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ACTIVE ELEMENTS OF HEAT ACCUMMULATION IN LABORATORY OF INTELLIGENT BUILDING - THERMAL ACCUMULATIVE PANELS

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Abstract: *There was installed a laboratory system with the controlled thermal accumulation possibility for the purpose of simulation methods evaluation, in Faculty of Applied Informatics, UTB in Zlin. The whole system employs a progressive elements for electricity production, heating and cooling. The system is going through the tests at present. The systems consists of thermal accumulative panels with active heating a cooling means - photovoltaic panels. The communication of the control system used is based on LONworks field bus with PID controllers with adjustable individual parameters. The controlled thermal accumulation properties could substantially decrease the energy consumption for heating and cooling and to utilize the renewable source of energy (thermal pumps, solar energy etc.). The system as designed could be used as a experimental base for the above described application testing a validating the results of computer simulation of the complicated thermal systems*
Key words: *Laboratory, thermal panels, LONWorks, PID controllers*

1. INTRODUCTION

Thermal properties of buildings prescribed by the present valid legislature are on the edge of economical sustainability (energy connected with farther increase of thermal insulated properties of building sections exceeding the energy saved by the measure itself). The next fact is that highly thermally insulated buildings without mechanical cooling (so called passive houses) based on low thermal accumulative properties could be in some situations overheated by internal and external heat gains – i.e. the effort to decrease of heating degree days could result in increasing cooling days (hours). It could be pointed out in this sense, that so called passive buildings from the point of view of energy consumption for heating, might be highly active from the cooling point of view. That is why there is effort to decrease energy consumption by other means in this field. The real possibility to decrease energy consumption is thorough optimization parameters of all involved quantities and their relations, which have an influence to energy consumption in buildings.
In the concrete field (HVAC), it is the primary task to optimize the thermal insulating and thermal accumulative parameters of buildings, its HVAC system and its performance .

Just mentioned inertial parameters of buildings, could have a substantial influence to reduction of degree days (either for heating and cooling) as well as an effective utilization of renewable sources of energy. From the point of view of control of inner thermal condition of building with the operative temperature as a desired value, the thermal inertia parameters buildings and utilised HVAC system and its control are of equal importance. By the other words, there is possible to optimise building, HVAC system and its control to achieve minimal energy consumption either for cooling and heating, at minimal cost. But solution of this task by analytical methods is possible only for simple application or with substantial simplifications. The complicated tasks might be solved by simulation methods. There exists a number of simulation methods used to model the individual conditions and parameters energy consumption in buildings, but it is difficult to evaluate the results experimentally. For the reason of experimental evaluation of simulation methods reliability (particularly modelling the boundary conditions) the controlled accumulative system has been built in the laboratory of intelligent buildings in faculty of applied informatics, Tomas Bata University in Zlin.

2. METHODS

The system consists of thermal accumulative panels with active heating a cooling means - photovoltaic panels. The communication of the control system used is based on LONworks field bus with PID controllers with adjustable individual parameters. The system is supplied by AC 230 V and it is possible to supply the system by the current from the photovoltaic system. The DC generated by the panels is transformed to the parameters of the main.
Both generated and consumed electricity consumption is measured. The panels could be heated by two ways, either by electrical heating foil connected to the main or by water piping build in the panel. Water is heated by other laboratory device. The panels can be cooled by water piping installed in the panels. Water could be cooled by thermoelectric heaters or by the other laboratory device.

The whole system is controlled by means of the compact control units based on the DDC control with main station (master) and satellites units (slaves). The main station collects the data from the control process. The individual controllers could be adjusted by main station, which has farther functions, like monitoring the process, collecting and transmitting the data by communication gate to the internet via the TCP/IP protocol. The basic scheme of the system is shown on the Fig. 1. The hydraulic circuits are connected to the sumps of cooled and heated water. The circuits are designed in the way, which enable to heat or cool the thermal accumulative panels by one piping system connected. The scheme of hydraulic circuits is shown on the Fig.2.

