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DECREASE OF COOLING ENERGY USE OF BUILDINGS

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Abstract:

The precise determination of radiating heat returns is an important factor of the establishment of energetic conditions of an building. Nowadays buildings shall use available renewable energy sources with increasing efficiency. A room having interior sizes of 3,0×3,0×2,8 m has been built for measuring radiated heat quantities. The exterior walls of the measuring room are made of 20-cm thick KINGSPAN cold-storage plant panel. In previous publication I presented the problems concerning the pilot plant. In this article of mine I am presenting the principle of the measuring and archiving device as well as development carried out during the pilot plant period. These results have proved that this direction was right to decide for which high-precision measurement an individually constructed high-precision device is suitable and so facilitates scientific conclusions in the energetic field concerning buildings.

1. Introduction

The precise determination of radiating heat returns is an important factor of the establishment of energetic conditions of a building. Nowadays buildings shall use available renewable energy sources with increasing efficiency. One of these is the radiated energy penetrating directly or indirectly into the building. Radiated heat returns emerge in all periods of the year with different intensity. In a year this quantity changes from month to month, but radiated energy keeps also changing within a day. In winter and autumn-spring transition period the radiated energy penetrating into the building shall be used the possibly highest efficiency. The research replies to the question if artificial cooling is necessary depending on incorporated fitting with glass and shading in climate conditions of Hungary, resp. how this energy quantity can be minimized. A room having interior sizes of 3,0×3,0×2,8 m has been built for measuring radiated heat quantities. The exterior walls of the measuring room are made of 20-cm thick KINGSPAN cold-storage plant panel. Between panels painted white from exterior PUR foam is inserted in a thickness of 20 cm. Therefore the heat transmission factor of the structure is 0,11 W/m^2K, which leads to a practically insignificant heat return through this structure. There is an opening sized 150×150 cm on one of the walls of the measuring room, into which different types of windows can be incorporated. On all sides of elements bordering the building 9 surface temperature sensors as well as 27 air temperature sensors have been arranged in three vertical and three horizontal evens. For realizing the research a temperature measuring data acquisition device had to be designed and constructed, which is suitable for measuring the temperature with the appropriate precision and frequency as well as archiving and evaluation of data.

2. Method and goal

An individual computerized data processing device measuring temperature shall be designed and constructed, which is suitable for measuring contact temperatures (side borders) and air temperature with a precision of 0,1 C^0. During the measurement of the temperature an analogue signal is available and a voltage is necessary so that the signal can also be processed and this analogue voltage had to be digitalized, because the computerized data recording can only be carried out in this form (Fig. 1).

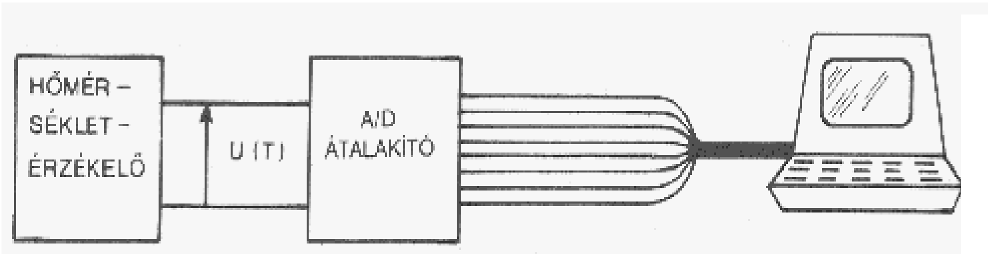


Fig. 1 Data processing scheme

Source: Collections of physical experiments by György Bérces

3. Selection of the measuring principle

3.1 Measurement of the temperature

The temperature is one of the determinant of the state of bodies. The temperature is such a feature of the body determining if the body is in thermal balance with other bodies. For this measurement only tools operating with the principle of electricity, because it is not worth using electric transformer for transforming physical quantities into electric ones, because this would only decrease the precision of the measurement. The thermometer shall have a low heat capacity in comparison to that of the system so that the state of the system only little changes. The low heat capacity of the thermometer is also desirable, because this facilitate the possibly lowest difference between the thermometer and environmental temperature. It can also briefly expressed that the thermometer's incapacity shall be as low as possible. The incapacity of the thermometer can be characterized by the time constant, resp. half period.

