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ALGORITHMIC SYSTEM DESIGN OF THERMOFLUID SYSTEMS

Jonas Weber, Ulf Lorenz

University of Siegen, Germany
jonas.weber@uni-siegen.de, ulf.lorenz@uni-siegen.de

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Abstract: Technical components are usually well optimized regarding soft characteristics, such as energy efficiency or reliability. However, simply combining these optimized components in a technical system does not necessarily lead to optimal systems. Therefore, focusing on a system perspective reveals new potential for optimization. To make use of this potential, we investigate an algorithmic system design approach associated with the novel research area 'Technical Operations Research' (TOR). It is originated from engineering and developed in cooperation with mathematicians as a part of the German Research Foundation (DFG) founded Collaborative Research Center (CRC) 805 'Control of Uncertainties in Load-Carrying Structures in Mechanical Engineering'. TOR was developed to combine technical and mathematical know-how in order to design optimal systems given a defined objective, such as energy consumption or lifetime cost. These systems are not only designed to operate in one fixed scenario which is usually associated with the maximum load. Rather, a full load profile is taken into consideration. Following the insight of previous research results on fluid systems, we examine thermofluid systems which can be interpreted as a fluid system with superimposed heat transfer. The structure of such a system can be abstracted as a graph – more specifically, a flow network. We translate the underlying optimization problem into a mixed-integer linear program which is designed to obey the physical laws of thermofluid mechanics. Typically, fluid systems can be considered as quasi stationary systems since their dynamic effects are mostly negligible. However, for thermofluid systems this assumption does not hold because time-dependency is an issue as storage tanks for the heated fluid gain importance. In order to handle the dynamic effects induced by the storage tanks, we further introduce a continuous-time representation based on a global event-based formulation.