WEB BASED MONITORING SYSTEM OF AN AIR CONDITIONING DEVICE

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Rezumat. *Lucrarea prezintă un sistem de monitorizare prin internet a unui echipament de condiționarea aerului reversibil, care poate funcționa ca instalație frigorifică sau ca pompă de căldură. Sunt prezentate construcția echipamentului, structura sistemului de achiziție a datelor și de monitorizare, structura bazei de date pentru stocarea valorilor parametrilor monitorizați. Este prezentată și soluția tehnică utilizată pentru afișarea parametrilor urmăriți, cu ajutorul unui panou virtual de monitorizare, realizat cu ajutorul unei aplicații software pentru internet. Concepția sistemului de achiziție a datelor și componentele aplicației software sunt originale.*

1. DESCRIPTION OF THE AIR CONDITIONING EQUIPMENT

The air conditioning equipment, for which was realized the web based monitoring, is a classical split system, composed from an external unit and an internal one. Such systems are presented in [1] and [2]. The refrigerant used is R22.

The principle working scheme of the air conditioning system is represented in figure 1.

The notations in figure 1 has the following meanings:

- HX OUT – external heat exchanger;
- HX IN – internal heat exchanger;
- 4WV – four ways valve;
- R – refrigeration working regime;
- HP – heat pump working regime.

The arrows represented on figure 1, near the two heat exchangers, are suggesting the flowing direction of the air through those heat exchangers.

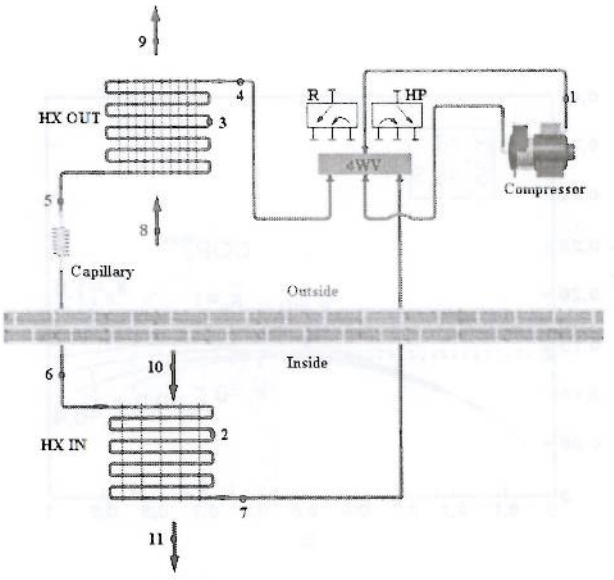

Fig. 1. Principle working scheme of the air conditioning system.

The four ways valve is controlling the working regime of the equipment, switching between the refrigeration and heat pump regime.

On the air conditioning equipment were connected digital sensors for temperatures measurements, in eleven measuring points, as it is indicated in figure 1. In this way it can be obtained in any moment, relevant information for the working mode of the equipment.

The significance of the notations representing the measurement points is the following:

1 – discharge temperature of the compressor;

2 – saturation temperature in HX IN (evaporation or condensation);

3 – saturation temperature in HX OUT (evaporation or condensation);

4 – temperature between 4WV and HX OUT;

5 – temperature between HX OUT and capillary tube;

6 – temperature between the capillary tube and HC IN;

7 – temperature between HX IN and 4WV;

8 – temperature of the air at the inlet in the HX OUT;

9 – temperature of the air at the inlet in the HX OUT;

10 – temperature of the air at the inlet in the HX IN;

11 – temperature of the air at the inlet in the HX IN.

If the saturation temperatures in HX OUT and HX IN (2 and 3) are known, the two working pressures from the installation can be computed. These pressures are representing the saturation pressures in the two heat exchangers, meaning the evaporating and the condensing pressures.

2. DESCRIPTION OF THE DATA ACQUISITION SYSTEM

The data acquisition system and the web based monitoring software are original and the working principle scheme is represented in figure 2.

The air conditioning device represents the equipment indicated in figure 2.

The values of the temperatures are read by a microcontroller noted MC. The temperature reading software, registered in the memory of the microcontroller, is equally sequentially displaying the values of the

temperatures, on a LCD display, and is transmitting the same temperatures values to a compatible IBM-PC computer of Pentium IV type, through the COM serial interface, as it is indicated in figure 3.

