TOWARDS SUPERSTRUCTURE-BASED DESIGN OF ORC PROCESSES, WORKING FLUIDS AND PROCESS FLOWSHEETS USING PC-SAFT

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ABSTRACT

Organic Rankine Cycles (ORC) transform low-temperature heat into electrical power. To best exploit the heat input, several methods have been proposed that integrate the design of ORC processes and working fluids [1]. Beside the process conditions and the working fluid, the optimal process flowsheet is essential, e.g., the optional usage of a heat exchanger for regeneration or steam bleeding in the turbine. However, the process flowsheet is commonly analysed only for a set of preselected working fluids. If the preselection fails, solutions will be suboptimal. To obtain overall optimal combinations of process conditions, working fluid and process flowsheet, the design of the process flowsheet has to be integrated into the process and working fluid design.

In this work, we present a method for the integrated design of ORC processes, working fluids and process flowsheets. The presented method is based on the 1-stage Continuous-Molecular Targeting – Computer-Aided Molecular Design method (1-stage CoMT-CAMD) [2]. In 1-stage CoMT-CAMD the PC-SAFT equation of state is used as physically-based thermodynamic model for both, equilibrium and transport properties. So far, 1-stage CoMT-CAMD was limited to the integrated thermo-economic design of process and working fluid based on the a priori definition of the process flowsheet. Here, we extend the method by a superstructure for the ORC flowsheet. Within the ORC superstructure, optional configurations for regeneration, reheating and turbine bleeding are considered. Thereby, the ORC process flowsheet can be directly considered as degree of freedom within 1-stage CoMT-CAMD using binary structural variables. For ease of use, the method is implemented in the process flowsheeting software gPROMS [3].

The resulting method is demonstrated for the design of a subcritical ORC for waste heat recovery. The integrated design is performed considering thermo-economic as well as thermodynamic objective functions. The result of the extended 1-stage CoMT-CAMD is an optimal combination of the ORC process conditions, working fluid and process flowsheet.

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