- Electronic temperature sensors; ha a p-n junction is used for measuring temperature, due to the characteristics of the diode in the case of permanent current approximately 2-mV voltage change (silicon) is caused by 1 C° temperature change. The rate of the change can be regarded linear in a wide temperature range and can be described by means of the function (4).

$$\Delta U = k(T1 - T2) \qquad (1)$$

The LM335 sensor is an integrated temperature sensor which has a high precision, can be easily calibrated and has a low heat capacity. Its operation imitates a tow-output Zenner-diode, the cutting voltage of which is in direct proportion to the absolute temperature, the temperature coefficient is 10mV/°K. In the case of calibration at 25 a precision of 1° can be achieved. Therefore I have chosen the LM 335 sensor distributed in trade.

3.2 Applied measuring transformer

The important aspect of the election of measuring-transforming tools was the availability of the National Instunents LabVIEW software being suitable for such type of data acquisition and due to the good contact of our institute with the manufacturer of the product the following tools have been put at our disposal.

3 pcs NI PCI-6259 (Fig. 2) multifunction data sheets containing 32 analogue inputs,
6 pcs NI SHC68-68-EPM 68 pin connect cables and
6 pcs NI BNC-2090A pads have been used..

Fig. 2, NI PCI-6259 16-Bit, 1 MS/s (Multichannel), 1.25 MS/s (1-Channel), 32 Analog Inputs

Source: http://sine.ni.com

3.2.1 Requirement of the *LabVIEW program*

For the appropriate operation of the program a medium-speed computer having at least 1GB memory is needed. The computer which I am using has 2 GHz processor, 2 GB physical memory and 40 GB hard disk, but the other parameters are not important. According to the instructions of present program the data sheet (Fig. 2) carried o9uts the measurement every minute, stores data by counting averages in every 5 minutes and then every day at 00:00 saves them into a declared folder of the computer provided them at first with time stamps. The computer is provide with a Linksys WRT54GL Wireless router as well as an exterior aerial and so data can be loaded at any time by accessing a remote table, resp. the program can be modified. The detailed presentation of the program is not Due to its extent the detailed presentation of the program can not be written down in this article.

3.3 Construction of the measuring device

It is worth knowing about the sensor that on its output (+ foot) the voltage (Vm) changes as a function of the temperature. By measuring this voltage the temperature can be calculated. The sensor supplies +10 mV voltage by C°. Before the use the sensor shall be calibrated. The calibration means that the output voltage is measured at 25 C° (V0=2,98V). By using this value the monetary temperature departure can be easily calculated which shall be corrected by means of the appropriate software [3].

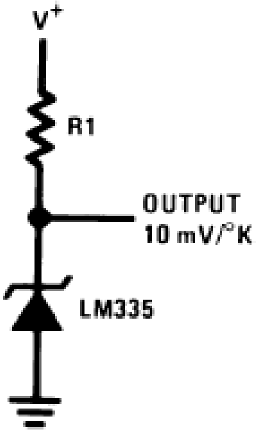
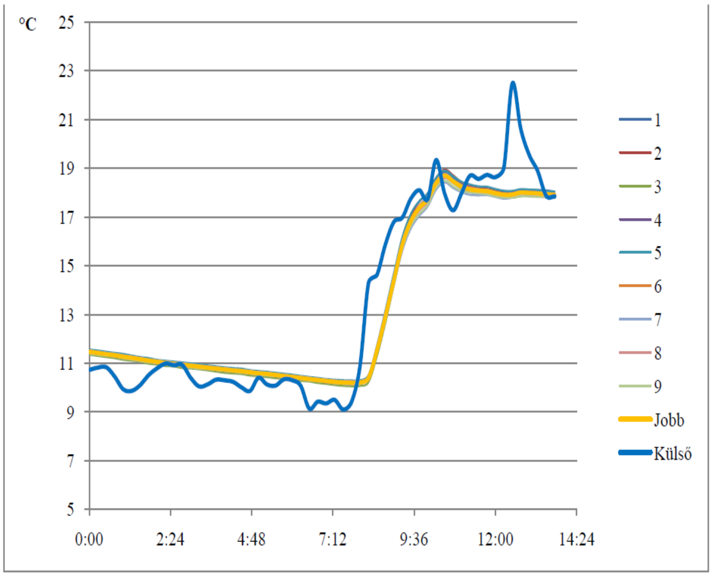


