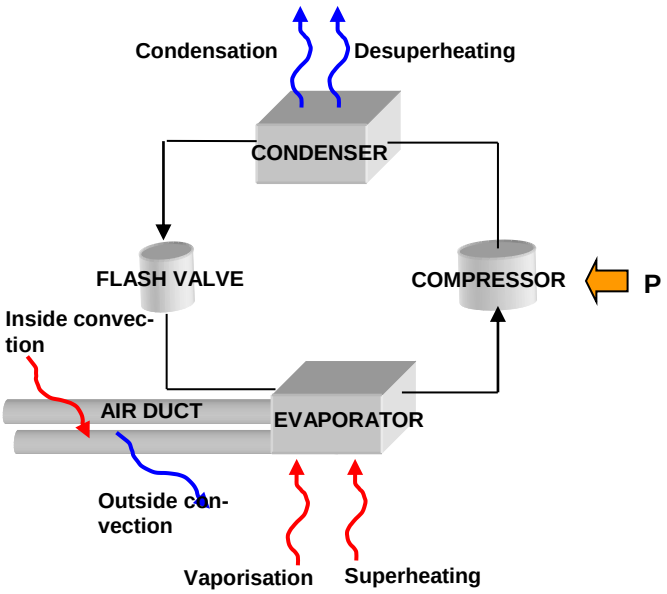
Systems & Advanced Technologies Engineering S.r.l.

MathWorks Partner

CONDIZ4HIL-RC

A SOFTWARE FOR THE REAL TIME SIMULATION OF AUTOMOTIVE HVAC REFRIGERATION CYCLES



OVERVIEW

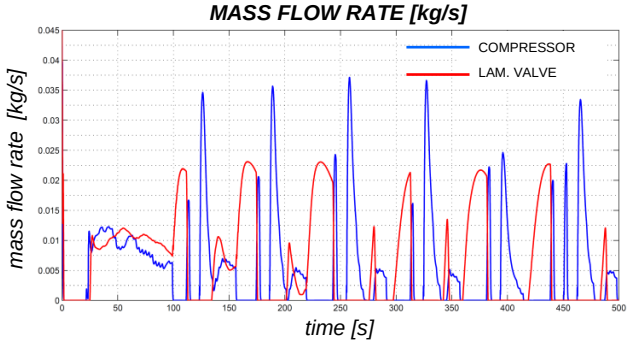
CONDIZ4HIL-RC is an application software, developed in the MATLAB/SIMULINK® environment, which simulates vehicles HVAC systems.
CONDIZ4HIL-RC is deployed as an S-function with supporting input assignment, preprocessing and plotting scripts and thermodynamic maps of the fluids of interest.
The S-function runs either offline as a standalone model or as part of a broader model, e.g. real time hardware in the loop (HIL) rapid prototyping systems based on a custom specific dSpace GmbH supporting platform.
The suffix RC version stands for "refrigeration cycle", i.e. the subsystem of the broader CONDIZ4HIL™ limited to the refrigerant fluid circuit, cycle and heat exchange with air, but not including the air circulation and passenger compartment thermal and fluid dynamics.
The results obtained can be plotted, saved and compared with experimental data as well as with other simulations by exploiting the powerful MATLAB environment.
In particular ***CONDIZ4HIL-RC*** simulates the thermodynamic behaviour of the whole process made up of the refrigeration system.

MODEL DESCRIPTION

The ***CONDIZ4HIL-RC*** model describes the subsystems and phenomena of the HVAC cycle (see the above figure), i.e. including:

1. Evaporator, as a metal mass with its own thermal capacitance. The liquid refrigerant may accumulate in the evaporator as a consequence of mass and energy dynamic balances.
2. Compressor, treated as:
   a. variable speed and variable displacement reciprocating machine,
   b. performing a polytropic compression with efficiency that can be function of revolution speed and compression ratio,
   c. considering the expansion of the clearance volume and consequent volumetric efficiency variation.
3. Condenser, as a metal mass with its own thermal capacitance, exchanging heat by convection with the external air. The liquid refrigerant may accumulate also in the condenser as a consequence of mass and energy dynamic balances;
4. The expansion valve treated as a variable throat orifice, taking into account the influence of compressible two-phase flow, flashing directly into the evaporator. This expansion valve is a thermostatic valve, with an opening characteristic defined as a look up table.

