

Freeze resistance test of heat pipe evacuated tube collectors; *now a question of the heat transfer fluid used !*

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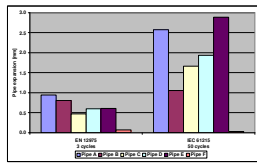
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After the extremely cold winter 2009/2010 massive frost damage to a larger evacuated tube collector field was reported in Bavaria. Examinations by the proprietor on site showed that a large number of collector heat pipes had burst as a result of the frost. In order to be able to assess the relevance of this matter, TÜV Rheinland decided to examine the issue in more detail.

At present the instruction that the collector loop must be operated with a glycol-water mixture is sufficient for positive evaluation of the frost resistance. This paper should show whether in fact this does always suffice.

Freeze resistance testing of individual heat pipes

In the first series of tests 30 individual heat pipes from 6 different manufacturers were subjected to both freeze resistance testing in accordance with EN 12975-2 with 3 cycles, and also to thermal cycling test in accordance with IEC 61215 with 50 cycles in a climatic chamber.



All heat pipes of 5 manufacturers showed expansion after only 3 cycles in accordance with the collector standard and virtually all heat pipes from these manufacturers burst after 50 PV IEC cycles.



Determination of suitable test sequences

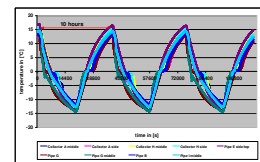
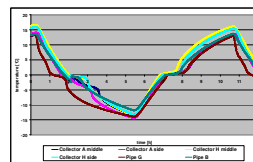
Should all these heat pipes really have frost problems in practice, then considerably more cases of damage could certainly be expected. For this reason it was decided to perform a second series of tests with two completely mounted collectors and also with heat pipes installed completely in the evacuated tubes. In order to adapt the conditions of the individual heat pipe to the conditions of the pipes installed in the collectors, the aperture in the evacuated tubes below the condenser was sealed convection-tight with insulating tape. A virtually vertical assembly was selected. Furthermore individual heat pipes both in the collectors and mounted individually were fitted with temperature sensors.

The series of tests have shown that heat pipes in general have a risk of freezing and it need to be evaluated, if this risk results in damages or not. Furthermore it became apparent that the cycle duration of at least 60 minutes for heat pipe collectors stated in EN 12975- 2 does not even remotely suffice. A cycle of eight to ten hours is required in order to achieve complete freezing or thawing. Only then can it be ensured that temperatures of -10°C and + 10°C are reached in the heat pipe.

In the same manner it could be determined that on the one hand testing of an individual heat pipe without a glass tube does not lead to realistic results, on the other hand, however, it is also not necessary to test a completely mounted collector. The use of individual convection resistant heat pipes with evacuated tubes represents a good compromise between both expenditure and the space required, and realistic testing.

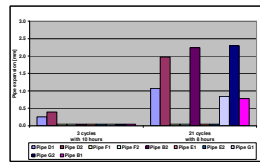
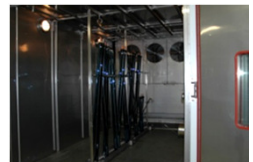
A combination of the test sequence with that for PV-modules is not possible as a result of the requisite cycle duration.

The following diagram shows the temperature pattern in both the lower area of the individual heat pipes and also the lower area of the individual heat pipes of the two completely mounted collectors. As the freezing and thawing rates only depend on the type of mounting to a slight extent, extensive complete testing is not necessary.



Freeze resistance testing of complete heat-pipe evacuated tubes with adapted cycle duration

As the three frost cycles with an extended cycle duration on the basis of EN 12975-2 only led to distortion with pipes of one of the 6 manufacturers, a further series of tests with 21 cycles was only carried out on individual heat-pipe evacuated tubes.



After this series of tests 50% of the pipes had considerable problems with the freeze resistance testing.

This shows that three frost cycles do not suffice for reliable confirmation of the frost resistance. The point is not to test everything to the point of destruction, but to develop an effective test procedure and to support end customers in the selection of collectors which are suitable for their climate.