**Simulation of conductivity increase in closed papermaking circuits**

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**Highlights**

* Chemical process simulation could predict conductivity in a recycled tissue mill.
* Conductivity sources are raw material, chemicals, water and anaerobic activity
* Inhibiting microbial anaerobic activity may reduce conductivity two-fold.
* Water management strategies must be evaluated by a thorough simulation study

**1. Introduction**

Reduction of fresh water usage in papermills has some consequences on process water quality. In particular, organic and inorganic dissolved and colloidal substances build-up can cause operating difficulties. Increase of organic dissolved and colloidal substances have an impact on drainage, chemical additives, microbial activities and deposits. Solutions exist to limit their disturbing effects such as separation of water loops, counter-current washing or recycling bio-treated effluents. On the other hand, inorganic dissolved species may become the limiting factor for further circuit closure as they interfere with charged polymeric additives [1]. We present a chemical process simulation approach to predict salinity increase in process water. This will help determining acceptable conductivity limit for paper production and adequate water management strategies.

**2. Methods**

First, conductivity sources throughout the circuits are identified. Four types of sources are considered (i) raw materials, (ii) fresh water, (iii) chemicals and (iv) anaerobic activity.

For pure chemicals, dedicated sources are available in the chemical process simulation (for instance: caustic soda, sodium bisulfite, etc.). For charged polymers, their specific contribution to conductivity is firstly determined by plotting a dilution curve. Then corresponding sources of counter ions are implemented (Na+ for anionic polymers and Cl- for cationic polymers).

The process simulation (Fig.1, left) determines the conductivity by resolving chemical equilibria together with biochemical equilibria resulting from anaerobic activity [2], [3]. Chemical speciation is used to calculate the corresponding conductivity.

**3. Results and discussion**

The conductivity calculated from the simulated ionic distribution fitted the measured conductivity profile quite well (Fig.1, right). The simulation made it possible to estimate the relative contribution of each conductivity source. In the tested tissue mill case, all sources contributed significantly to conductivity. Raw material released various ions. Fresh water was a significant source of ions as well. Chemicals were a significant source of conductivity as producing wet-strength grades requires alkaline conditions for broke repulping. In closed circuits conditions, anaerobic activity may cause important conductivity rise. The simulation showed that inhibiting anaerobic activity could reduce conductivity two-fold, as it is coupled to the other sources and effects, e.g. dissolution of calcium carbonate filler from the raw material due to produced organic acids.



**Figure 1.** Simplified view of the process simulation with chemical modules (left) and prediction of conductivity throughout the process (right).

**4. Conclusions**

Results have shown that the relative contribution of each conductivity source is very mill-dependent. Therefore the strategy to help reducing conductivity rise in closed circuits conditions will be specific to each situation. This depends on produced grade, fresh water quality, initial water consumption, chemicals used and water management strategy.

The simulation can now be used to test various wastewater recycling scenarios. One promising option is to reduce fresh water consumption by recycling bio-treated effluent back to the process. This makes use of the waste water treatment plant as a kidney for organic material, but also deconcentrates the circuits in calcium as calcium carbonate is precipitated in the aerobic treatment. This has potential to help papermills limiting ionic species build-up when reducing their water footprint.

**References**

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