COMPRESSOR AND LAMINATION VALVE MASS FLOW RATE [kg/s]



The thermodynamic system behaves as an open loop subsystem, under the following exogenous inputs to the model, which, together with the model output, allow closing the vehicle HVAC control loop and completing the set of influencing quantities:

1. Control signals from the ECU controller, defining
   a. compressor speed and/or displacement (tilt of the stroke regulation plate),
   b. cut-off signals (AC-ON/OFF).
2. The external environmental conditions (pressure, temperature, humidity).
3. The air cycle interface conditions (flow rate, inlet pressure, temperature, humidity).

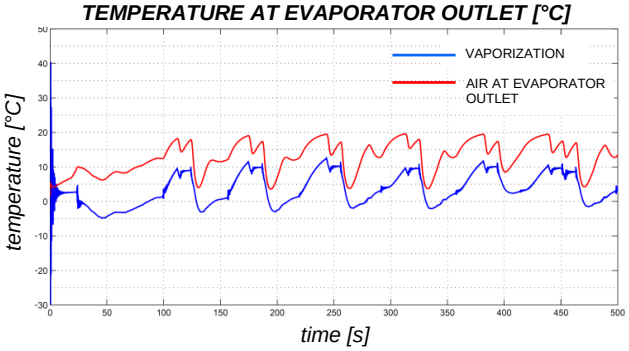
MODELS OPTIMIZATION AND TESTING

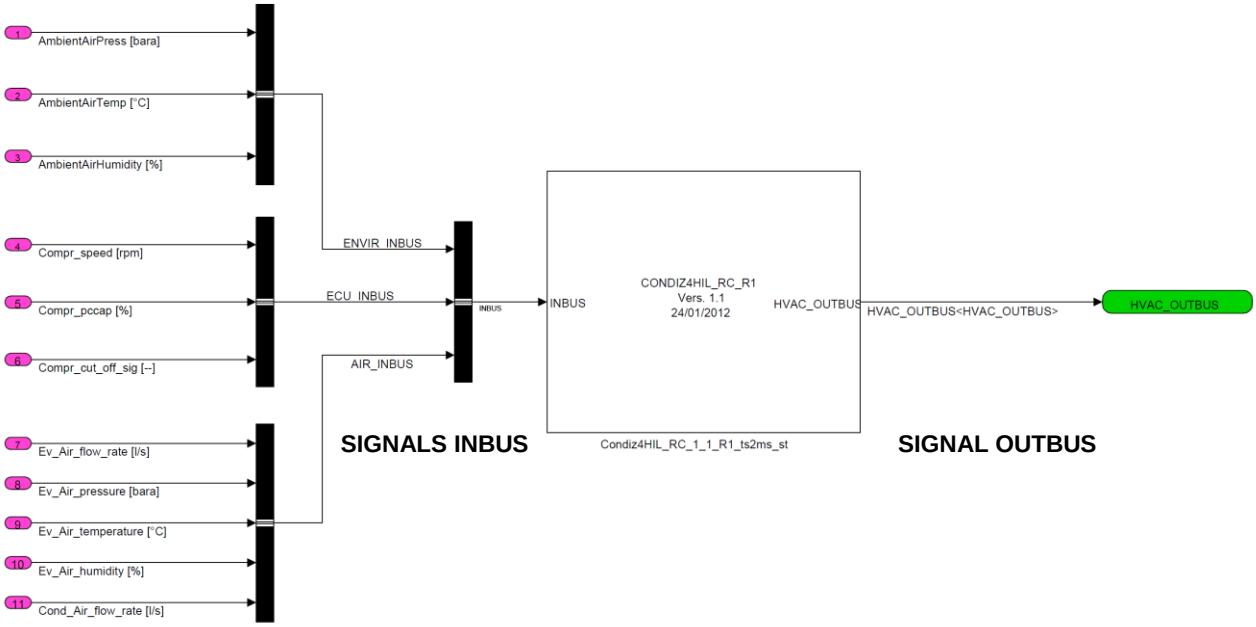
Since the models are developed in MATLAB®/Simulink® environment, the model can be deployed not only for the specific end platform, but also as Simulink® S-function module in order to perform:

- off-line parameters optimization;
- off-line testing;
- SIL (Software In-the-Loop) testing.

The flexibility of the model is guaranteed by a set of tunable parameters that can be easily optimized for the specific refrigeration cycle components by a few dedicated test sessions.
S.A.T.E. provides a specific service of tuning and optimization to find one or more sets of values for the tunable parameters of the models, corresponding to different refrigeration cycle components or refrigerant.

VAPORIZATION TEMPERATURE AND AIR TEMPERATURE AT EVAPORATOR OUTLET [°C]





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