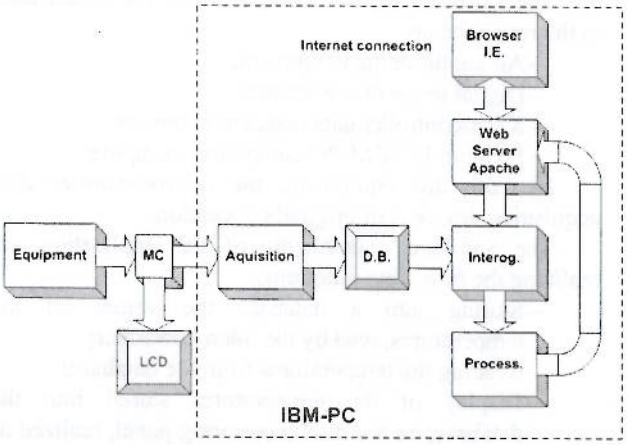

Fig. 2. Working principle scheme of the data acquisition system and the web based monitoring system.

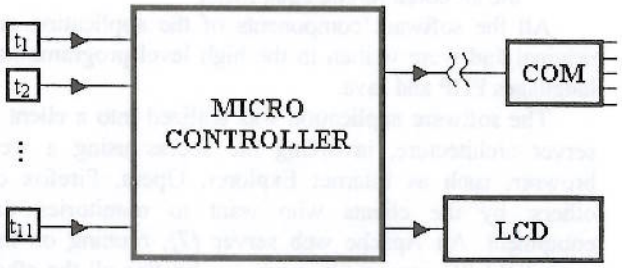

Fig. 3. Principle scheme of the temperature reading system using a microcontroller.

3. SOFTWARE COMPONENTS OF THE WEB BASED MONITORING APPLICATION

The web based working regime monitoring of the air conditioning equipment, includes several software components, realizing the following functions:

- Storing into a database of the temperatures values read by the microcontroller;
- Reading the temperatures from the database;
- Displaying the temperatures on a monitoring virtual panel, realized as a web page;
- Graphical representation of all the temperatures for the last 10 working minutes;
- Graphical representation of the working cycle of the air conditioning equipment.

The database, noted in figure 2 with DB, was designed to store the values of the measured parameters, is a MySQL type and allows interrogation via Internet. Such types of databases are presented in [3].

The storing into the database of the temperatures values read by the microcontroller MC is realized by an original software component named "Acquisition" in figure 2 and written in the Java language [4]. The data acquisition software is operating continuously, reading and storing the temperatures values into the database, until the operator stops this software component.

The display of the temperatures read from the database, was performed on a virtual monitoring panel, realized as a web page and represented in figure 4.

It can be easy observed that each temperature value was displayed right in the measurement point, on a virtual digital display. This virtual panel can be displayed on any computer connected on Internet, indicating the address of the web page from figure 4:

`www.termo.utcluj.ro/conditionare`

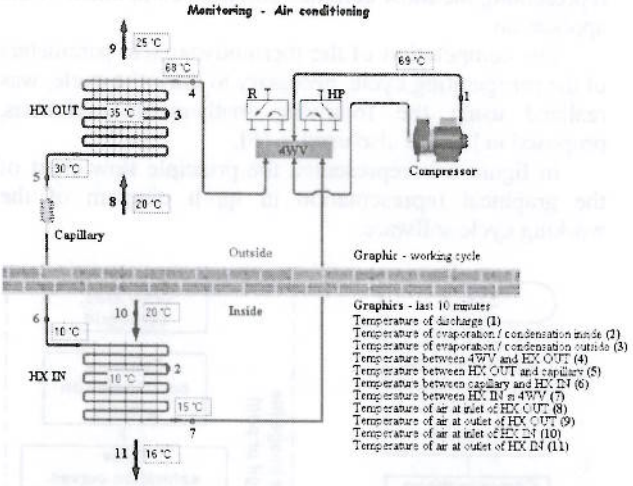

Fig. 4. Virtual monitoring panel, realised as a web page.

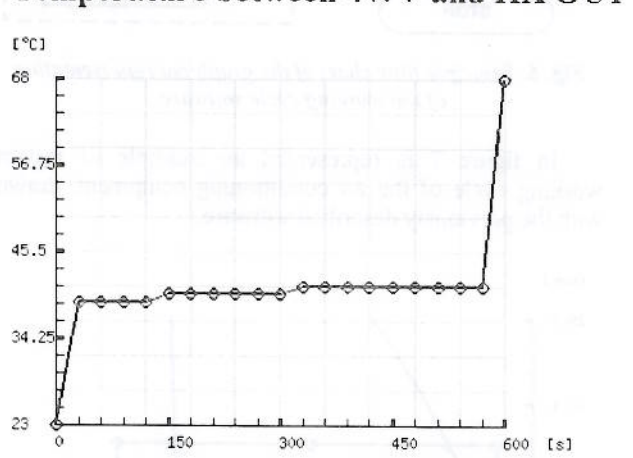

Fig. 5. Example of graphic for temperature variation.