Fig. 3 Linking of LM335

Source: http://www.national.com/mpf/LM/LM335.html

The calibration of sensor can not be carried out one by one, because all sensors are different distances from the data acquisition input point pof the measuring tool and the length of cables influences the measured value and so I have connected all cables with the sensor, provided with position number and sized to the data finder and having measured the values by means of the program written for this completed the result with the offset voltage corresponding to the temperature of 25 C° to the appropriate value (Fig. 4).



Az ábrán jól látszik, hogy a görbék követik egymást, tehát kalibrálásuk megfelelően

Fig. 4

The measuring system has been locally placed on the top of the measuring room and so the system had to be so designed that it could resist the inclemencies of weather. The most serious problem has meant the conduction of the energy raised in the closed space established in this way (heat produced by the computer and data sheets). The quantity of the heat produced by the device can also the value of 160 W according to calculations, but since these tools can not permanently operate with whole capacity; I have used the cooling surface of the electric heating bag distributed in trade for cooling the closed measuring seat-box. I had regarded the capacity of 94 W of two cooling bag sufficient, which was also confirmed by the safe operation in two summer months. The electric cooling operates only if the temperature is 40 C° in the computer casing. In consideration with the duration of the cooling surface as well as the lower environmental heat burdening in the winter and transition period I have placed two computer casing ventilators ensuring the cooling at a temperature higher than 25 C° by blowing in and pumping out air. Moreover, I have coated the measuring seat-box with an 8-cm thick heat-insulating layer (Fig. 5). In the case of a temperature of 40 C° in summer the decrease of heat burdening is required. During the pilot plant period the necessity of these tools for the safe operation was proved and so it was possible that I measured 55 C°, which did not cause any trouble inside the measuring seat-box.

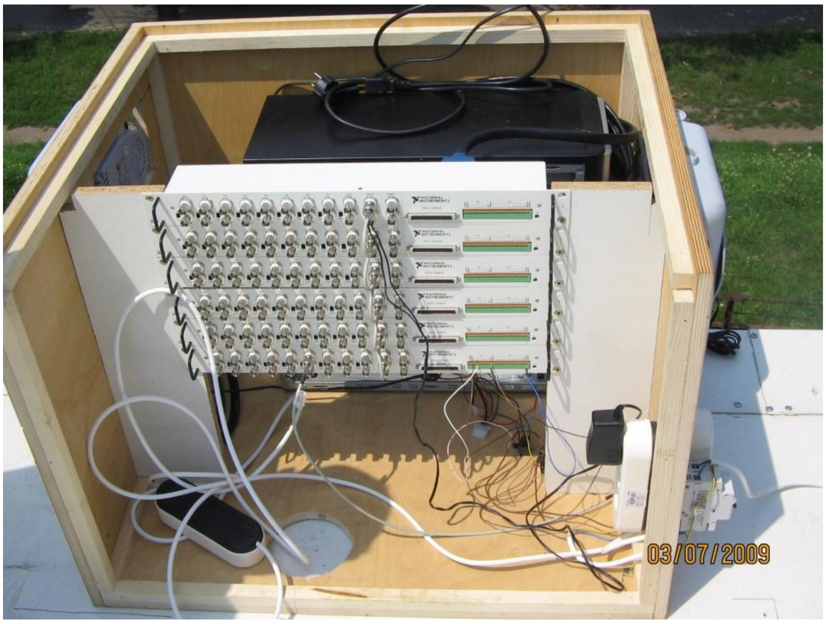


Fig. 5 Measuring seat-box

4. LabVIEW

The Labview program running on the computer carried out the control as well as calculation and archiving tasks in the background. For handling a remote measuring data acquisition computer reachable on Internet I have prepared a handling surface (Fig. 6) where momentary values can be read, the daily trend can be tracked; resp. the automatic and manual control of ventilators can be changed.

