ABSTRACT

The present experimental and theoretical investigations are aimed to the analysis of the thermal and physical performance in the cooling water and condensation side of thermoplate.

For the experimental investigations two apparatuses were developed. At one of these plants the single phase cooling fluid heat transfer and pressure drop were examined, while at the other one the experiments were made for condensation

In the cooling water side experiments, thermoplate with commercial geometry is heated by DC power supply unit. The dissipated electric energy at the plate is taken up as thermal energy from the attempt fluid. As the attempt Fluid pure Water and Malrotherm oil were used. For the determination of the heat transfer coefficient first a plate temperature as function of the electrical plate resistance was measured. With this function the heat transfer coefficients can be determined at different mass flow rates and different temperatures of the Medium. The results from the measuring data, correlations for the heat transfer and pressure drop were set up. The measurements were carried out, showing that the welded joints affect particularly the heat transfer over the zone of flow in a complex way, so that in this case no analogy to the transport process exists with flow in flat channels (equidistant even plates) or pipes.

The experimental investigation in condensation side is aimed to the analysis of the heat transfer and pressure drop of condensing Isopropanol and water in thermoplate apparatus at low pressure range. In the experiment two vertical thermoplate channels are formed in the exchanger by three plates of commercial geometry. Downflow of the condensing Isopropanol at the wall channels release heat to the upflow of cold water inside the thermoplate. The effects of the vapour celerity, the degree of condensation, inert gas concentration, the temperature gradient and the system pressure are explored in detail. Finally, an empirical correlation for the Isopropanol condensation heat transfer and frictional factor in thermoplate is proposed. The both correlations consider the shear stress at the surface of the condensate film, the surface tension and the suction of condensing vapour. These correlations can show the experimental results with deviation smaller than $\pm 10\,\%$.

As the results show, the thermal and physical performance of the examined thermal plate deviates clearly with the condensation from the performance of conventional channels with even walls. Within the range of small Reynolds number (Re < 70) 40% higher heat transfer coefficients in the comparison to the condensation in vertical pipes are resulted. The structure of the cooling surface, the dimensions of the flow channels and the process parameters (flow rate, temperature, material properties and composition of mixture) affect the thermal performance of the thermoplates in a complex way, so that various possibilities are offered for an efficient design of the thermoplate-condenser.

The developed model offers the possibility, optimisation and a better design of thermoplates in practice. According to this model the Film-roughness and Film-thickness, the pressure drop and the heat transfer coefficient can be determined.