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NUMERICAL MODELLING AND IR THERMOGRAPHY MEASUREMENTS IN THE HEAT TRANSFER ASSESMENT OF THE SOLAR COLLECTOR

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ABSTRACT

In a plate type of solar collector having tube banks attached to the absorber plate the collector efficiency (Eq.1) is directly dependent on the heat losses from the absorber plate to surrounding as well as on a goodness of the absorber plate cooling by working media. Convective and radiate heat losses, for a given glazing and its distance from the absorber plate, are lower when the absorber temperature is kept lower as a consequence of a more efficient heat transfer between the working media passing in tubes attached to the absorber. Therefore, it is a crucial task to ensure a good contact between the tubes and absorber plate. In practice that is normally done by applying different types of welding or, alternatively, by special gluing procedures.
The geometry of the contact area can be preliminary evaluated by means of a numerical computation of the heat transfer from the heated absorber to the fluid passing throughout tubes. Such numerical model is developed in the both 2D and 3D domain and provided here together with the results concerning the influence of different geometries, flow conditions and number of the contacts. The resulting efficiency obtained is compared with the performed measurements on the simulated solar collector. The comparison indicates fairly good agreement (within 4%) between the computed and test results (Fig.1).
The additional method for inspection of the absorber plate cooling efficiency is based on use of IR camera for recording a temperature

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field profile over the absorber plate. The recorded IR images (Fig.2) clearly indicate places of the improperly performed contact between tubes and plate as well as inefficiently cooled absorber plate areas due to the position and geometry of the tube bank. The recorded temperature field is compared against the numerically obtained one for the case without glazing.

The overall collector efficiency is defined as

$$\eta = \frac{\phi_k}{\phi_s} = \frac{\phi_k}{E_{sun} * A_k} \tag{1}$$

where ϕ_k is collected energy by collector, ϕ_s is total irradiated solar energy E_{sun} over the used absorber surface area A_k.

Fig.1 Comparison with numerically obtained results with measured values

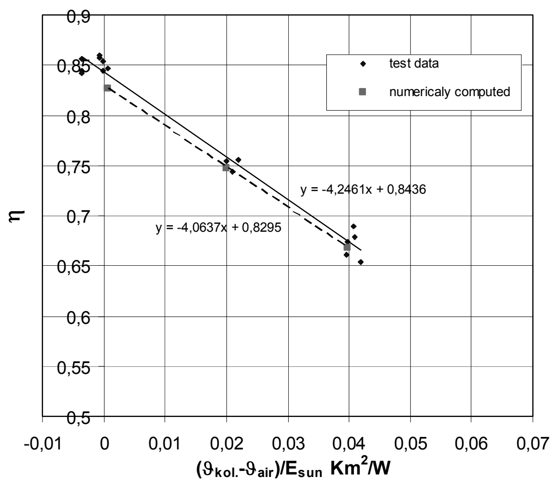

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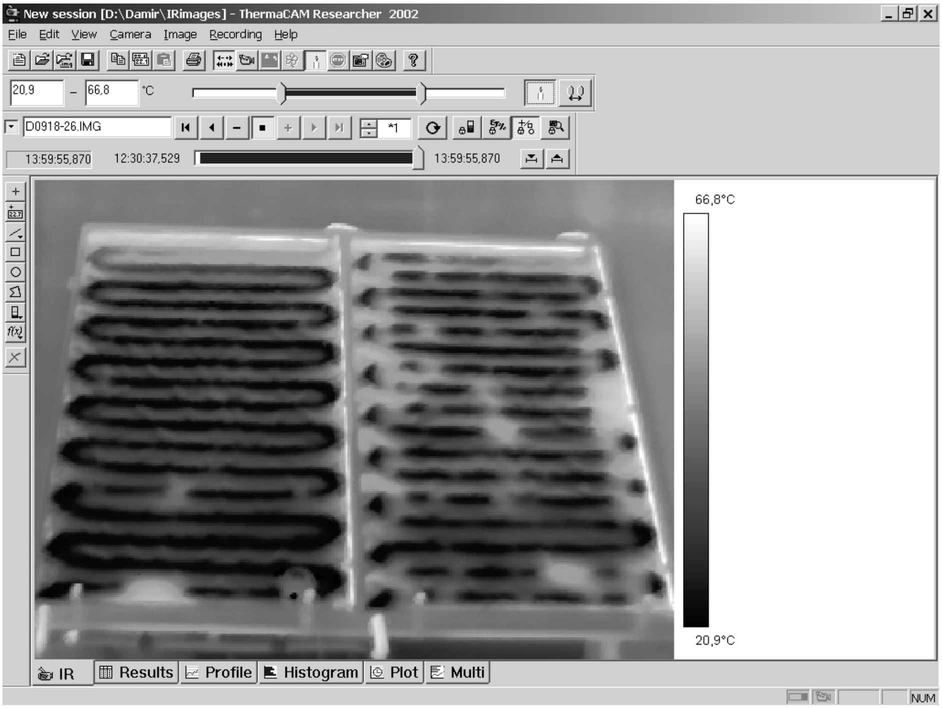
Fig 2. Infrared image of tested collectors working as evaporators within the heat pump running with R134a.



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