**11th International Research/Expert Conference**
**"Trends in the Development of Machinery and Associated Technology"**
**TMT 2007, Hammamet, Tunisia, 05-09 September, 2007.**

# NEW LABORATORY IN TOMAS BATA UNIVERSITY AS A MEAN AND ENVIRONMENT FOR MODELLING OF CONTROL SYSTEMS OVER SYSTEMS WITH ACCUMULATION

**Martin Zálešák**
**Tomas Bata Univerzity in Zlín**
**Faculty of Applied Informatics**
**Department of Automation and Control Engineering**
**Nad Stráněmi 4511, 760 05 Zlín**
**Czech Republic**

## ABSTRACT
*A new multipurpose laboratory of technology in buildings has been built in Tomas Bata University, Faculty of Applied Informatics and set into test operation.*
*Laboratory comprises several subjects like modern HVAC system application, with renewable source of energy implemented (solar collectors and reversible heat pump application), modern system of control, based on the open bus communication system of KNX, communication gate based on the TCP/IP protocol.*
*The laboratory has several function, but one of them is an avaluation mean of thermal modelling methods. The work describes the laboratory and brief results of modelling of the thermal behaviour of the laboratory by using FEMLAB modelling programmes*
**Keywords:** laboratory, thermal modelling, HVAC control system, KNX bus system

## 1. INTRODUCTION
A new multipurpose laboratory has been built in the Faculty of Applied Informatics in Tomas Bata University at Zlin. The aim of the project was to build multipurpose laboratory as an experimental educational, research and development base ground for subjects dealing with applied control system in advanced building technologies systems (Intelligent buildings) enabling study and evaluation of specific parts of the system and system as a whole as concern as a its function, control and communication.
Particularly the project represents the heating, ventilation and air conditional system (HVAC) and its components, renewable sources of energy utilization, lighting and safe technologies application, applied communication technologies, open control and monitoring system, meteorological parameters study and transfer, thermal modelling techniques training and evaluation.
Laboratory will so fulfil one of necessary conditions for introduction of a new study subject - intelligent buildings technologies, with necessary study of selected parts of heat transfer, control and communication systems and specific building technologies.
In the above stated sense, the laboratory could be divided into parts as follows:
- technology of HVAC systems with renewable energy sources utilization;
- heat transfer processes technologies and components study;
- control and monitoring systems technologies;
- safe and security technologies communication training;
- thermal modelling;
- meteorological parameters measuring techniques, data transfer and utilization.

## 2. TECHNOLOGY OF HVAC SYSTEMS

Technology of HVAC systems is represented by an air-conditioning system with utilization of renewable sources of energy.

### 2.1. Air system

Income fresh air is sucked via external wall inlet, passing via air filter, heat recovery part (represented by plate heat exchanger), then passing to heat exchangers (coolers and heaters) and then is distributed by fresh air fan to the laboratory room via air distribution system. The system is schematically shown on the figure 1.

