Thermocontrol System for Refrigeration Camera

V. Videkov[1], V. Manoev[2], S. Tabakov[3], M. Manoeva[4], C. Lazarov[5]

Abstract – **The paper presents development methodology and results of 1 year exploitation of a control and back up system for a cold store thermo gram. In case of dynamic cooling off the premises by forced circulation of airflow it is necessary to carefully allocate the control sensors. After the thermo-points are determined they are arranged in specific housing and connected to controller. The reading times for premises thermo- profile display are optimized. After statistic analysis of data, the correction procedures in the software are defined.**

Keywords – **temperature, control, data analysis**

I. Introduction

In many cases the storage in refrigerating cameras requires precise temperature control. Concerning some chemical or other products storage their temperature range can be comparatively narrow. For example, the soldering pastes (1), as well as some foodstuffs (2), are stored at low positive temperatures. When the refrigerating premises are considerably big, it is not enough to rely only on the temperature provided by the air-conditioning system, but control is necessary too. The last is usually associated with data back-up.

II. Task

It is necessary to develop a control system for cold store temperature, giving a real picture for the whole space and notifying for critic A The da B splayed and recorded. Th ould be C. The temperature change range is to be from 4 to 7 ˚C.

III. Approach

To solve this task it is required to develop a system to control the temperature in separate thermo-points, which should be selected appropriately. It is also necessary to develop a system for measuring the temperature with the adequate precision. In (3)the structure of such system is presented as well as the adjustment of the sensors. After development of the system and its implementation it is required a long term calibration to be carried out.

IV. System structure

The system structure consists of modules, connected by information bus and each module includes digital sensors for temperature and interface – fig.1.

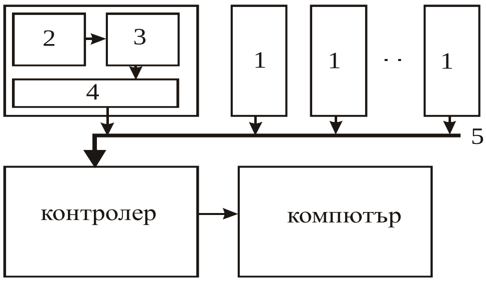

Fig. 1 System block-diagram

The main element in the system is the digital sensor 2, which is a single integrated circuit (smart sensor). Its selection is due to the necessity of data transfer from several thermo-points to a distance.

Except that sensor the measurement module 1 includes buffer 3 and interface 4. All modules along the bus 5 are connected to the controller, which does the primary processing and transmits the data to a computer, where the review and back up are done. It is also possible to visualize the data on a controller display.

Control thermo-points determination is done by taking the thermal picture of the premises and estimating airflows. The premises critical points are defined and connected to the refrigerator airflow system – fig.2, the walls and the entrance of the premises. Crucial is the assessment of the airflow from the refrigerator, where the temperature difference is most substantial. The circulation of the air current is mainly along the ceiling, the back wall and the floor. In the left part on the side of the exit the direction change of the flow is at the height of 70cm. Having in mind the above the amount of the control points (6 in number) and their location are defined. Three of the points turned out to be critical concerning the temperature and air current – these are the exit of the air conditioner, the back wall and the zone of the premises entrance. In order receiving optimal data, another – 7th control thermo-point is used for measuring the external temperature.

The sensors are installed in a special double housing allowing intensive thermal exchange and at the same time defense from mechanical damages during activities in the refrigeration camera. In the first housing the electronic elements and the outgoing connection are placed. In the

[1]Valentin Videkov is with the Faculty of Electronics, 8 St. Kl. Ohridsky blvd. Technical University of Sofia, 1797 Sofia Bulgaria, E-mail: videkov@ecad.tu-sofia.bg.

[2]Ventsyslav Manoev is with the Faculty of Electronics, 8 St. Kl. Ohridsky blvd. Technical University of Sofia, 1797 Sofia Bulgaria, E-mail: ventsy_m@mail.bg.

