Membrane Processes for the Circular Economy

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Abstract:

Globally there is a move for greater recycling to be embedded throughout industry and community processes, and this is often referred to as the circular economy. In the circular economy, materials are collected and circulated back into the economy as feed materials or are reused as products. It is envisage that recirculation of materials will not only provide better stewardship of materials by reducing waste and improving their efficiency of use, but may often reduce greenhouse gas emissions. To achieve recirculated of materials they must be of quality that allows their reuse, and this often involves purification. For process industries this will often involve the use of membranes because of their ability for selectivity, consistency and low energy. Here two examples of potential membrane processes to support the transition to the circular economy are provided.

In the Kraft pulping process, strong alkali along with sulphite is used to dissolve lignin from wood to release cellulosic fibres. In this process sodium hydroxide is converted to sodium carbonate, but is recycled via a lime addition converting the sodium carbonate back to sodium hydroxide and calcium carbonate. The calcium carbonate is then processed through a thermal recaustication process to regenerate lime from the calcium carbonate. This process requires significant energy and consumes hydrocarbon fuels in the thermal process. An alternative process of membrane electrolysis was explored for regeneration of the sodium hydroxide. Laboratory experiments indicated that regeneration via electrolysis enabled more efficient use of sodium hydroxide by achieving greater conversion of sodium carbonate to sodium hydroxide and thus reducing Kraft process inefficiencies. Additionally, the regeneration process required similar energy consumption to that of the thermal regeneration process but the use of electrical power rather than hydrocarbon fuels offers the potential to reduce greenhouse gases.

For herbicide wastewater, treatment via reverse osmosis (RO), temperature swing RO and nanofiltration were considered. The temperature swing RO process allowed high recovery of the herbicide and potential for recovery of herbicide upon cooling, while the nanofiltration process also enabled herbicide recovery and volume reduction of the wastewater.

Keywords: membrane process; circular economy; membrane electrolysis; pulp and paper; MCPA