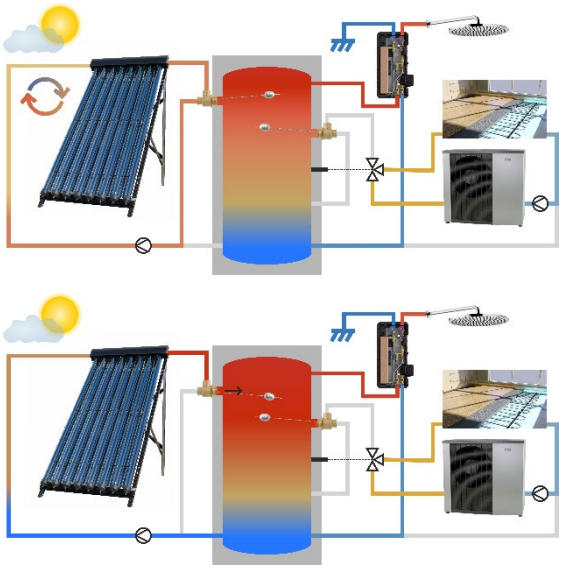
Model and experimental study of heat transfer in vacuum tube heat pipe collectors

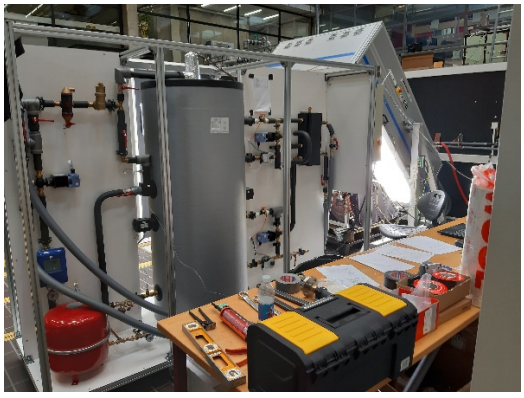
Introduction:

The Conico Direct Multi-Pass Solar System, developed by Conico Valves bv in Veldhoven, is a unique solar system that achieves increased efficiency in vacuum tube heat pipe solar collectors, by maximizing the heat transfer in the manifold of the collector. The system uses multiple collector passes (by means of the proprietary Thermo-Differential Valve technology) to achieve the desired temperature, so a high flow rate can be used for improved heat transfer, and uses



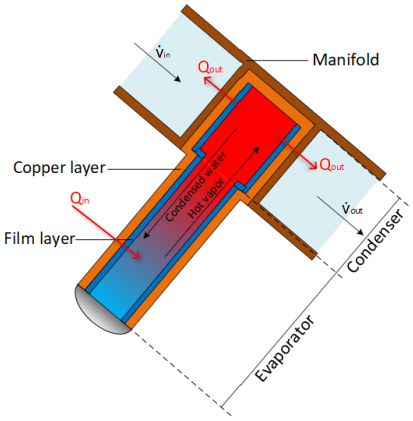
water instead of glycol-mixture, to further improve heat transfer.

Previous MSc-thesis research at TU/e has investigated the influence of the flow rate and the multi-pass operation on the efficiency of the collector (using the experimental set-up pictured below), and found a very significant positive dependency.



To further develop the understanding of the heat transfer mechanisms at play, and to understand the influence of other design factors of the collector and the solar system on the efficiency, further research with the experimental set-up and the solar simulator is required, as well as some modelling work.

The vacuum tube collector heat pipe collectors used in the Conico Multi-Pass Solar System use vacuum tubes of the 'Sydney' type, which means the glass tube is double-walled, with vacuum between the walls (like a thermos-bottle). The absorber layer is present on the inside glass wall, and an aluminium fin is used to transfer heat from the glass wall to evaporator side of a copper heat pipe. The condenser side of the copper heat pipe sits in a manifold using a dry connection.



Liquid flows through the inside of the manifold to transfer heat from the manifold to the storage tank, and the heat transfer inside the manifold is a critical factor, as well as the operation of the heat pipe during the highly transient multi-pass operation.

Project description:

The goal of the project is to shed further light on the heat transfer in the collector during multi-pass operation, by means of experimental study, and to help find the optimal operating parameters for the DMP solar system. Furthermore, the goal is to successfully translate the operation of the DMP solar system to a computer model environment, so the annual performance can be modelled, which can be used to further optimise the system, and to compare performance to conventional systems.

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