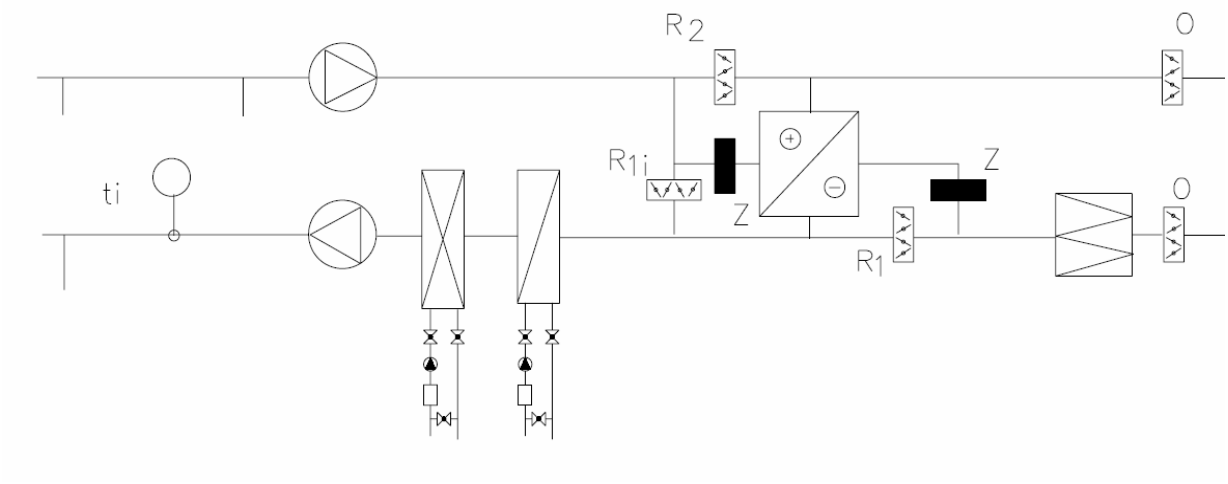


*Figure 1. The HVAC system schema*

Exhausted air is sucked via outlets placed in the false ceiling by the exhaust fan and going opposite way via heat recovery system to the outlets located on the roof. The air-conditioning system view is shown on the figure 2.

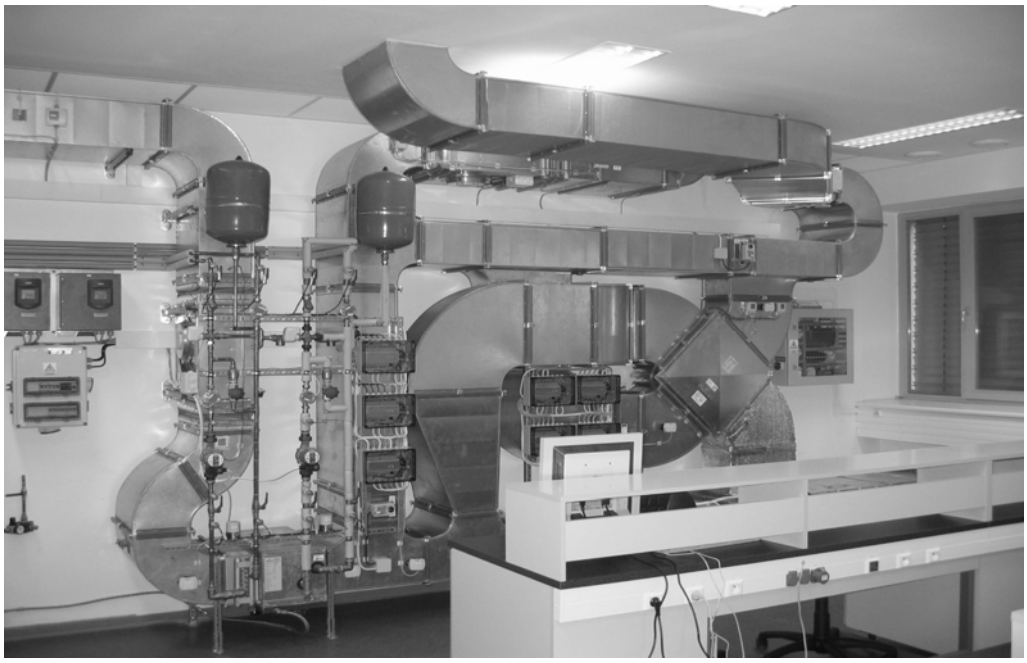

*Figure 2. View on the air-conditional system*

## 2.2. Energy system

As a basic energy source of heating and cooling is used a heat pump, with energy utilization of superheated coolant gas. The heat pump operates in both modes - heating and cooling. Farther the bivalent electrical heater in combination with a solar collector is utilised for heating. For the case of cooling and heating operation within one day, which is required in certain period of a year, the vessels accumulating heating water and cooling water are supplied. The energy system is shown schematically in the figure 3.

