RESEARCH AND EDUCATION OF THE APPLICATION OF RENEWABLE RESOURCES AT THE FACULTY OF ENGINEERING UNIVERSITY OF SZEGED

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ABSTRACT

At the Faculty of Engineering and it's legal predecessor – the College Faculty of Food Engineering – we research the utilizing of solar energy since 2004. In our narrower region – the south of the Great Hungarian Plain – the utilizing of solar energy could be advantageous, therewith in our new building we will be able to study the utilization of geothermal heat. We can use our results in the education, too. The equipments we applied to researhes our students could use during the making of their diploma work or preparation for competitions, too. In this article we would like to introduce our results and plans about solar and geothermal energy utilizing.

1. EXPERIMENTAL SOLAR EQUIPMENT

Using our prior experiences we have designed a newer experimental measuring system in 2010:

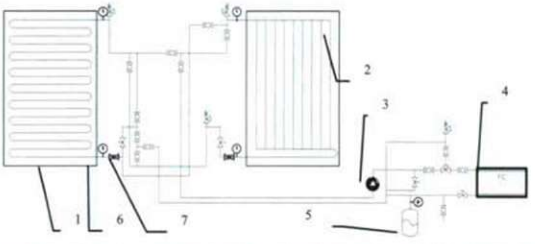

Figure 1. Experimental equipment for measuring the efficiency of solar collectors. 1 – collector with coil-pipe, 2 – collector with parallel pipes, 3 – circulation pump, 4 – fancoil, 5 – expansion tank, 6 – thermometers, 7 – volume flow rate measuring

We used our own-designed collectors. The covering of these collectors is removable, so we could test the collectors with different polycarbonate sheets and uncovered. With the unit we can operate the collectors in parallel or serial connection. In the serial connection we can change the order of the two collectors. It is possible to lock out either collector.

Figure 2. Experimental solar equipment

The equipment transfers the heat output of the collectors to the external air by a fancoil. The cooling fan can be adjusted continuously. The cooling capacity can be decreased further with a bypass pipe.

The circulation pump is adjustable in five steps. In function of the return temperature the pump does further adjusting.

Differently from the conventional ones the water-meters in the equipment measures by displacement, with rotating piston. The volume flow rate could be measured from 7.5 l/h, which is an extremely low value. The accuracy of the water-meters is ± 2%. The impulse-relays signals by liters. We saved the impulse signals with a two-channel datalogger.

The temperatures were measured by K-type thermocouples with two Testo 177-T4 datalogger. The accuracy of the measuring is ± 0.3 °C.

Besides the measuring of the volume flow rates and the temperatures marked in Fig. 2., we measured the temperature and humidify of the external air and the solar irradiation. The irradiation was measured by a Lambrecht 16131 pyranometer mounted between the collectors in the same plane.

Fig. 3 represents the results of a diurnal measuring.

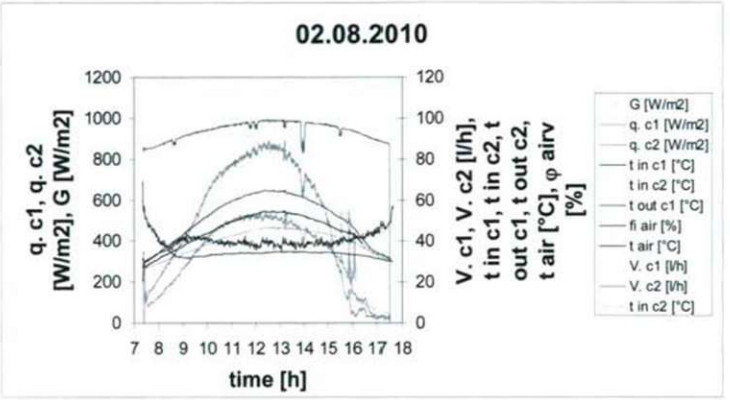

Figure 3. Results of a diurnal measuring

During the most of the measuring we have saved the datas by 5 sec. It enables to analyze the transient processes. It results very high amount of datas, so it requires a database management software.

The equipment used by our students during measuring excercises and making of their diploma work. By these tasks they acquire practice of collectors, pump controlling, measuring of temperature, solar irradiation and volume flow rate, handling of dataloggers and database softwares.