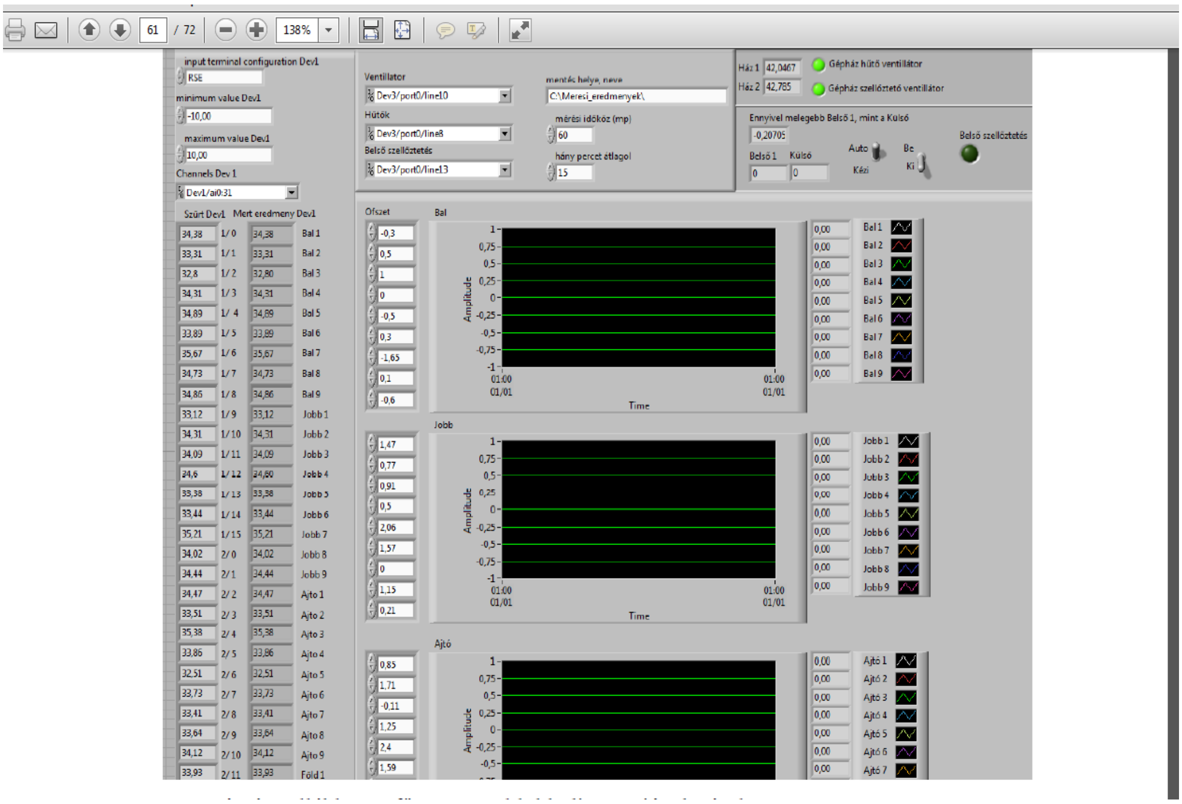


Fig. 6 Labview handling surface

5. Passive cooling

I have used 4 pcs ventilators sized 120X120mm and having a capacity 12 V, 1 W for regulating the interior temperature of the building. In the building there is no, resp. there is only a little heat accumulating block and so its enough to use low-capacity ventilators for regulating the interior and exterior temperature with an appropriate ventilation. The conditions of operation are determined by taking exterior and interior temperatures into account, the model building can only adsorb and emit heat through the window-glass and so the daily temperature change is quite low.

These data Fig. 7) (Fig 8) show the daily minimum and maximum temperature. Since the room is airtight, there is no natural ventilation. Since there is no natural ventilation and the building has a light structure, the room has also been overheated. Results differing from this show the necessity of controlled natural ventilation.