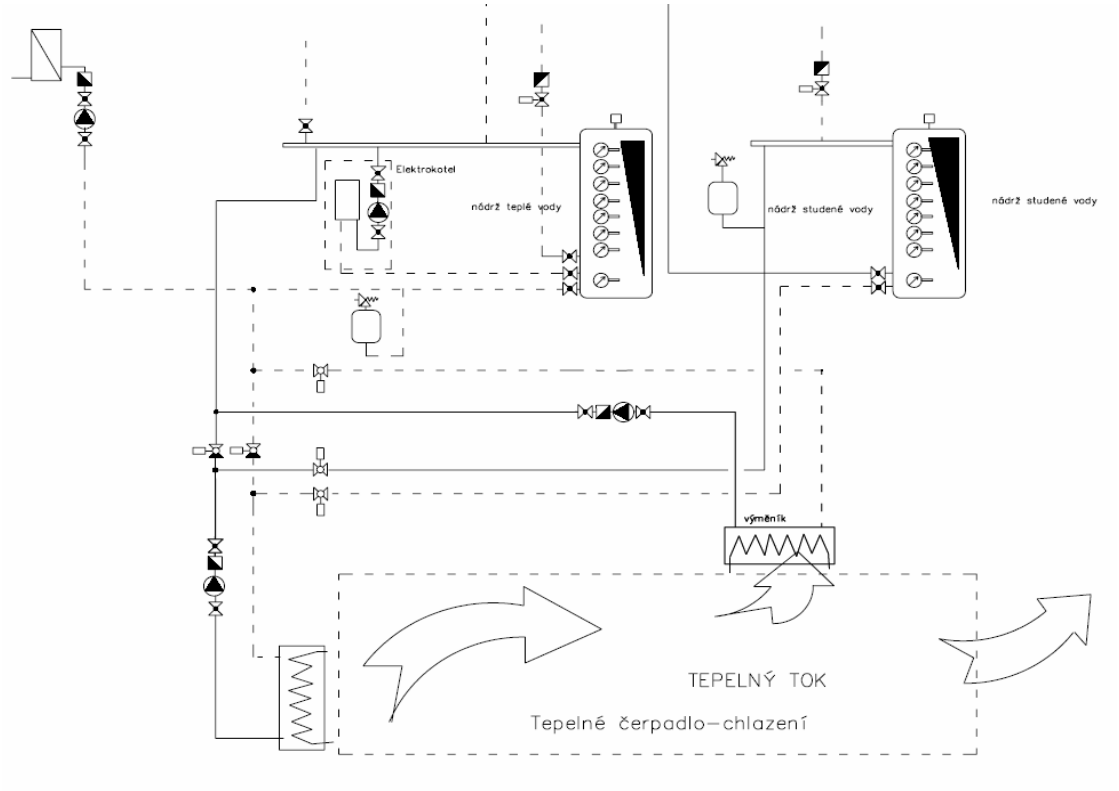


*Figure 3. The energy system*

## 2.3. Control and monitoring systems

Control and monitoring system of the HVAC system is based on the open bus communication system of KNX with communication gate based on the TCP/IP protocol.

## 3. MODELLING

Technological device applied in the laboratory may be used as well as a mean for evaluation of the modelling methods of thermal behaviour of complicated systems generally and buildings and buildings parts particularly. Thermo-dynamical parameters - specifically steady state and transient performance of the system - are important for the HVAC system and its control system design. Particularly the parameters such as dead time, build up (rise) time and deliverance time for .second order system are the subject of interest.

From the very beginning the FEMLAB program (3.1 version) of COMSOL was studied as a possible mean for the modelling. To program a segment of building with complicated geometry and structure is a timing procedure and thus means limit for the solution speed.