2. MEASURING SYSTEM WITH BUDERUS COLLECTORS

Beside of the analysis of the own-designed collectors we have started to utilizing of Buderus atmospheric flat collectors, argon-filled flat collectors and vacuum-tube collectors.

Figure 4. Measuring system with Buderus collectors

There are three independent collector system available for the students. Each system has two collectors, wich could be connected in parallel or serial. Each system has a solar tank: two system have conventional solar tanks, and the third has a solar tank with thermosiphon. This construction has an inner core. With the valves of this inner core this tank can especially keep the temperature-layering during the diversion of domestic hot water.

This system also has a pyranometer to measure the global irradiation, so we can calculate the efficiency. Later the measuring system will available for students via Internet too.

3. WIRELESS MEASUREMENT AND DATALOGGER SYSTEM

In 2010 we put in practice our National Instruments WSN system. With this equipment we can measure temperatures and collect impulse signals in distant places at the same time.

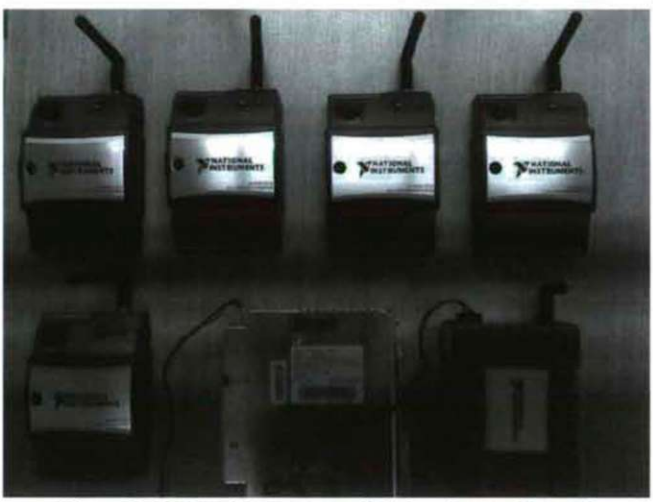

Figure 5. National Instruments Wireless Sensor Network

The gateway communicates with the PC via the network interface. We have 5 nodes. The nodes can measure 4-4 temperatures with thermocouples. One node can handle impulse signals. The nodes send the data to the gateway via wireless connection. In case of line of sight transmission the system can measure from hundreds of meters. Beside the tetst on the equipments of the Faculty, our students can measure in industrial establishments. The WSN-system is suitable for measuring, data logging and controlling too: we can adjust industrial procedures according to the measured parameters, so our students could test different control algorithms.

The system is operated by a virtual instrument made with LabVIEW software.

The course of the LabVIEW graphical program environment is a part of the engineering education at the Faculty, so our students can apply the acquired knowledge during the test of solar and other systems.

Actually we use the system in industrial environment: the system is measuring the temperature distribution of a vacuum-tube collector field. Fig. 6 represents the layout of the collector field and the arrangement of the thermocouples:

