MATLAB BASED ENGINEERING TOOL FOR EMBEDDED HEAT PUMP CONTROLLER DESIGN

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Matlab is unquestionably a powerful tool for model based advanced controller design. However, it still requires an expert to go through all required steps from model building to the final controller deployment to an embedded platform. We have been developing a Matlab based engineering tool that should not require expert knowledge and will guide an application engineer through thecomplete workflow of controller design for domestic heat pumps.

Domestic heat pumps transport heat from a low temperature reservoir (e.g. outdoor air) to a high temperature reservoir (e.g. hydronic heating water) by using electrical energy. Modern heat pumps have modulating components (compressor, fan, expansion valve, pump, etc.) and the controller objective is to coordinate them to maximize heat transport efficiency throughout the whole year under changing conditions and demands (seasonal efficiency). Our heat pump controller is based on a multivariable model based approach combining an off-line optimization and on-line Model Predictive Control (MPC). We are also addressing optimal defrosting of air evaporator by Kalman filter observer and price driven scheduling.

The controller design starts by constructing a heat pump topology from a library of Simulink components. The components are generic with tunable parameters that are in the next step calibrated by linking measurement points with experimental data. The Simulink scheme can then be used for dynamic simulations, steady state optimization on a grid of operating points, MPC design, observer calibration and finally controller deployment. The workflow is based on a Simulink scheme including special components and a Matlab based GUI. Notable features are: mixed-phase control oriented component models, single wire components interconnection, mixed-phase material libraries integration, unified Simulink real-time process connectivity based on shared memory and hardware specific proxy servers and simplified MPC and observer tuning by overall user preferences. The final controller is deployed to a custom hardware platform with wide universal connectivity.

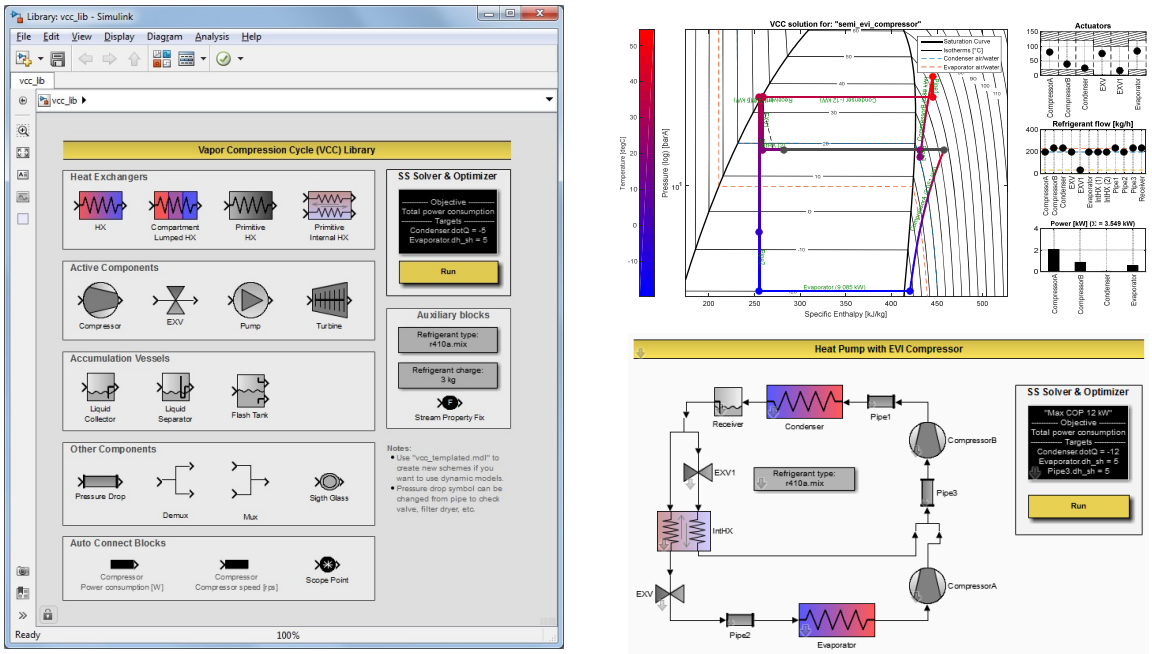

Figure 1: Simulink library for vapor compressor cycle (left), heat pump scheme constructed from Simulink components (bottom right) and an optimization result for a single operating point in the pressure-enthalpy diagram (top right).