Universität Stuttgart
Institut für Kernenergetik
und Energiesysteme

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Masterthesis

Design improvement of the inlet plenum for a plate-fin heat exchanger to optimise the inflow characteristics of CO_2 close to the critical point

Objective:

The main objective is to optimise the inlet and outlet plenums of the heat exchanger in order to achieve a uniform flow distribution into the channels and to minimise pressure losses, considering the working fluid CO_2 in subcritical and supercritical state.

Background:

Since the accidents in the boiling water reactors in Fukushima Dia-ichi, the removal of decay heat became a main part of the reactor safety research. For this reason, a new concept has been developed over the last years for decay heat removal. This concept is a sCO_2-operated decay heat removal system based on a Brayton cycle.
The sCO_2-4-NPP project, intends to bring this heat removal system closer to the market. The system mainly consists of a heat exchanger at the heat source, a turbo-compressor system and a heat exchanger at the ultimate heat sink (ambient air). Since the system is a self-sufficient thermodynamic cycle that starts automatically with supplied heat the minimisation of pressure drop for each cycle component plays an important role. The company FIVES Cryo developed plate-fin heat exchangers with supercritical CO_2 as a working fluid for the heat sink. To ensure maximum use of the heat transfer surface of the heat exchanger, a uniform flow distribution through the channels is required. By optimising the plenum geometry, the flow distribution in the channels should be improved while minimising pressure drop. Since the CO_2 can occur in both subcritical and supercritical states within the heat exchanger, the simulations should take both states into account.

Approach:

- Familiarisation with plena design and non-uniform flow distribution in heat exchangers.
- Compilation of potential inlet plenum geometries.
- Simulation of the flow in the inlet plenum and analysis of the flow distribution.
- Optimisation of plena designs and comparison.
- Elaboration and presentation of the results.

Conditions:

- Ability to work independently and self-motivation.
- Interest in supercritical fluids and numerical simulations .
- Good English reading and writing / good German speaking skills.

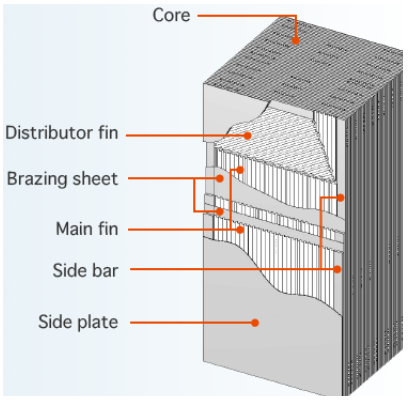

Figure: Plate-fin heat exchanger
Source: FIVES Cryo

Start: Immediately

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Status 02.11.2021