[3]Serafim Tabakov is with the Faculty of Electronics, 8 St. Kl. Ohridsky blvd. Technical University of Sofia, 1797 Sofia Bulgaria, E-mail: savi@ecad.tu-sofia.bg .

[4]Mariana Manoeva is with the Faculty of Computer Systems, 8 St. Kl. Ohridsky blvd. Technical University of Sofia, 1797 Sofia Bulgaria, E-mail: marymv@yahoo.com.

[5]Cvetomir Lazarov is with the Faculty of Physics, University of Sofia, Sofia Bulgaria, E-mail: qaz@mail.bg.

second external housing the internal one is placed and the connection with the communication network is established – fig.3. The volume of the camera is 200 m^3.

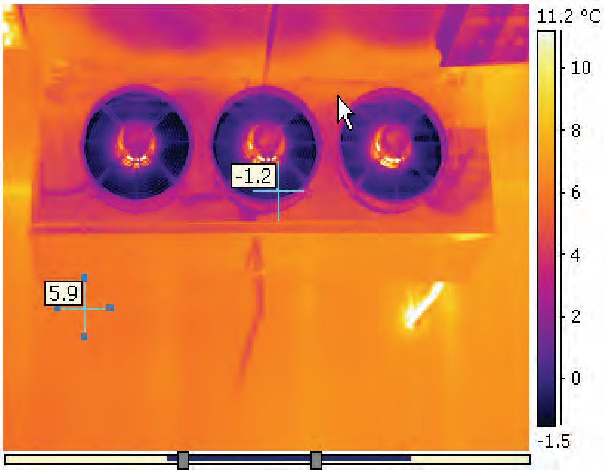

Fig.2 Thermal picture of freezing aggregate.


Fig. 3 Temperature sensor – installation and communication channels

III. Result

At the first configuration of the thermo-points it was established considerable external influence, from the operation of the air-conditioner and other power systems. The dynamic range of changes showed certain incompatibility with the physically determinable processes – fig.4.

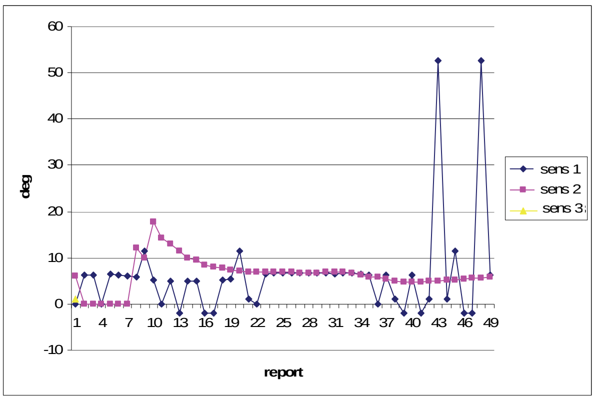

Fig. 4 Sensors data without filtration

A filtrating function is developed to ensure proper data transfer and physical characteristics of the system. In addition the sensors are connected in a contour reducing the external electrical influences. That allows acquisition of considerably more reliable data from each thermo-point. Fig.5 shows part of extract for February 1, 2007 after software data check-up, and fig. 6 shows a fragment after applying complete control according also some physical criteria (December 12, 2007).

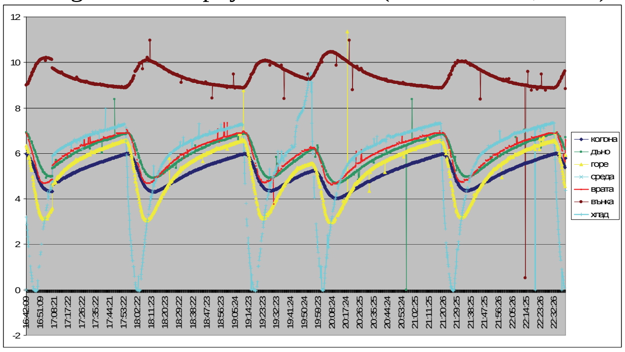
Fig. 5 Software control of data transfer

The acquisition of reliable data allows not only monitoring and recording the temperature of the premises but also to analyze other processes with different elaboration and function, as the operation of the air-conditioner (regardless of its control system), presence of air circulation, influence of external temperature, etc. Fig 7 shows a fragment indicating opening of external doors and change in the cycle of the external sensor.

