Simulation and optimization of an industrial multiple-effect evaporator using machine learning and mechanistic models

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An industrial multiple-effect evaporator was simulated and optimized using a hybrid modeling framework which integrates mechanistic models with machine learning for better predictive performance. The mechanistic models predict the major operating variables including the flow rates, temperatures, and compositions of the input and output streams which flow through the evaporator, and the machine learning forecasts the pressure drop through each stage of the evaporator at a steady-state condition. Aspen Plus was used to construct the mechanistic models, and feedforward neural networks were trained and validated to build the machine learning models using a set of historical operation data from the operation of the evaporator. The hybrid model showed excellent performance in predicting the major operating variables with the absolute predictive errors of 0.8% - 3.4%. The optimization result revealed that the steam consumption of the evaporator could be reduced up to 13% when operating at the optimal condition.