The reading process of the temperatures from the database and the displaying on the virtual monitoring panel is realized by the software component named "Interog" on figure 2. The software was written in PHP language [3].

The graphical representation of the temperatures variations, for the last 10 working minutes of the equipment was possible using parametric software for graphical representation. To load this software, the monitoring interface was completed by realizing a set of links to this software, as it is shown in figure 4.

The parametric graphical representation software component to draw the temperature variation in any measurement point was written in the PHP language. In figure 5 is presented an example of graphic drawn using the parametric graphical representation software.

The graphical representation of the working cycle of the air conditioning equipment is representing one of the most complex and useful functions of the whole web based monitoring software application. The graphical representation software to draw the working cycle, in lgp-h diagram was written in PHP language and is representing the most complex software component of the application.

The computation of the thermodynamical parameters of the refrigerating cycle, necessary to draw the cycle, was realized using the following mathematical relations, proposed in [5] and also used in [6].

In figure 6 is represented the principle flow chart of the graphical representation in lgp-h diagram of the working cycle software.

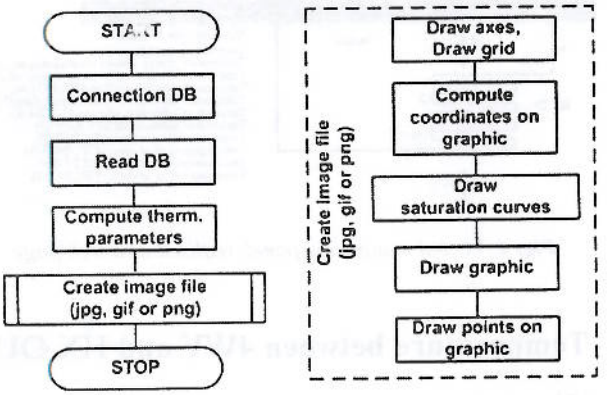

Fig. 6. Principle flow chart of the graphical representation of the working cycle software.

In figure 7 is represented an example of instant working cycle of the air conditioning equipment, drawn with the previously described software.

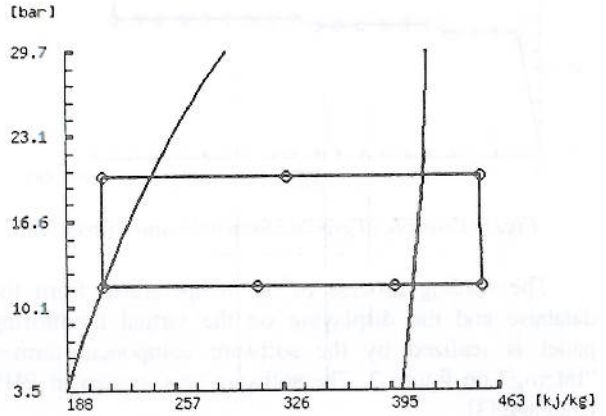

Fig. 7. Working cycle of the air conditioning equipment.

CONCLUSIONS

The web based monitoring application, for an air conditioning equipment, includes both hardware and software elements, representing an original product as a whole and by its components.

The hardware devices component of the bench used in the researche are:

- Air conditioning equipment;
- Digital temperature sensors;
- Microcontroller data acquisition device;
- Pentium IV IBM-PC compatible computer.

Between this equipment, the microcontroller data acquisition device is of original conception.

The software components of the application are realizing the following functions:

- Storing into a database the values of the temperatures, read by the microcontroller;
- Reading the temperatures from the database;
- Display of the temperatures stored into the database, on a virtual monitoring panel, realized as a web page;
- Graphical representation of all the temperature variations, for the last 10 working minutes of the equipment;
- Graphical representation of the working cycle of the air conditioning equipment.

All the software components of the application are original and were written in the high level programming languages PHP and Java.

The software application was realized into a client – server architecture, involving the access using a web browser, such as Internet Explorer, Opera, Firefox or others, by the clients who want to monitories the equipment. An Apache web server *{7}*, running on the same IBM-PC compatible computer, hosting all the other software components presented in the paper, processes the monitoring clients requests.

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