Fig. 1. The basic scheme of the system

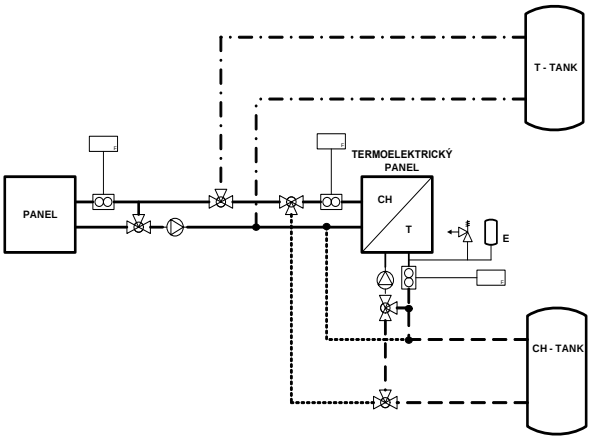

Fig. 2. The scheme of hydraulic circuits

From the point of view of research, the basic part of the system is the thermal panel. The panel is built as a composition of set of 24 individual panels with the total size 2,4 m x 2 m. . The active part of the panel is an organic PCM wax, which changes the solid state to the liquid one within the temperature range from 21 ^{o}C to 27 ^{o}C. The total thermal capacity within the temperature range is higher than 170 kJ/kg. Thermal conductivity of the wax is 0,14 - 0,18 W/(m.K). The section of the panel shows Fig. 3.

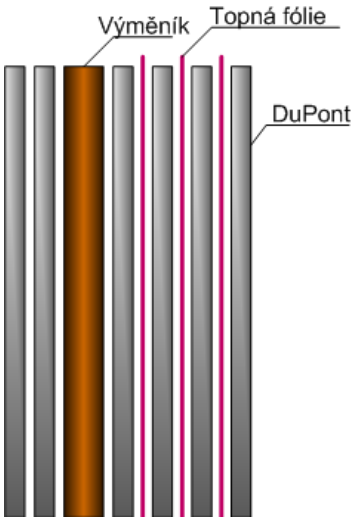

Fig. 3. The section of the thermal panel

It is used a distributed field bus for monitoring a and control of the processes. The kernel of the system are created by compact units based on DDC type of control. These units are based on control logics and provide connection of measurement field sensors and active elements. They are equipped as well analogue-digital transducers and all necessary input and output accessories, which enable to control the active parts of the system as pumps, control valves etc. Due to great numbers of control points and sensors, five control units are installed in the system. The units communicate peer to peer on the base of LONWorks network, which enable the connection of the field bus with the operation station. The operators could communicate with the individual control units and to configure them via LNS server. Data from LNS server could be transferred to OPC server, which enables to transform the data to the graphical environment. The system could be operated then via TCP/IP protocol by remote control. Fig. 5 shows the architecture of the control system.

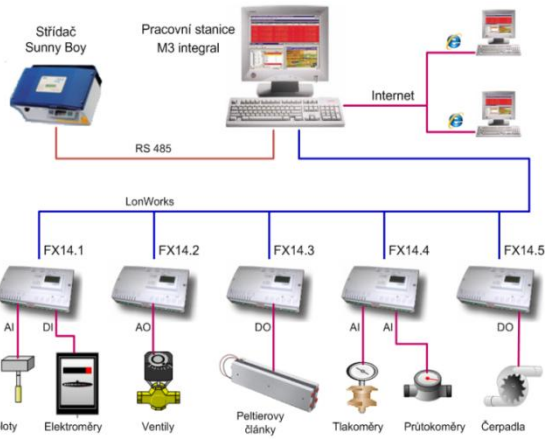

Fig. 4. Architecture of the control system

3. RESULTS

The construction of system should has had overcome some weak points and obstacles as concern as the thermoelectric cooling system hydraulics, piping structure inside the thermal panel (to assure uniform temperature distribution), electrical connection and installation. First tests of the system performance shows that the intent of the project – research of the thermal properties of the room with the controlled accumulation - could be achieved.

4. CONCLUSSION

The thermal accumulation properties of buildings are directly and indirectly connected with energy consumption for heating and cooling of the same. The controlled thermal accumulation properties could substantially decrease the energy consumption for heating and cooling and to utilize the renewable source of energy (thermal pumps, solar energy etc.). The system as designed could be used as a experimental base for the above described application testing a validating the results of computer simulation of the complicated thermal systems.

5. ACKNOWLEDGEMENT

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