Chair of
Automatic Control

FAU

Student Job

Modeling and Control of Vapor Compression Cycles

Motivation

Vapor compression cycles (VCCs) are used in a variety of applications. Moreover, with the increasing relevance of more environmentally friendly refrigerants such as carbon dioxide (CO2), VCCs are often operated transcritically, see Figure 1. Particularly in the automotive sector, namely electric vehicles (EVs), efficient operation of VCCs for cooling or heating is essential, ideally saving driving range. Due to the intertwined thermodynamic state transitions of the refrigerant throughout the cycle and its fluid dynamics, VCCs are highly nonlinear systems. Additionally, the control challenges arising from this are further compounded by the numerous driving situations and environmental conditions to which VCCs are exposed in EV applications.

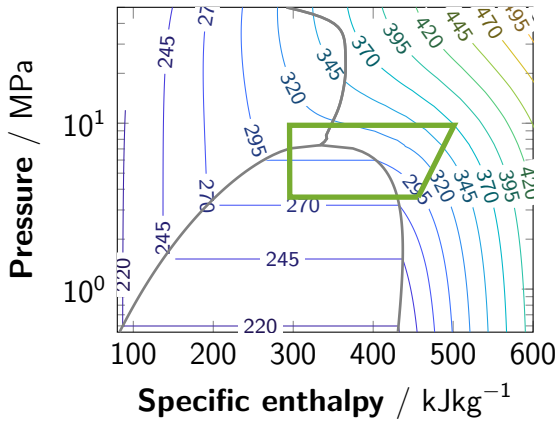

Figure 1: CO2 pressure-enthalpy plot with a transcritical VCC (green) based on [1].

Task Description

In this student job, a multiple-input-multiple-output (MIMO) state-space controller for a VCC will be investigated. First, a nonlinear state-space model of a VCC given in [1] will be implemented and parameterized in MATLAB. Second, the model will be linearized around a given operating point and a linearized state-space controller will be designed. Finally, the controller will be validated in Simscape.

Requirements

- Strong foundation in thermodynamics, particularly in VCC operation
- Strong foundation in nonlinear state-space modeling and MIMO controller design
- Intermediate skills in MATLAB and numerical simulation

References

[1] Bryan Rasmussen, Rajani Shah, A.B. Musser, A.G. Alleyne, C.W. Bullard, Pega Hrnjak, and N.R. Miller. Control-Oriented Modeling of Transcritical Vapor Compression Systems. January 2004.

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