

Improved approach to steady state simulation of multi-effect distillation plants

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ABSTRACT

Over the past years the landscape of process simulation has tremendously changed. Based on increasingly powerful hardware and improved software applications simulation has come to a new dimension. In order to stay abreast of these changes the OPUS™ simulation program has been developed. Against the top-down philosophy of earlier simulation programs this tool is based on a bottom-up approach enabling the user to simulate any imaginable process configuration. This paper presents the physical and thermodynamic background the current model library for multi-effect distillation (MED) processes is based on. As the most essential models for computer aided steady-state simulation of MED processes the single MED effect, the final condenser and the thermal vapour compressor are described in detail. Along with governing heat and mass balances implemented heat transfer coefficient correlations for condensation inside horizontal plain tubes as well as falling film evaporation on horizontal plain tubes are discussed and compared. Results show significant differences in heat transfer prediction and the necessity to pay utmost attention to the proper selection of such correlations becomes evident. For thermal vapour compression (TVC) both a theoretically based approach and suppliers' design characteristics were incorporated into the simulation program. From checking the obtained data against each other the theoretical approach arose to be much too conservative, resulting in efficiencies exceeding 100% related to suppliers' design characteristics. Used correlations for physical properties of water, water vapour and seawater are stated and a possible new approach for describing physical properties of seawater based on the fundamental equation for the Gibbs energy is presented. The reliability of the current simulation results is evaluated against several project data provided by diverse EPC contractors. The comparisons show a good agreement and the results are within accuracy that allows reasonable prediction of varying operational conditions. Eventually, an outlook on further simulation enhancements is given.

Keywords: Process simulation; Thermal desalination; Multi-effect distillation (MED); Heat transfer; Thermal vapour compression; OPUS™
