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Design of a membrane process in a countercurrent operation for the treatment of industrial effluents

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Abstract

The design of a plant with membrane modules for effluent treatment and metal recovery in a countercurrent continuous operation is addressed for the first time in this work. The design is formulated as a nonlinear programming problem where the set of algebraic and differential equations that model the membrane separation processes are included as equality constraints. The separation objectives related to maximum contaminant concentration in the effluent and minimum contaminant composition in the product for re-use are posed as inequality constraints.The objective function to be minimised is the total membrane area required in the plant. The optimisation variables are the flowrates and membrane areas.

As a motivating example the removal and recovery of Cr(VI) is analysed, which poses a real challenge for pollution prevention and has a wide range of applications of industrial interest. The countercurrent continuous operation requires less membrane area than the cocurrent operation, indicating that this flow pattern should be further explored at the conceptual design stage.

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