Evaluation of thermosiphon systems by adopting a total cost accounting approach

INFO Sheet A4

Description:	• *The pros and cons of replacing traditional materials with polymeric materials in solar thermosiphon systems are analyzed by adopting a total cost accounting approach.* • *In terms of climatic and environmental performance, polymeric materials reveal lower environmental impacts than traditional ones like metals. In terms of total costs this may also be true but more work is needed to answer this question properly.*
Date:	May 2015
Authors:	Bo Carlsson, Linnaeus University; Michaela Meir, John Rekstad, Aventa AS; Andreas Piekarczyk and Regine Weiß, Fhg ISE; Dieter Preiß, AEE-INTEC
Download at:	http://task39.iea-shc.org/publications

Introduction

To assess the suitability of polymer based solar thermosiphon systems three polymeric systems under development have been selected and compared with thermosiphon systems in which traditional materials like metals were used. For the comparison, a total cost accounting approach is adopted, which involves the analysis of differences in thermal performance, end-user investment costs, operation and maintenance (O&M) costs, reliability and long-term performance, climatic and environmental performance in relation to the costs of the polymeric systems versus those of the traditional ones.

All thermosiphon systems are analyzed on the assumption that they are installed in Palermo, Italy. All systems have a hot water tank of 120 liters which corresponds to the daily hot water load for a typical one-family house in that region. The solar absorber area for all systems is approximately 2m^2. But by making use of computer simulation, the solar absorber area for each system is adjusted so that all systems yield the same solar fraction with respect to hot water production.

Life cycle analysis

Assessment of climatic and environmental performance in relation to costs is made by life cycle analysis. To convert an environmental or a climatic impact indicator into costs, the same methodology as in a previous Task 39 case study [1] is employed.

For the life cycle analysis, process trees with inventory data from the Ecoinvent data base [2], representative for Europe, are used; see for example [3]. End-of-life scenarios including both recycling and no recycling are considered.

The life cycle analysis results clearly indicate that a replacement of traditional materials, for example metals, with polymeric materials increases the climatic and environmental performance significantly, when they are expressed in terms of the IPCC 100 (Intergovernmental Panel on Climate Change) as indicator and the Ecoindicator 99, H/A indicator (Hierarchist/Average) [4, 6]. In terms of climatic and environmental costs per amount of solar heat collected, this difference, however, is not that significant. When present day carbon dioxide emission tax rates are used to convert climatic performance into climatic costs and a comparison is made with an equivalent heating system with natural gas boiler, the climatic cost per solar heat collected is just 6% of the equivalent heating system. [1].

End-user investment costs, O&M costs, long-term performance and expected service life of systems

In estimating future end-user investment costs and O&M costs for the systems studied, models and results from the ongoing EU project SCOOP [5] were consulted. If the yearly O&M costs may be set at 1% and the expected lifetime of the solar thermosiphon systems at 15 years, we expect the sum of end-user investment costs and operation and maintenance costs for the polymeric based thermosiphon systems to be less than 290€/m^2 solar collector area or 400€/kWth. From the analysis made on the polymeric based solar thermosiphon systems so far this seems to be competitive with traditional systems and a realistic goal to achieve.

References

[1]*"A total cost perspective on use of polymeric materials in solar collectors – Importance of environmental performance on suitability";* Bo Carlsson, Helena Persson, Michaela Meir, John Rekstad; Applied Energy 125 (2014) 10–20

[2] http://www.ecoinvent.org/

[3]*"Life Cycle Analysis von Polymermaterialien für neue Produktionsverfahren von thermischen Solarkollektoren";* Masterarbeit von Regine Weiß, Universität Ulm, 2014

[4] ILCD Handbook, Analysis of existing Environmental Impact Assessment methodologies for use in Life Cycle Assessment, First edition, European Commission Joint Research Centre Institute, 2010.

[5] SCOOP website: http://eu-scoop.org

[6] M. Thompson, R. J. Ellis, A.B. Wildavsky, Use of the Hierarchist view of the Cultural Theory and the use of an average weighting system , "Cultural Theory – Political cultures" Boulder 1990.