All polymeric thermosiphon system

INFO Sheet B8

Description:	*Low cost simple design thermosiphon concepts based on polymer structured sheets have been patented and developed. One concept is presented.*
Date:	May 2015
Authors:	John Rekstad, Michaela Meir, Aventa AS, Norway
Download at:	http://task39.iea-shc.org/publications

Introduction

The challenge to develop a thermosiphon system (TSS) based on polymeric materials was background of the EU FP7 research project SCOOP. A patent related to two TSS designs based on extruded, structured polymeric sheets was submitted for evaluation [1]. The present INFO Sheet deals with the Aventa TSS-concept only. The second was presented in Piekarczyk et al., 2014 [3]. Major advantages using polymeric materials are: low material costs, advanced processing techniques allowing mass production and low manufacturing costs, low weight, easier handling, transport and installation.

Twin-wall sheet absorber

The TSS is based on the use of extruded twin wall sheets from the commodity plastic Polypropylene (PP) as absorber material. The channel structure in extruded twin wall sheets gives an opportunity to design a flow circuit with a minimum of flow resistance where a quite moderate "driving pressure" due to temperature gradients in a hydraulic system, can provide a significant volume flow. Consequently, fair system efficiency can in principle be achieved in spite of the poor heat conductivity of the polymeric material.

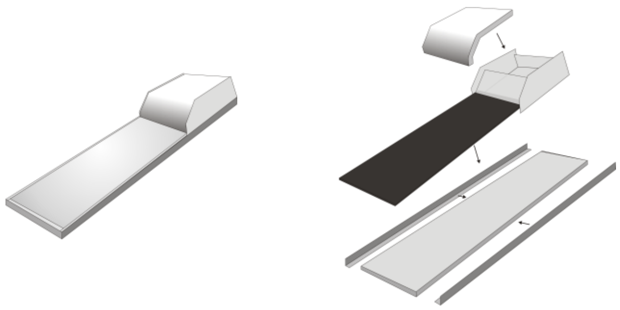

Figure 1: Illustration of the AventaSolar TSS. The flat design with integrated storage (left) consist of polycarbonate glazing, a twin-wall sheet absorber, rear and storage tank insulation and framing for façade or roof mounting (right).

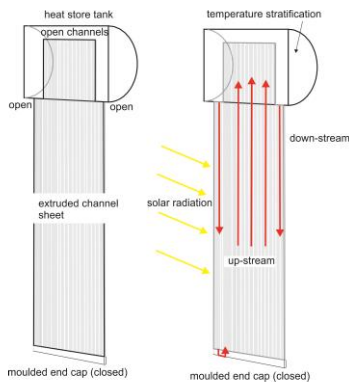

Figure 2: Functional design of the AventaSolar TSS

Hydraulic design of the thermosiphon system

Figure 1 shows the principal design of the thermosiphon system. The basic components are an extruded twin-wall sheet, a storage tank of about 60L welded to the top end of the sheet and an endcap to the bottom end of the sheet. The collector area is approximately 1m². The circulation of the heat carrier fluid develops within the same twin wall sheet. Cold water flows down in the outer channels terminated at the bottom of the storage tank and rises –heated by solar irradiation - in the central channels ending close to the top of the storage tank (Figure 2). This is a key design for developing a well-defined hydraulic circulation, where stratification inside the storage tank initiates the water circulation. An important aspect is how this design functions during night-time: The absorber sheet cools down and both channel groups are exposed to the same cooling effect due to radiation and convection. This prohibits inverse circulation and tapping of heat from the storage tank. Since a thermosiphon system is permanently filled with water, overheating and boiling can be a challenge. Low pressure is preferable for a thermosiphon system of polymeric materials, which means that the boiling temperature in the system is close to 100°C. To limit the system temperature below this threshold is a necessity, but this requirement opens at the same time for using commoditive polymeric materials, which are less expensive than high temperature performance polymers. Hence, the overheating protection is a crucial part of the design.

Preparation of domestic hot water

The domestic water can in principle be heated in two ways: 1) to use the water in the thermosiphon storage tank directly as domestic water (direct system) and 2) to insert a tank heat exchanger into the system water of the TSS heat store (indirect system). The heat exchanger sustains the pressure of the domestic water grid, while the pressure inside the heat store is equal the atmospheric pressure. One aspect for the choice is the stationary heat transfer during continuous tapping of domestic hot water; another aspect is the stored volume of heated water contained in the heat exchanger.

Installation and integration - Advantages

Several basic installation modes are targeted with the present design: For roof or façade integration with the storage tank on the back side of the system, a roof top or free standing installation with the storage tank on the top side or behind of the absorber surface as illustrated in Figure 3.

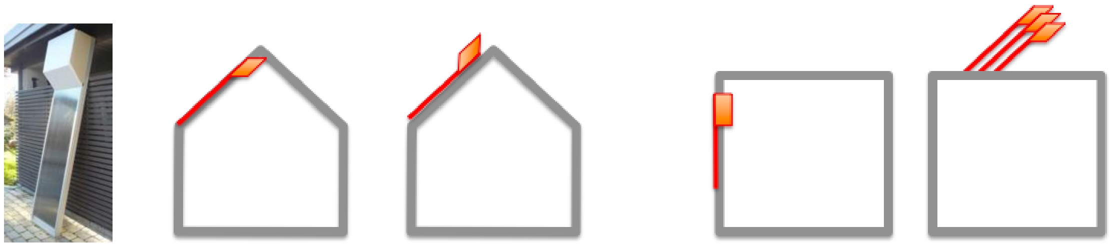

Figure 3: Different installation and integration options for the AventaSolar TSS concept.

References

[1] Köhl M., Rekstad J, Piekarczyk A. and Meir M., Extruded Thermosiphon-Solar-Thermal-System, Deutsche Patentanmeldung, Sept, 2013.
[2] EU FP7 Project SCOOP; website: http://www.eu-scoop.org
[3] Piekarczyk A. et al., 2014. Development of Fully Polymeric thermosiphon systems based on extruded commodity plastic sheets. Gleisdorf Solar 2014, Gleisdorf, Austria.