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Topic	Environmental Engineering
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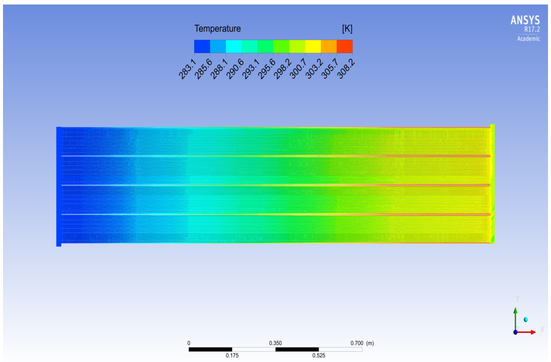
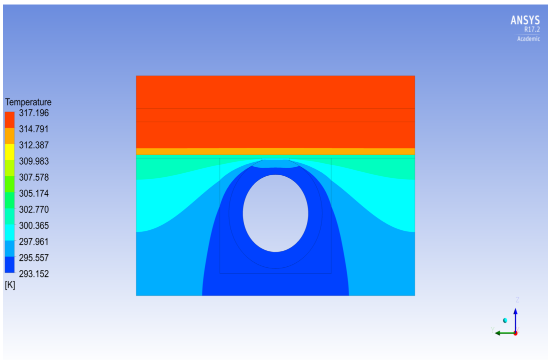
CFD Simulation of PVT Hybrid Collectors

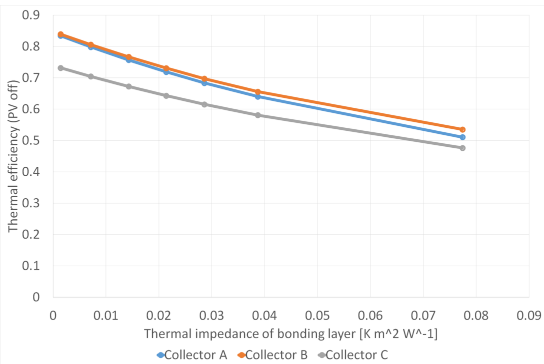
Simulation and analysis of a cooling system for optimal and flexible utilization of PV/T



Water temperature contour normal to PVT plane of collector B



Cross section temperature contour of collector C



Influence of bonding layer thermal impedance on thermal collector efficiency

Problem: The performance of PVT hybrid systems depends on many variables. They include dimensions of the components, cooling channel layout, thermal material properties like thermal conductivity and heat capacity, optical material properties like transmissivity and extinction coefficient, arrangement of the PV cells and environmental conditions like ambient temperature, wind conditions and irradiance. The number of variables that change locally and over time combined with the fact that the whole collector is large compared to the required resolution to get the flow characteristics right, means meaningful assumptions have to be made in order to get results in an acceptable timeframe.

Proceeding: Based on the literal study of the topic, empirical models were chosen to account for the environmental conditions of the PVT collector. These are models that are commonly used in the solar thermal industry and are capable of modelling the important physical phenomena around the collector. The empirical models are integrated into CFD simulations that calculate internal heat transfer processes and the flow of the cooling liquid. The impact of the different variables is studied by simulating the cross sections of the cooling channels with different configurations. The flow caracteristics and pressure levels are studied by simulating the complete water domain. The simulations are validated by comparison with the results of field experiments.

Result: Three default collector designs and possible design changes for each of them were analysed, two of those default designs exist as field experiments. The results agree with the field experiments and can therefore provide predictions on the benefit of possible design changes. The most crucial parameter determining performance for the existing default designs turned out to be the thermal resistance of the bonding layer that connects the PV cell on top to the heat absorber below. Varying the bonding resistance between the resistance of a perfectly applied EVA layer and the resistance of a 2mm air gap demonstrates this.