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Comparison of different approaches for improvement of nanofiltration of industrial effluent

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Wastewater from resin production, particularly phenolic resins, is characterized by extremely high levels of organic pollutants such as phenol, formaldehyde, and solvents. These effluents often exhibit high chemical oxygen demand (COD), toxicity and low pH, making them resistant to conventional biological treatment alone. Current treatment strategies emphasize a multi-stage approach to meet discharge standards and promote water reuse**.** Phenol and formaldehyde can be recovered selectively through liquid-liquid extraction (LLE) using specialized extractants. The resulting stripping concentrates can be directly reused in the next resin production cycle. Resins could also be synthesized on-site by forming resol phenolic resins or mixed urea-formaldehyde resins within the treatment stream itself. This simultaneously purifies the water and produces a marketable technical product. Solvents can also be reclaimed using fractional distillation or vacuum distillation. Advanced membrane distillation and pervaporation offer lower-energy alternatives for breaking azeotropes and recovering pure solvents. Solid residues or concentrated organic fractions can be repurposed into wood-polymer composites or sodium phenolat**e**. These materials could be used in construction and other industrial sectors. The aim of our work was theoretically compare three different approaches to tackle with a problem of industrial wastewater: i) Ca precipitation with CO_2, ii) Ca precipitation with Ca acetate and ammonium carbamate; and iii) Ca precipitation with $NaCO_3$. Effluent was pretreated by aerobic biological wastewater treatment plant and then proceed by nanofiltration, where $CaSO_4$ is deposited on membranes as a result of chemicals added in previous processes. With application of precipitation Ca should be removed before nanofiltration to prevent clogging. Average effluent flow was 2 m^3/h, COD 20,000 mg/L, pH 6-8, concentration of the sulphate 1000 mg/L and concentration of the Cl^- 100 mg/L. To compare optimal processes, Life Cycle Assessment (LCA) was calculated using SimaPro model to compare environmental impact based on 13 environmental parameters for all processes (carbon footprint, ozone depletion, Etc.)