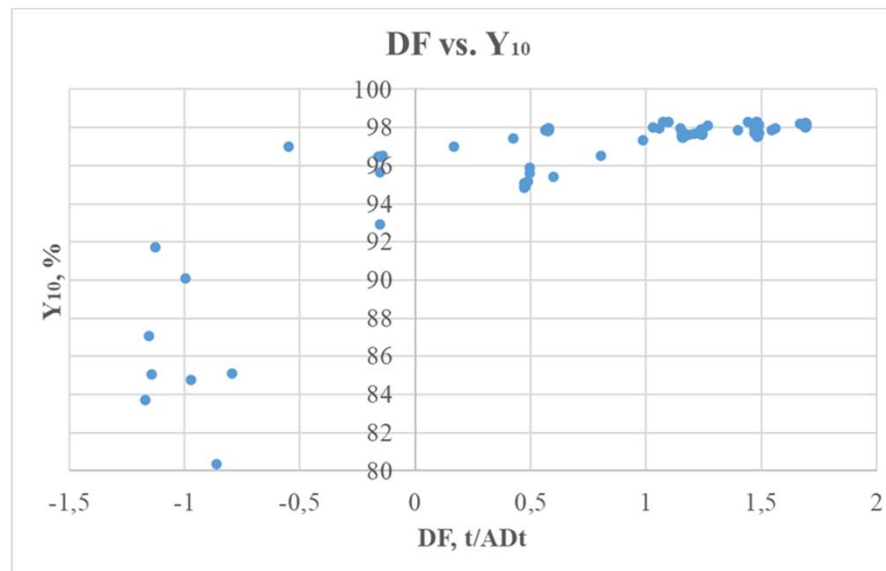
Results

- 1) Washer's optimization
- 2) Effect of air/gas to performance of washer
- 3) Effect of dilution factor on washing efficiency and evaporation plant



Mill A, DD-Washer washing efficiency optimization

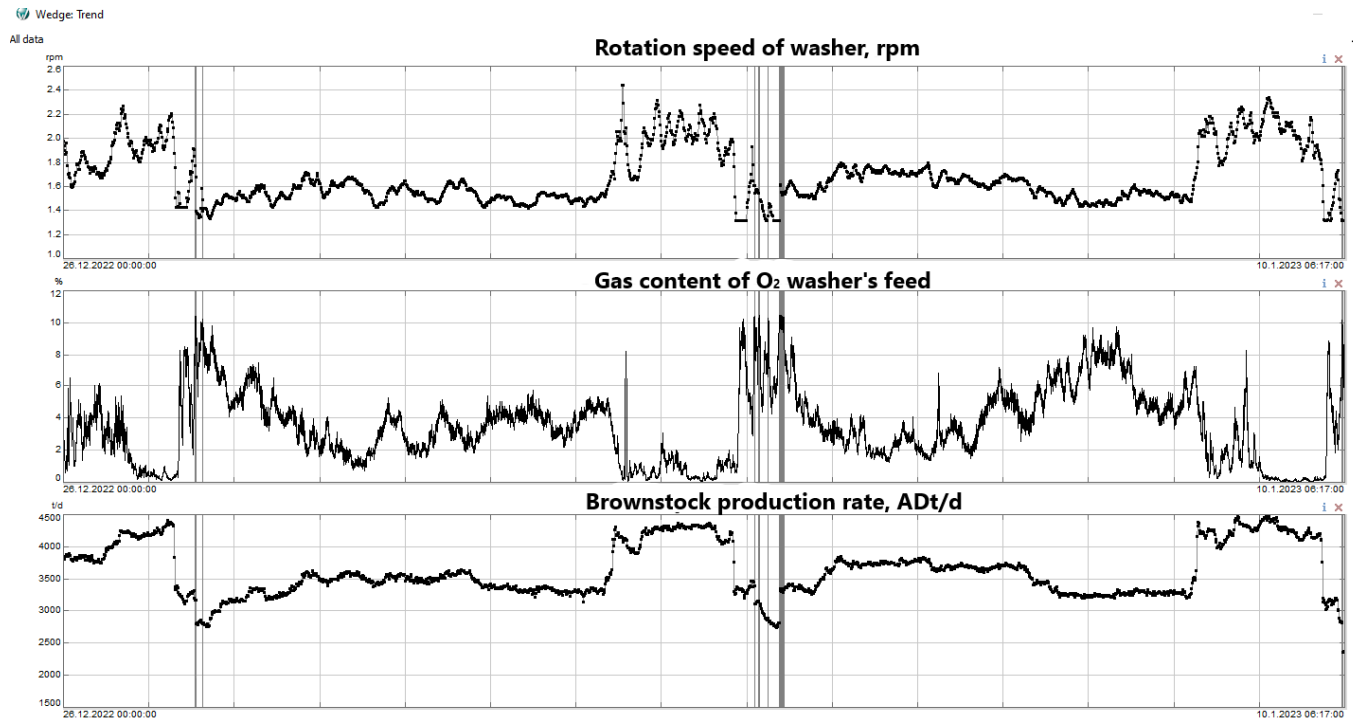
- DF changed on a wide scale. It can be seen that when DF is above zero, Y_{10} remains high
- It was noticed that the amounts of washing liquid and screw dilution were not standardized in relation to production (the changes in DF made it difficult to analyze the experiment results)