The modelling procedure in FEMLAB program consists of three phases - i.e. pre-processing, processing, post processing. One of the advantages of the FEMLAB programme is compatibility with ACAD programs and many graphical applications. Disadvantages are complicated creation of the more sophisticated models. The modell of room in ACAD format is shown on the figure 3. Results of comparision of measured and simulated air temperature is shown on the figure 5.

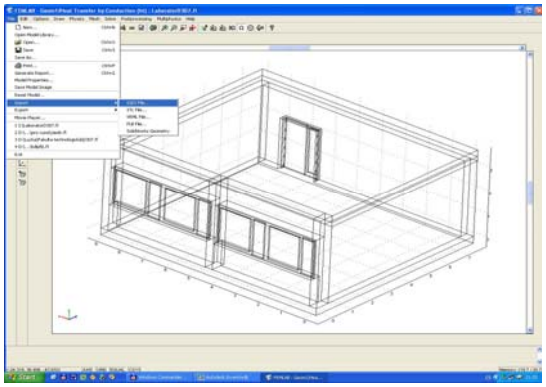

*Figure 4. The ACAD model*

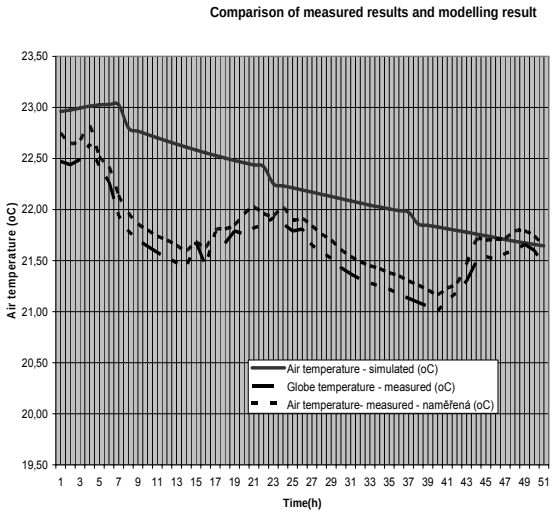


*Figure 5. Results of comparision of measured and simulated air temperature*

The result of thermal dynamic study based on the programmed structure is shown on the figure 6.

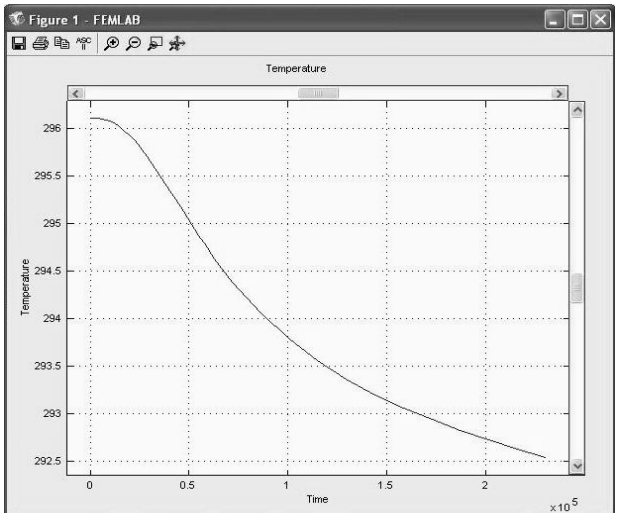


*Figure 6. The result of thermal dynamic study based on the programmed structure*

## 4. CONCLUSIONS

The experiment will continue to study of utilization of other suitable programme tools (ESPr). The aim is, based on the experiment, to have a mean for design of suitable HVAC and control system parameters for different types of buildings in order to optimise their energy consumption during the year.

## 5. REFERENCES

[1] Zálešák, M.: Final evaluation of laboratory of integrated systems in buildings. UTB 2007, Zlin
[2] Šišák, J.: Thermal Simulation and Modelling of the building structure by means of FEMLAB programme. UTB 2006, Zlín