A Pulp & Paper Industry perspective for the advancement of black liquor membrane technology from the APPTI Black Liquor Concentration Committee December 2021

Exciting times to see black liquor membrane concentration technology advance in both academia and the private sector. Since this committee's publishing of the Black Liquor Concentration Road Map [1] in April 2016 this technology has come a long way. As we see progress through the publicly announced demonstrations and breakthroughs, the Industrial Pulp & Paper BLC APPTI sponsors would like to reiterate the key targets identified and cited in the roadmap for selectivity, flux, and fouling. It is critically important to keep the industrial goals in mind during the next steps in the technology evaluation and developments towards commercialization.

Selectivity

Optimal separations of water, ions, and organics

Separation technologies must show separation effectiveness of both organics and the salts. Ideally, the quality of the exit water permeate stream would be suitable for reuse elsewhere in the process and, at a minimum, would not interfere with existing wastewater treatment processes. The target is <0.1% solids in the permeate. The committee has issued a standard shown in the table below.

Table BLC Committee Permeate Quality Goals

"Soda" as Na2SO4, mg/L	< 100
Sodium as Na, mg/L	< 30
Sulfate as SO4, mg/L	< 10
Conductivity, uS/cm2	< 300
pH range	7.0-10.0
Total dissolved solids, wt%	< 0.10
Total Organic Carbon (TOC), wt%	< 0.10

The goal has not changed from the original roadmap, the ideal situation is achieving permeate of similar quality to existing multiple effect evaporator condensates which are routinely reused in the process for pulp washing and other operations.

Flux

Advanced high-flux membrane systems

The new technology must ultimately be able to handle the throughput/flux volumes experienced at a 1,000 ton per day pulp mill line with reasonable footprint, estimated to be 1,200 to 1,800 gallons per minute of weak black liquor. However, the technology could be implemented in a modular manner as a pre-evaporation stage which does not require full stream process flows but can be supplied a fixed-flow portion with the goal of increasing the black liquor solids concentration of the total stream to the multiple effect evaporators.

Withstand high-temperature, high-pH environments

Separation technologies must be able to process black liquor solids from 35% up to 55% salts and up to 65% organics; 1,000 ppm MeOH; pH 12+; operating temperatures of 80–95°C.

Fouling resistance/system availability

As membrane systems begin to gain interest for supplementing traditional evaporator units, understanding membrane life and the impact on operating expenses along with capital cost for installation will be critical to their inception. Small-scale demonstrations of low flow (2 to 5 gpm) are an excellent way to demonstrate materials for selectivity, preliminary fouling and durability; however, the next demonstration phase needs to grow to a useful pre-evaporation level (10-15% of total flow or ~200 gpm units) that are run for long periods of time to prove membrane longevity. This will be used to validate techno economic analysis (TEA) toward commercial implementation and viability.

□ Membrane fouling must be monitored and controlled.
□ Membrane technology must require less downtime for cleaning/maintenance than current evaporators.
□ Membrane materials must be reasonable in cost and durability such that operating costs do not outweigh the energy savings.

Reference

Black Liquor Concentration Research Roadmap, Agenda 2020 Technology Alliance, (APPTI), April 2016.