Mill C, effect of air/gas to performance of washer

- It can be seen from the figure that the gas content for the washer varies greatly, normally 1 to 8 %.
- Higher gas contents were observed when the temperature of the upper part of the second reactor in the oxygen stage was below 100 Celsius degrees and the suspension could not expand.
- The rotation speed of the washer follows the production and thus the effect of the gas on the drainage, at least with these gas mass fractions, is small.
- However, with the measurement, changes in the gas content entering the washer can be observed in real time, and the reasons for this can be searched.

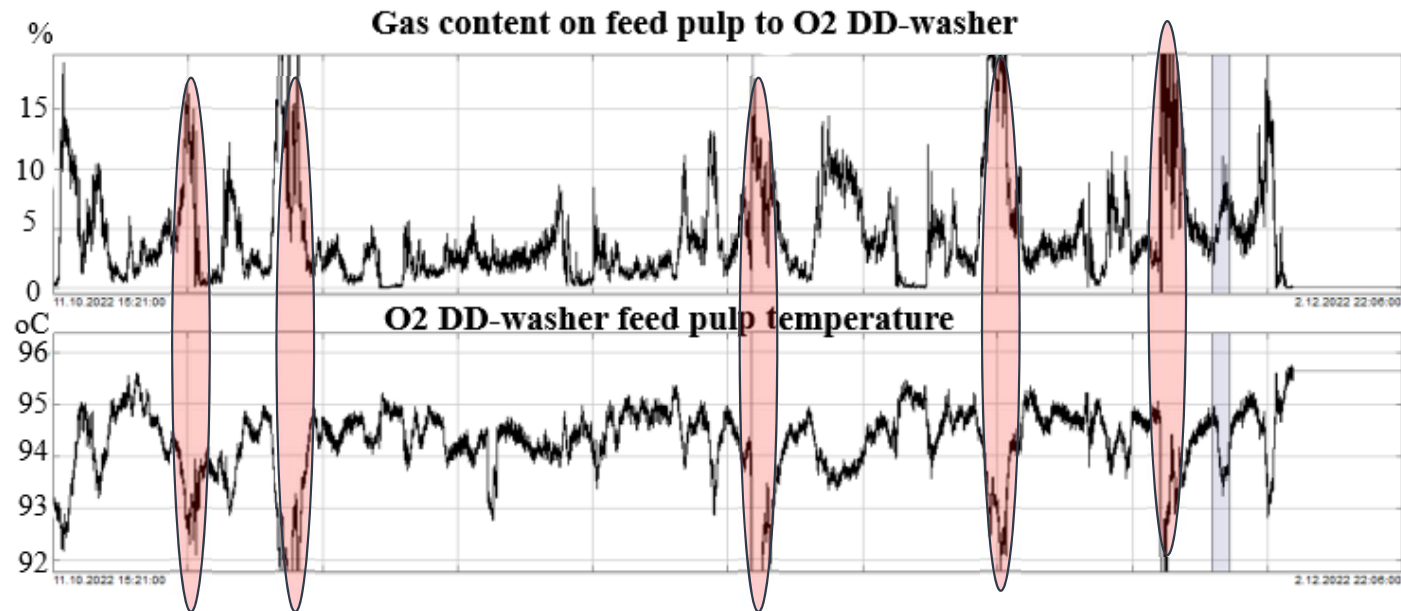


New experimental study is coming!



Mill C, effect of flashing to air content

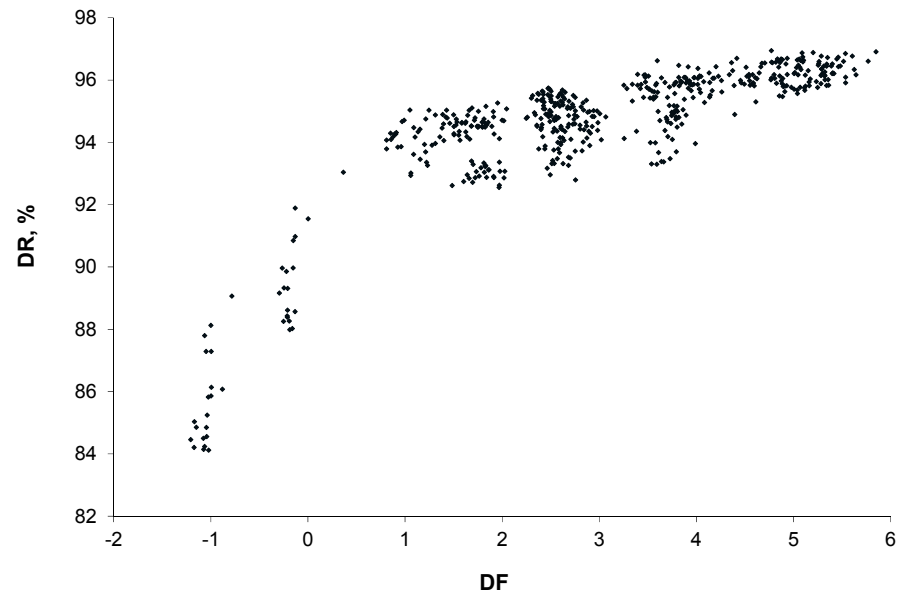
- It can be seen that when temperature is lower, more gas goes to the washer.
- After the oxygen delignification, gases are removed by flashing at over 100 degrees, if the temperature is too low in flashing, the gases are not removed sufficiently, and may will end up to the next washer.





Effect of dilution factor on washing efficiency and evaporation costs

- The amount of wash water affects the washing efficiency.
- The optimal dilution factor is always mill-specific. Too low DF collapses the efficiency of washing and excess DF increase the evaporation costs.
- TDS measurements can be used to monitor DF, monitor the operation of the washer and whole fiber line. Since available DF is limited, it underlines necessity of efficient washing.



Effect of the dilution factor (DF) on the displacement ratio (DR) at Mill B.



Conclusions

- In short, when fiberline washing is performed poorly, all areas of the mill are negatively affected. When it is done well, increased black liquor solids, decreased carryover to the bleach plant and decreased environmental impacts result. These impacts had a clear effect on the cost-effectiveness of the whole pulp mill.
- The results obtained indicate that the measuring results of the refractometer can be used in various ways to monitor and control brown stock washing before and after oxygen delignification.
- Gas content measurement give a good picture of the amount of gases in the pulp stream. Gas measurement together with TDS efficiency calculation, give the opportunity to monitor and optimize washing.



Thank you for your attention!

Questions?

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