FLECS - a research project in cooperation with the companies Airbus Deutschland GmbH and CeBeNetwork GmbH. Its task: to develop a library for the dynamical simulation of an Environmental Control System (ECS). This library should be built up in modular structure. In this way each component of the ECS is related to one model block. A very important role inside the simulation of ECS plays the description of a Air Cycle Machine. For the dynamical description of this system the dynamical behaviour of Heat Exchangers has to be investigated.

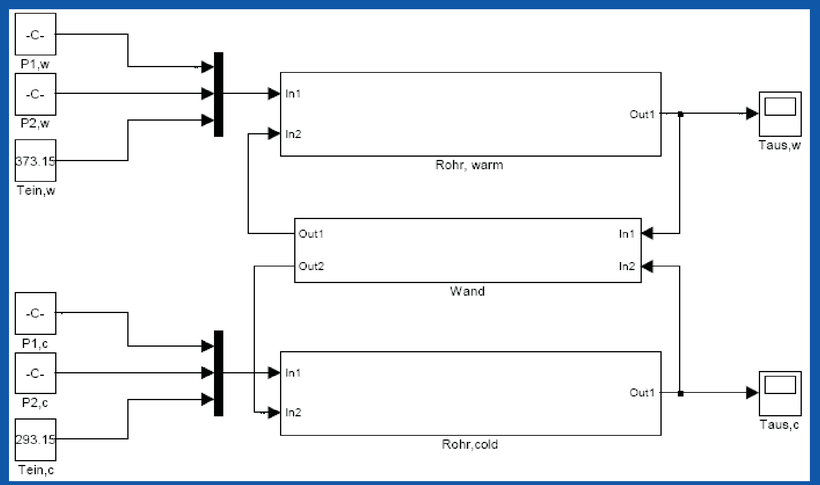

Figure 2: Block diagram of a Heat Exchanger consisting of two ducts and a wall

The program MATLAB/Simulink from the company MatWorks is used as platform to built up this dynamical database. In Fig. 2 the block diagram of a Heat Exchanger in a Simulink operator interface is shown. The Heat Exchanger consists of 2 ducts and a wall in between, which is treated as Heat Transfer Unit. The ducts themselves are related to flow properties and to volumetric properties. The solutions of the flow equations respectively the enthalpy equations define the inner structure of each component. In Fig. 3 the configuration of one of the ducts is shown.

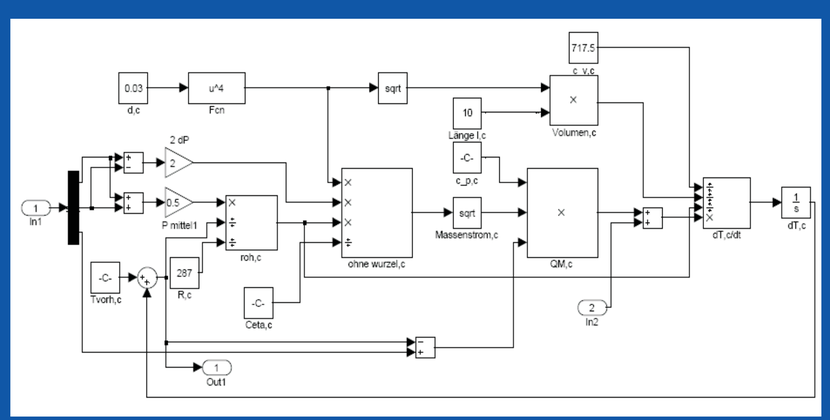

Figure 3: The configuration of a Heat exchanger duct in the program Simulink

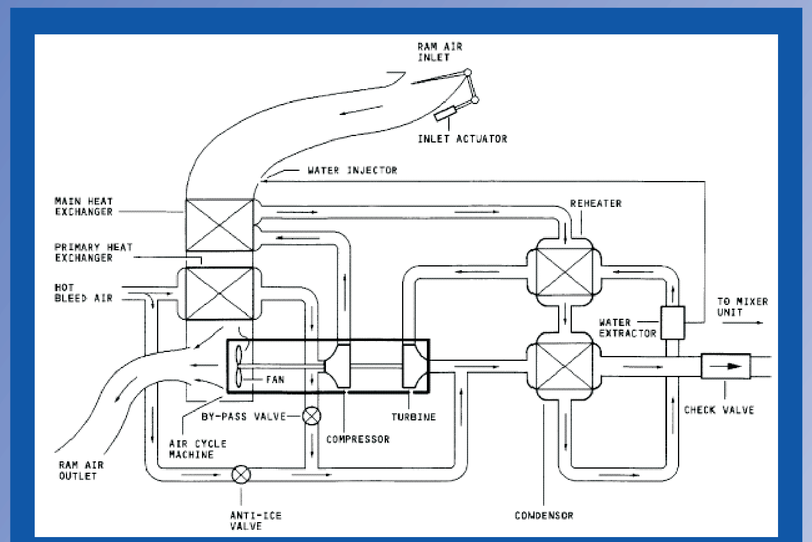

Figure 1: General design of an Air Cycle Machine

This modular assembly has the advantage that the setup of a Heat Exchanger can be changed and therefore the functionality is not limited to one special type. With help of this structure the Heat Exchanger can be embedded in a more comprehensive ECS database.

Fig. 4 shows the result of the dynamical simulation of a Heat Exchanger. Both ducts, subsequently called hot and cold side, are initialized at a temperature of 20 °C = 293.15 K. Hot air (T = 373.15 K) flows inside the hot side. A flow (T = 293.15 K) enters into the cold side. Over the wall a Heat Flux is transferred from the hot side to the cold side. Both sides start to heat up until an equilibrium temperature is reached. This equilibrium temperature is correlated to the chosen mass flow (m_{dot} = 1.4 kg/s) through the Heat Exchanger and the possible heat transfer rate through the wall.

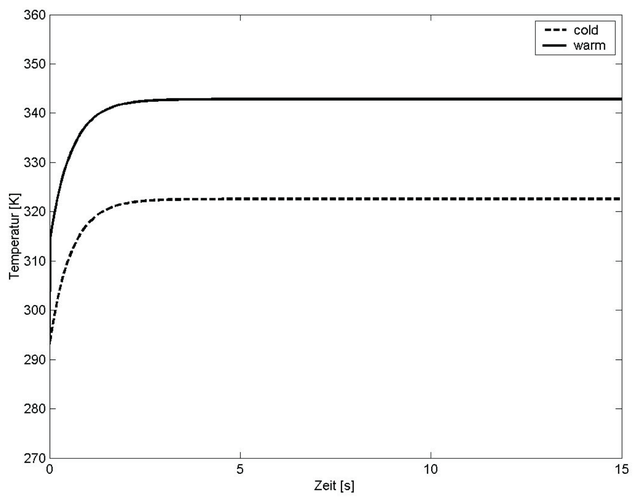

Figure 4: The temperature characteristic inside the ducts of the Heat Exchanger

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Simulation of Heat Exchangers with Simulink

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