Performance requirements (thermal stress)

INFO Sheet B2

Description:	*Thermal stress in polymeric solar thermal collectors*
Date:	May 2015
Authors:	T. Ramschak, D. Preiß / AEE INTEC, Gleisdorf, Austria
Download at:	http://task39.iea-shc.org/publications

Introduction

Solar thermal systems that reach the stagnation state will overheat, resulting in high temperature and pressure loads for the collector and the surrounding components. Depending on how well these loads can be limited without reducing the efficiency in normal operation, determines whether high performance polymers or low-cost engineering or commodity plastics can be used.

Thermal stress in solar thermal collectors with and without overheating protection

In the case of collectors based on polymeric materials with overheating protection (OHP), the thermal loads will be reduced by a controlled increase of the heat- or optical losses by either backcooling (see B5), ventilation (see B7), thermotropic switching (see B6) or in the case of thermosiphon systems by hydraulic circuits that are open to the atmosphere (see B8). All these methods should keep the collector temperature below the critical temperature of about 95 °C (max. 100 °C) during stagnation. In the other case a drain-back system provides for the automatic emptying of the collector and piping when the system is turned off. The circulation pump shuts itself down and the water drains by gravity to the drain-back tank which can be open to the atmosphere. By means of such drain-back systems collector overheating can´t be avoided but the correlated pressure loads are reduced or waived entirely. The pressure progression can be looked up in the accompanying INFO Sheet B3: "Pressure stress".

Figure 1 depicts the simulated mean absorber temperature frequency of the reference systems and solar thermal systems based on polymeric materials with OHP (backcooling) and without OHP (drain-back) for a single-family house in Central Europe by varying applications. In the reference system the maximum achieved temperatures during stagnation reaches 195 °C. The temperature in the drain-back systems reached a maximum level of 165 °C due to the nonselective coated polymeric absorber. The systems with an active OHP are limited to 90 °C. Figure 2 represents a cross-section of the mean absorber temperature frequency per year through the simulated polymeric systems with and without OHP for different applications and systems concepts in various locations. The lower limits of the temperature profiles are mainly determined by climate conditions, whereas the upper limits additionally depend on the collector properties and concepts as well as on the heat demand. The maximum temperature in thermosiphon systems is limited to system design and due to the fact of an inherent mains water supply and of course the user behavior (hot water tap profiles).

The performance requirements (thermal-pressure stress) for the reference and polymeric systems are summarized and displayed in a convenient matrix format in the INFO Sheet B3: "Pressure stress".