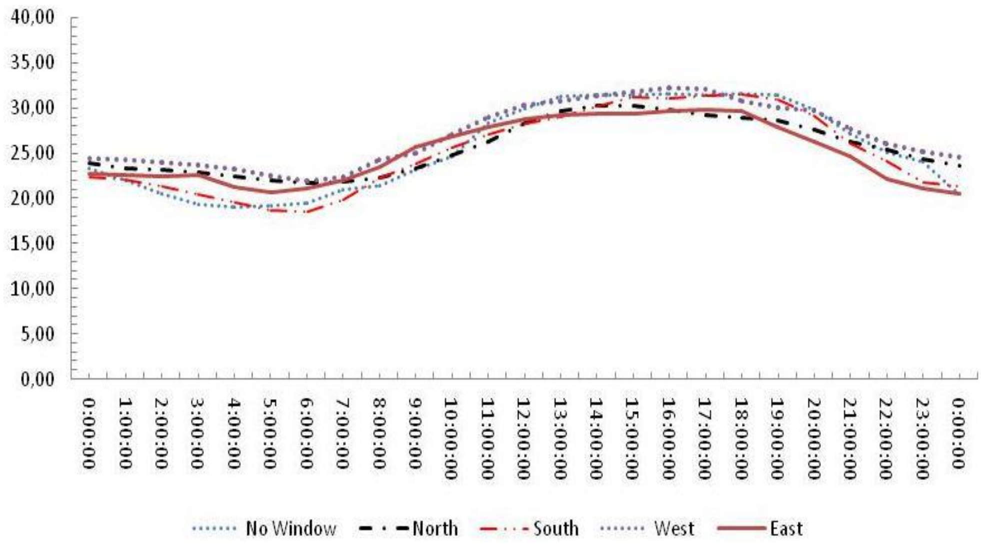


Fig. 7 Exterior temperature

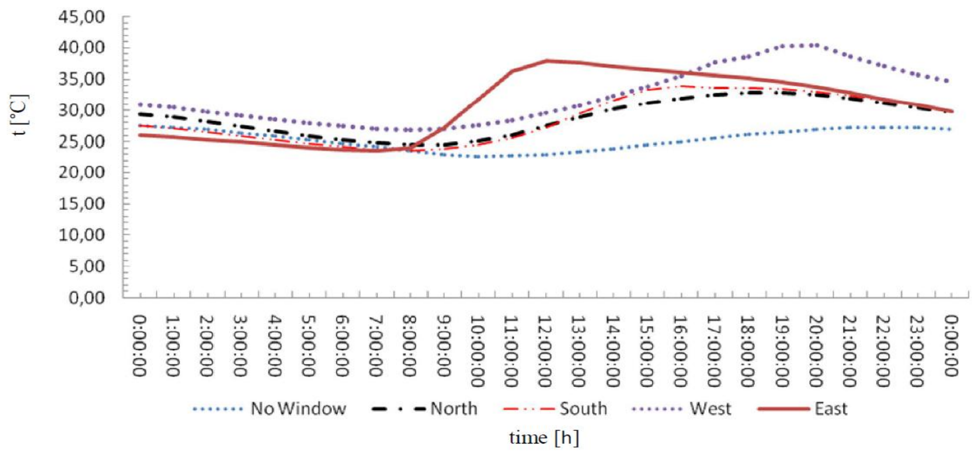


Fig. 8 Interior temperature

Source: Emeric Csáki article-16th „Building Services, Mechanical and Building Industry Days" International Conference, 14-15 October 2010, Debrecen, Hungary

Airing ventilators are calibrated to the average temperature control value. If the temperature of the interior air is higher than 22 C° and the exterior temperature is at least 2 C° lower than the interior one, the two upper ventilator operate by blowing out air and the two lower one operate by blowing in it until the equalization of the temperature of interior and exterior air. Ventilators can also control in inverse direction and so if the temperature of interior air is lower than 22 C° and the temperature of exterior air is lower, the two upper ventilator operate by blowing in air and the two lower one operate by blowing in out.

6. Summary

The precise determination of radiating heat returns is an important factor of the establishment of energetic conditions of a building. Nowadays buildings shall use available renewable energy sources with increasing efficiency. A room having interior sizes of 3,0×3,0×2,8 m has been built for measuring radiated heat quantities. The exterior walls of the measuring room are made of 20-cm thick KINGSPAN cold-storage plant panel. Between panels painted white from exterior PUR foam is inserted in a thickness of 20 cm. In previous publication I presented the problems concerning the pilot plant. In this article of mine I am presenting the principle of the measuring and archiving device as well as development carried out during the pilot plant period. These results have proved that this direction was right to decide for which high-precision measurement an individually constructed high-precision device is suitable and so facilitates scientific conclusions in the energetic field concerning buildings.

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