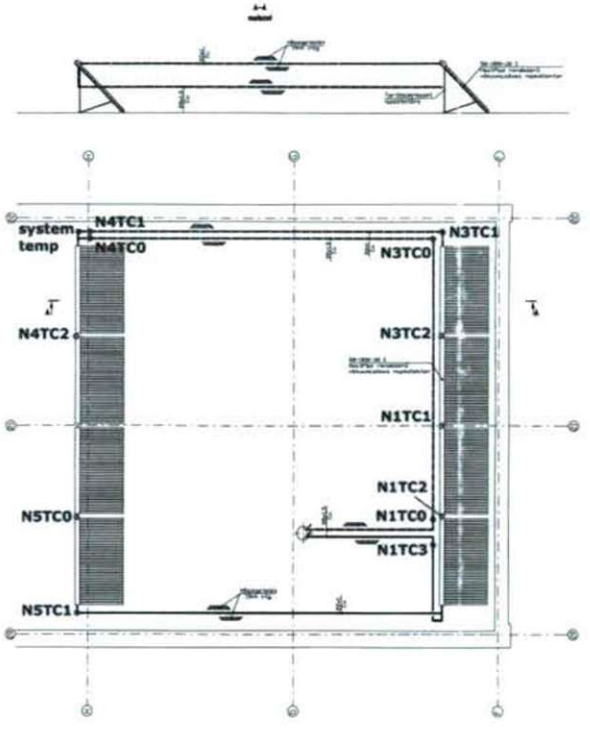

Figure 6. Arrangement of the thermocouples in the collector field

This collector field has compound connection: 4-4 collectors are connected to serial, and this two group are in parallel. The control system of the collectors has only 1 thermocouple. It measures the hypothetical average temperature (system temp in Fig. 6).

The higher the temperature of the collector, the higher the heat loss by the cooling effect of the external air, so the efficiency of the next collector in serial is lower than the previous, because the temperature is higher. Depending on the volume rate flow it is possible to reach the maximum temperature before the last collectors. In this case the the last collectors performance is negative: the heat loss is higher than the irradiation. This kind of operation is unwanted. With the WSN system we could measure this unwanted operation.

Fig. 7 represents the temperature distribution of a two weeks interval:

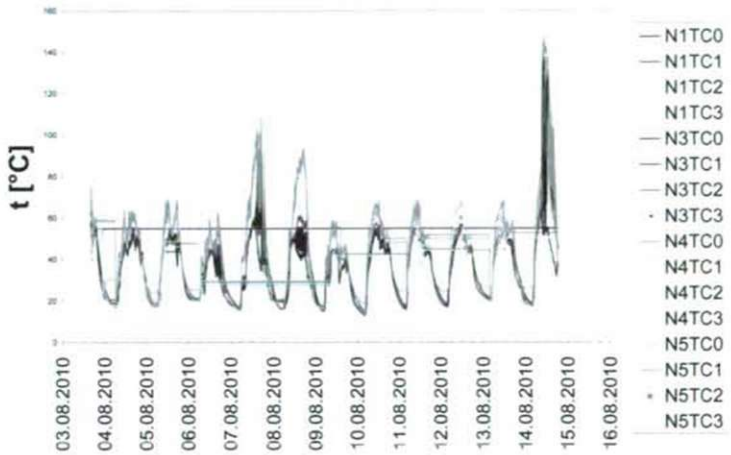

Figure 7. Temperature distribution in the solar collector field

After the evaluation of the database we will able to do the necessary modifications of the control to reach higher efficiency.

4. SOLAR COLLECTOR, SOLAR CELL AND GEOTHERMAL HEAT PUMP SYSTEM IN THE NEW BUILDING OF THE FACULTY

The acceptance of the building was in March, 2011. The heating, the domestic hot water and the lighting system uses renewable resources.

The heat demand is supplied by two geothermal heat pump with blow pipes. The natural gas used only to aid the heating if it is necessary.

The solar collectors join to the domestic hot water system. In summer the collectors can supply the heat demand of the DHW system, in autumn, winter and spring the collector system is a pre-heater of the DHW system.

Figure 8. The new building of Faculty of Engineering, Univerity of Szeged

The lighting and the outer decorative lighting is particularly supplied by the solar cell system.

The controlling system of the building will measure and logging the parameters hereafter:
– temperatures of the blow pipes of the heat pumps,
– temperatures of the heating subsystems,
– temperature and amount of the domestic hot water,
– solar radiation and external air temperature,
– internal temperatures,
– power and efficiency of the solar cells,
– heat output and efficiency of the solar collectors,
– total energy and renewable energy demand of the building.

By the temperature database we will able to optimize the system. We will able to analyse the long term environmental effect of the building and confirm the researches of the geothermal heat pumps.

The building and the database from the controlling system will give a unique possibility to improve the practical education for the mechanical engineering, technical manager, materials engineer, bioengineer and environmental engineer students.

5. DIPLOMA WORKS

Joining our researches our students in the past years making diploma works about the themes hereafter:
Utilizing of solar collectors in domestic hot water systems
Utilizing of solar collectors in low-temperature heating systems
Solar water supply systems
PCM solar tank
Heating systems with heat pump
Payback-time analysis of building services systems for renewable resources
Combined building energy supply systems

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