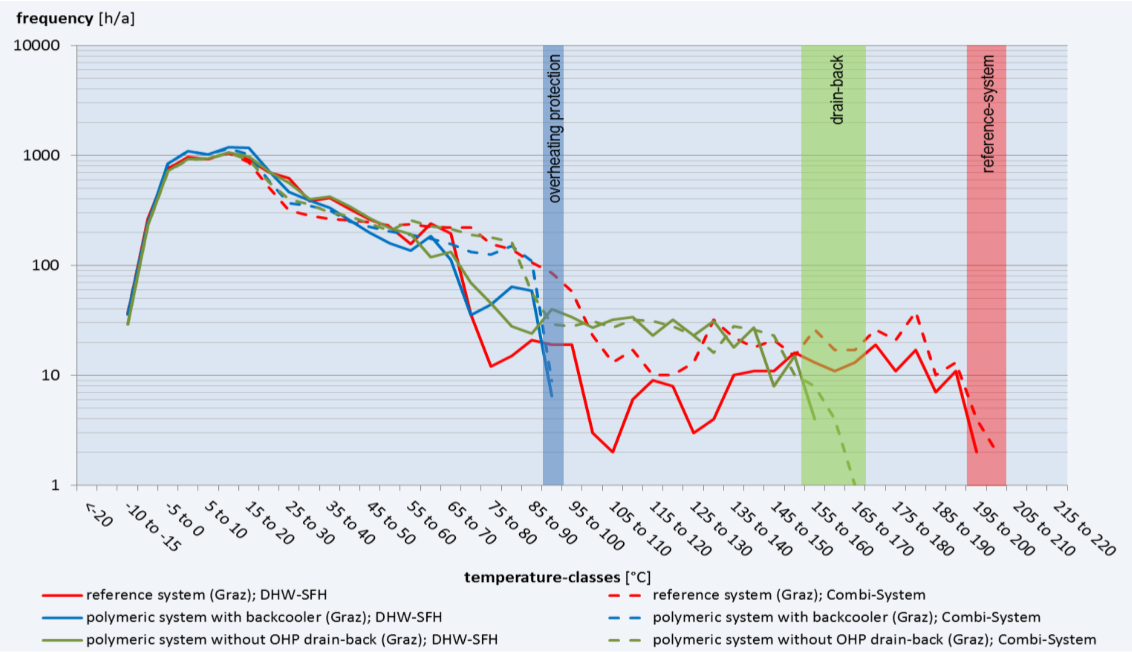

Figure 1: Frequency (log scale) of the mean absorber temperatures of polymeric collectors with OHP (backcooler; blue), without OHP(drain-back; green), and the reference collector (red) in varying applications (domestic hot water; combi systems) for single family houses in Central Europe (Graz, Austria)

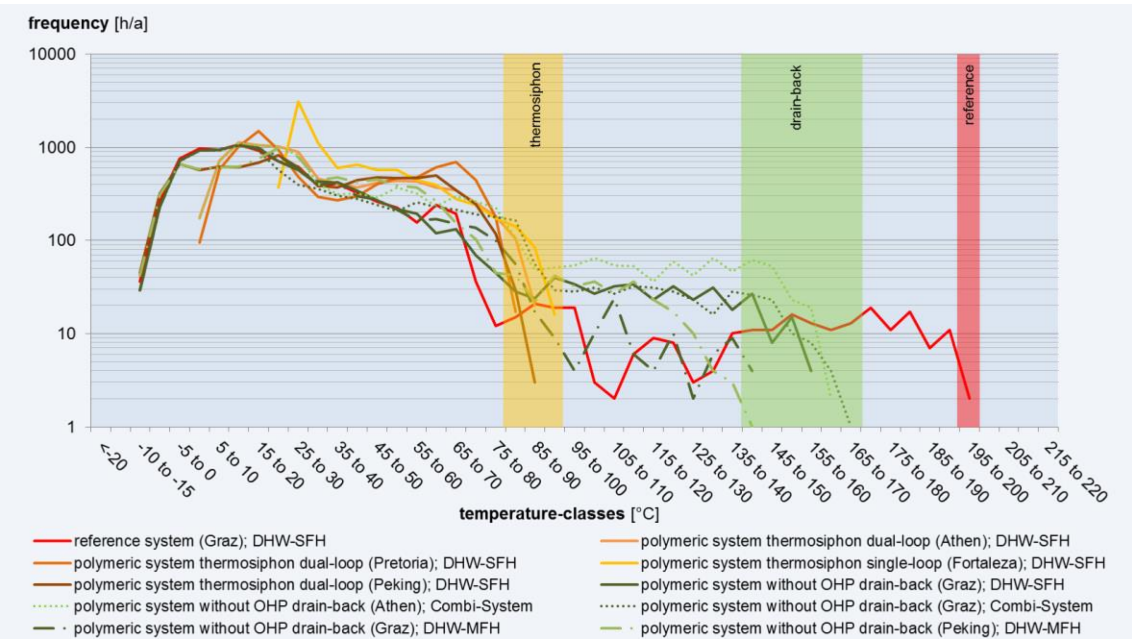

Figure 2: Frequency (log scale) of the mean absorber temperatures of polymeric collectors with OHP (thermosiphon; yellow), without OHP (drain-back; green), and the reference collector (red) in varying climate zones and applications (domestic hot water; combi-systems) for single- and multifamily houses.

References

Kaiser A., Hausner R., Ramschak T., Streicher W. (2013) Leistungsanforderungen an Polymermaterialien in solarthermischen Systemen, EE-Zeitschrift für eine nachhaltige Energiezukunft 2013-1:12-16, Gleisdorf, Austria