Proc. EuroSun '98, Portoroz (SI), 14. - 17.9.1998 Vol.2, III.2.51-1..6

CONCEPT OF A SOLAR ABSORBER SYSTEM FOR PREHEATING FEEDING WATER FOR DISTRICT HEATING NETS

K. VAJEN, M. KRÄMER, R. ORTHS*,
E. K. BORONBAEV°, A. PAIZULDAEVA°, E. A. VASILYEVA#

Universität Marburg, Fachbereich Physik (Germany)
* Wagner & Co Solartechnik, Cölbe (Germany)
° Kyrgyz State University of Construction, Transport and Architecture, Bishkek (Kyrgyzstan)
Heat and Power Plant of Bishkek City, Bishkek (Kyrgyzstan)

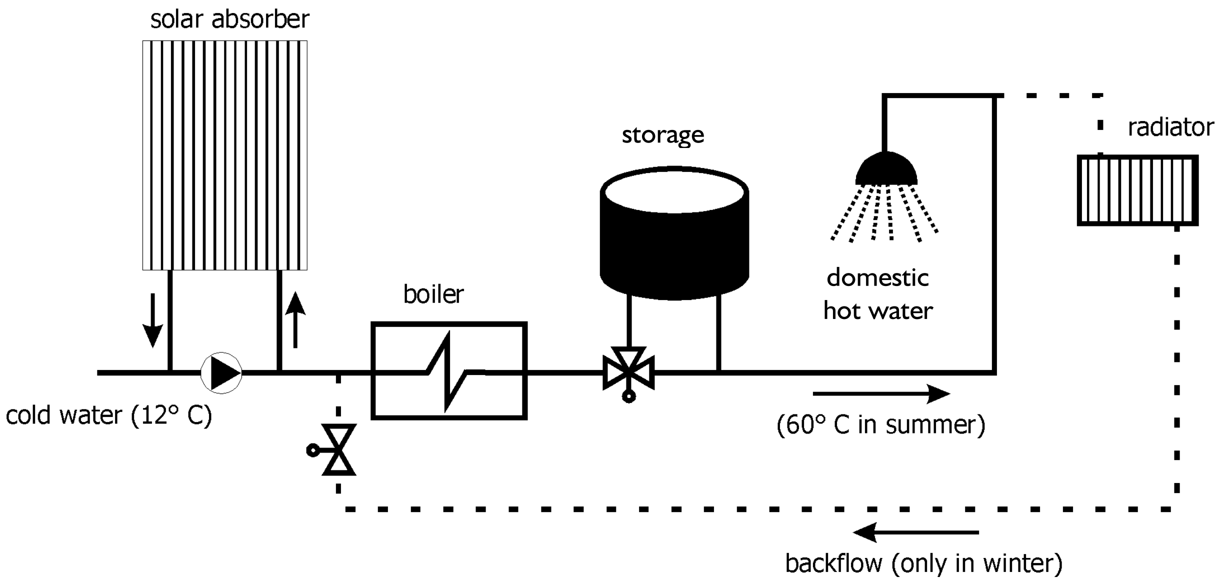
ABSTRACT. EPDM-absorbers, well-known in Central Europe for heating swimming pools, have been installed to preheat domestic water in a heat and power plant in Bishkek (Kyrgyzstan). The special construction of district heating nets of many cities in the former Soviet Union and the climatic conditions of Central Asia lead to an ideal environment for the use of solar thermal energy. Fluid temperatures which nearly always are far below ambient temperatures do not only result in heat gains at night instead of losses but also in collector "efficiencies" far above 1. Calculations of solar energy prices lead to about 6 Euro/MWh (≙ 12 DM/MWh).

1. INTRODUCTION

The heat supply of cities in the former Soviet Union usually is provided by one or more district heating (and power) plants. So it is in Bishkek, the capital of Kyrgyzstan. 650.000 inhabitants receive domestic hot water and energy for room heating from the Heat and Power Plant of Bishkek City. The district heating net (fig.1), however, shows some differences to common Central European technology. In Bishkek (as in many other cities of the CIS) one finds an open circle system: domestic hot water is taken by the consumers directly out of the net without any heat-exchanger coupling. In Bishkek the amount of 2000..4000 m^3/h water has to be refilled into the net. This is carried out at one central place. Cold water is taken from the ground and artesian sources and is led to boilers which heat it to the required temperature of 60°C.

Due to Kyrgyzstan's climatic conditions (Central Asia, latitude 43° north, comparable with Rome), altogether this are ideal conditions for the implementation of solar thermal systems. So it stands to reason to preheat the cold water directly by

----
Correspondence should be addressed to:
Universität Marburg, FB Physik, K. Vajen, D-35032 Marburg,
Phone: +49-6421 / 284148, Fax: / 286535, e-mail: solar@physik.uni-marburg.de



uncovered solar collectors. In Central Europe they are well-known for swimming-pool heating.

Figure 1. Simplified scheme of the district heating net in Bishkek

2. MEASUREMENTS

In June 98 a test plant of a 50 m^2 EPDM absorber field was installed on one roof of the District Heating Plant of Bishkek City. The absorber has an inclination of 4° to west. The water was taken from the pressure pipe (after the pumps) and led back to the pressure-less pipe, so that no extra pump was necessary to force water circulation. The flow rate was varied by a hand valve and also unspecified altered due to pressure changes in the net. The Variation width was 10 l/m^2h up to 120 l/m^2h.

Apart from the flow rate, the global, diffuse and long wave radiation, T_{in}, T_{out}, T_{amb}, humidity, wind-speed and -direction were measured (see fig. 2). Measuring was automated by a computer system. Mean values of up to 4000 single measurements were stored on the harddisk

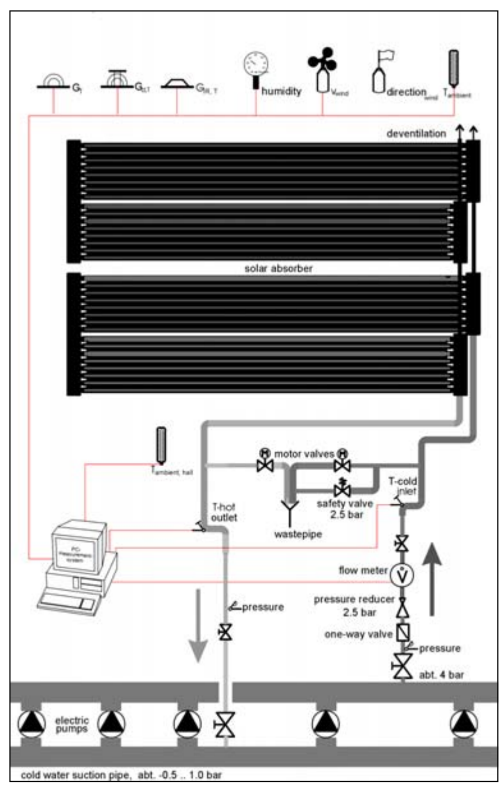


Figure 2. Scheme of the test-plant. The water circulation through the absorber was forced by existing pumps.

Correspondence should be addressed to:
Universität Marburg, FB Physik, K. Vajen, D-35032 Marburg,
Phone: +49-6421 / 284148, Fax: / 286535, e-mail: solar@physik.uni-marburg.de

minutely. The system is working since June nearly without problems and measuring of some of the mentioned quantities is still going on. Although technical problems complicated realisation of the test-plant, in the end the working behaviour could be made accurately.

3. (First) Results

Data from June, 13 to August, 10 were taken for the following evaluation. The cold water inlet temperature was always about 12 to 13°C. The ambient temperature, however, was nearly always higher, even at night. This leads to the unusual behaviour, that the net energy balance of the absorber shows profits from the surroundings instead of losses. In fig. 3 is shown, that at the selected days the useful thermal power is much higher than the irradiance during the day. It is also shown, that the fluid temperature at these days was always far below ambient temperature. Of course, this temperature difference depends on the flow rate.

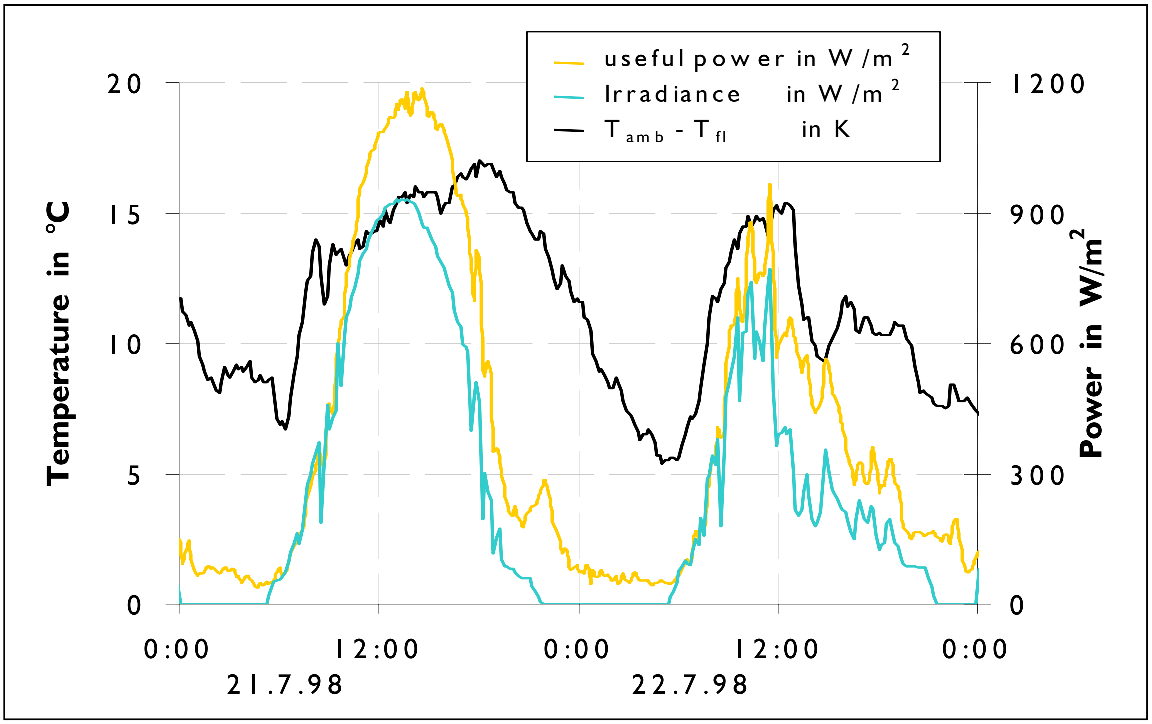


Figure 3. Measured quantities of $T_{amb} - T_{fl}$, power and irradiance.

In fig. 4 the dependency of the collector efficiency during the day (this means 5.30 to 20.30) from flow rate can be recognised. Best results could be achieved at highest flow rates. More than 40 l/m^{2}h lead to collector "efficiencies" more than 100%. Note, that unlike usual collector characteristics nearly all dots can be found in the 2nd quadrant of the coordinate system.

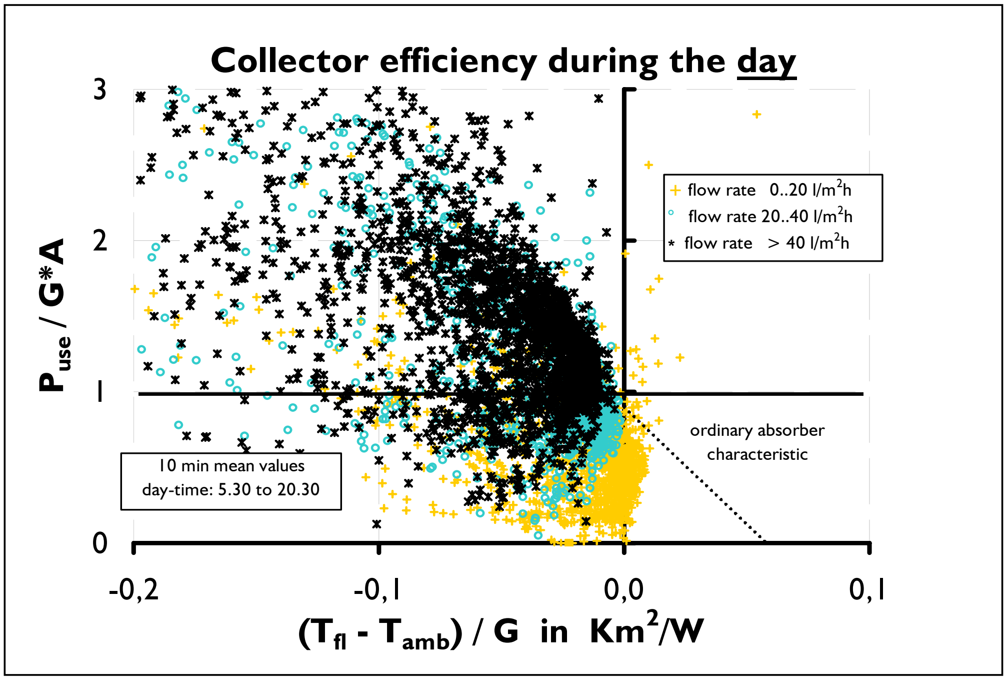


Figure 4. Measured 10 min mean values of the collector efficiency, which increase with increasing flow rate. The collector efficiency is nearly always > 1 at high flow rates. (June to August 1998)

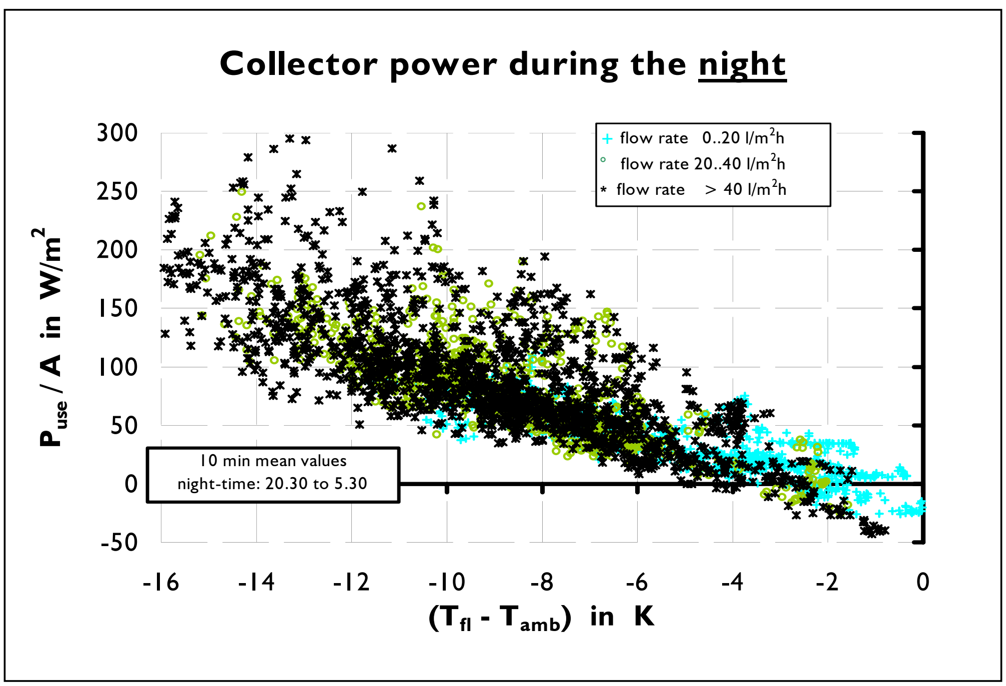


Figure 5. Measured 10 min mean values of the collector power. Even at night remarkable heat gains, nearly independent of the flow rate, were measured. (June to August 1998)

In contrast to the collector efficiency at day, during the night (20.30 to 5.30) the power gains seem to be independent of the flow rate. The average heat gains during the night were 0.7 kWh/m^{2}night or 80 W/m^2, respectively (see fig. 5).

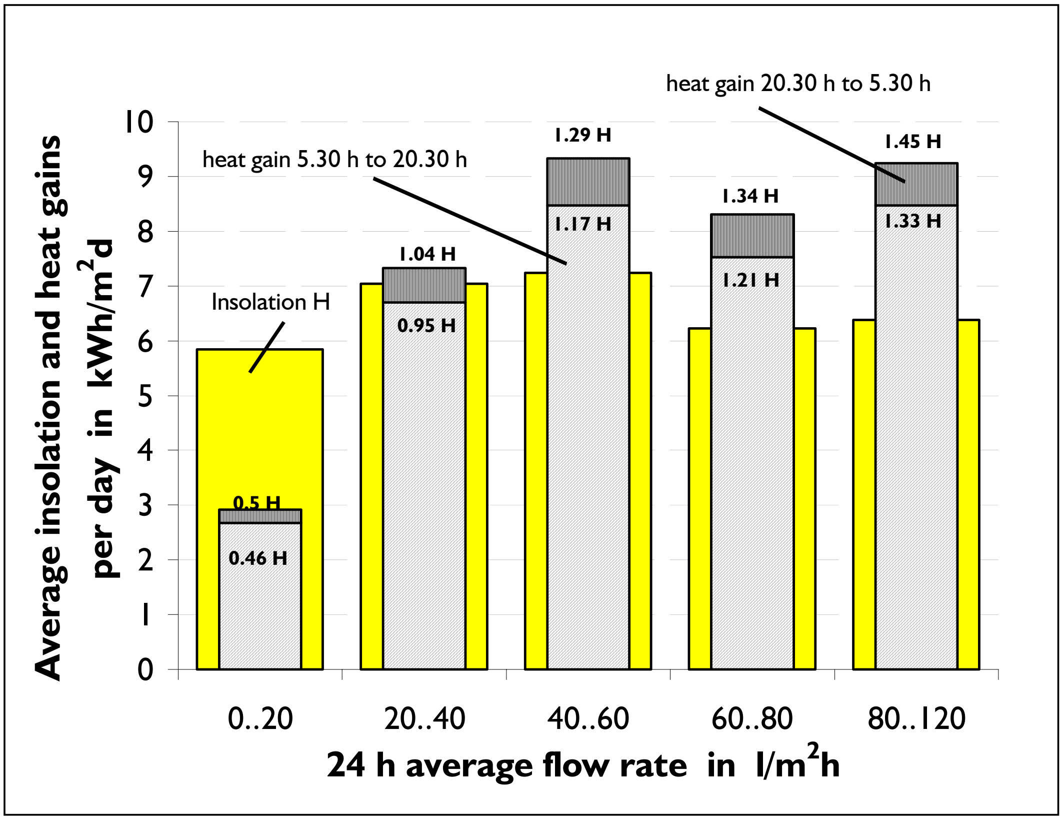


Figure 6. Average values of daily insolations and heat gains. The best results could be observed at high flow rates

Fig. 6 shows average daily insolation and heat gains at different flow rate classes. The variations of the flow rate were independent of the irradiance level. The average heat gains during the day at higher flow rates are higher than the average insolation. Together with the heat gains at night, the average daily heat gain was 1.45 of the insolation value. At single days even ratios (heat gain/insolation) up to 2 could be observed.

4. Conclusions

The yearly heat gains of an uncovered collector can be estimated to be higher than 1100 kWh/m^2. This is the result of combining the operation time (during the frost-free period) with the average heat gains per day at high flow rates and with radiation data, measured in Bishkek since March 98. So the absorber heat gains can be expected to be more than twice as high as common for collector systems in Central Europe, furthermore the costs of the installation of absorbers are very low.

With the results measured at the test-plant solar energy prices of about 6 Euro/MWh ($\triangleq$ 12 DM/MWh) can be expected. This is below the today's prices of fossil energy on the world market. So the absorber system in Bishkek could be a solar thermal installation able to compete economically with all conventional energy sources. The estimated technical potential is about 40000 m^2 absorber field. An installation (abt. 4000 m^2) in Bishkek is under consideration.

Acknowledgements

The authors would like to express their sincere thanks to the following persons and institutions for financial and logistic support:
Unversität Marburg, Wagner & Co Solartechnik in Cölbe, International Bureau of the BMBF, Heat and Power Plant of Bishkek City, esp. W. J. Brosovskij (master chemical department), Botschaft der Bundesrepublik Deutschland in Bischkek, GTZ office in Bishkek.