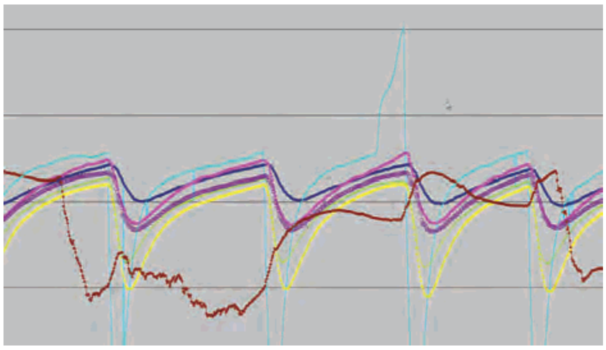
Fig. 7 External temperature change (offsets in one of the sensors shown– the external one)

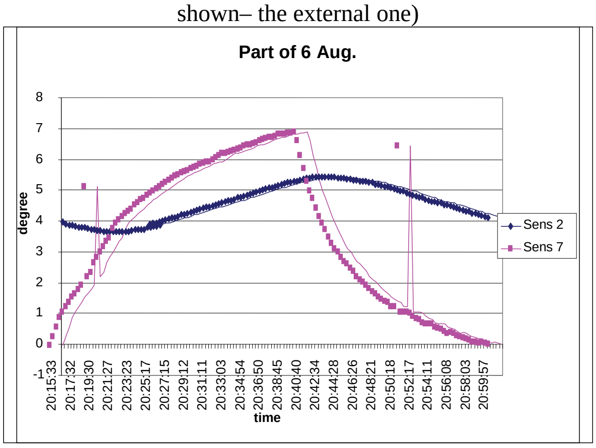

Fig. 8 One detail of the operation of two neighboring sensors in short term interval

That led to introducing the common correlation analysis for couple of sensors. When keeping the correlation dependence there is “calm” situation in the premises. In case of change there is irregular situation. Results from the correlation analysis of separate couples of sensors can be seen on fig. 9

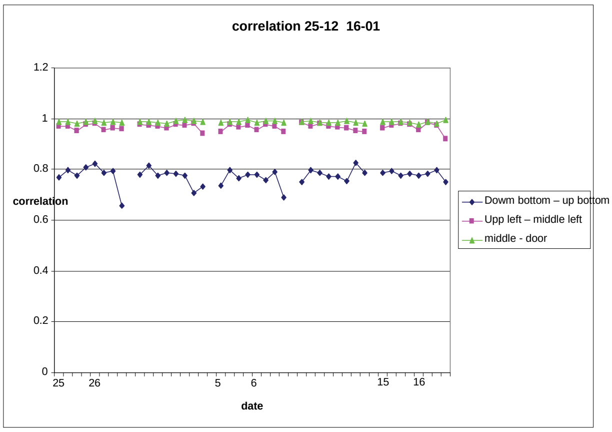

Fig. 9 Correlation links between separate sensors.

In the table below the summarized results for the worst case scenario temperature conditions - of high external temperature in August 2008, are displayed.

date	middle	bottom	door
6-21.08			
Average temperature	3.898135	4.815219	5.992638
max	5.65	7.04	7.25
min	1.84	0.71	4.65
dispersion	0.86446	0.605429	0.575312

IV. Conclusion

A control and back-up data system for cold store temperature distribution is developed. For proper operation of the system hardware and software precautions of the noise influence are applied. Thus the data records can be used in short term as well as for long term intervals. The results can be used not only for direct temperature assessments, but for indirect assessments of premises situation as well.

Reference

[1] http://www.elfaelektroonika.ee/cgi-bin/web_store.cgi?artnr=!82-925-00&lng=rus&ddl=1#desc

[2] