Overheating protection

INFO Sheet B4

Description:	*Summary of approaches to reduce critical thermal loads on collector components to enable the usage of cost-effective polymeric materials*
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Introduction

In order to enable the usage of cost-effective polymeric materials in flat-plate collectors, approaches to control and reduce the maximum absorber temperature are necessary.

Principles for Overheating Protection Measures

Overheating protection measures are characterized by changing the collector performance when critical thermal loads occur. There are two basic approaches that need to be differentiated: the reduction of the optical efficiency and the increase of the thermal energy losses.

A reduction of the optical efficiency can be either achieved by transmitting less solar radiation through the front side or alternatively by a lower heat conversion at the absorber surface. Therefore, these measures change the effective transmission-absorption product. Figure 1 shows the potential mechanisms that can reduce the optical efficiency of a collector.

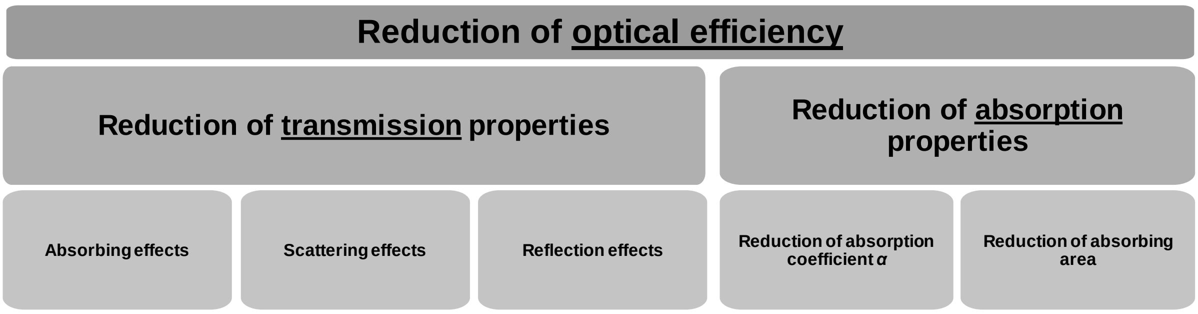

Figure 1: Overview of mechanisms reducing the optical efficiency (according to Reiter et al. 2012)

In addition to these measures, the removal of excess thermal energy is a further option, which could be realized either by increased thermal losses of the solar collector or by active cooling. Figure 2 shows the various modes of removal of thermal energy which can be applied in the collector or in the solar-thermal system.

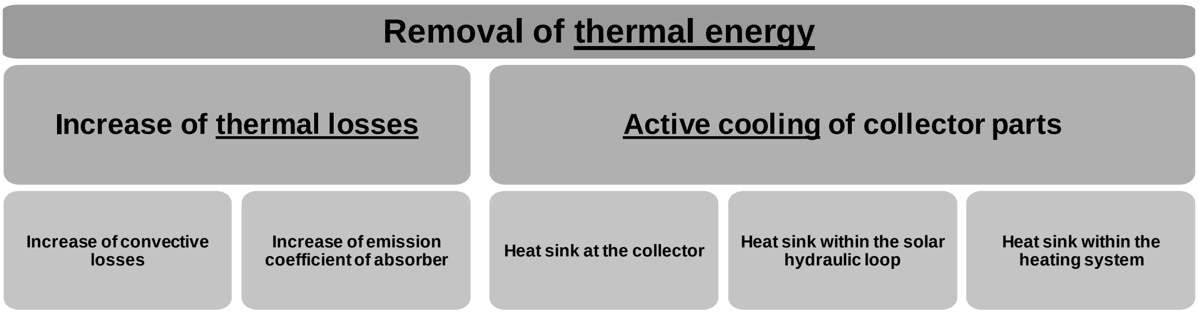

Figure 2: Overview of mechanisms and solutions for the removal of excess thermal energy (according to Reiter et al. 2012)

Adjustment of the Collector Efficiency

Beside active or passive measures to control the performance of the collector and the component temperatures, lowering the collector efficiency provides relevant potential for overheating protection. The efficiency reduction by increased losses can be divided into two effects. On the one hand, there are constant losses caused by the transmission properties of the glazing and the absorption properties of the absorber. On the other hand, there are temperature dependent thermal losses caused by convection, conduction and radiation.

In order to adjust the efficiency, the collector performance is to be reduced with regard to the overall system yield. During system operation, the efficiency of such a collector must therefore be close to a conventional collector and should strongly decrease at higher collector temperatures.

As a second aspect for the efficiency adjustment, the collector manufacturing costs also need be taken into consideration. The collector cost reduction has to compensate the efficiency reduction because of the lowered solar yield of the polymeric system, when competing with metal based collectors. Therefore efficiency reduction should preferably be realized by omitting manufacturing steps or by saving material. The most effective approach is using a black pigmented absorber material instead of a selective absorber coating. The second possibility to simplify the manufacturing process is to leave the insulation out. Besides that, innovative casing designs made of polymeric foam — combining standard casing and insulation functions — are very promising.

References

Reiter, C. and Trinkl, C. and Zörner, W. (2012) Thermal Loads on Solar Collectors and Options for their Reduction. In: KOEHL, M. et al. (eds.) *Polymeric Materials for Solar Thermal Applications*. 1st ed. Weinheim (GER): Wiley-VCH Verlag GmbH & Co. KGaA.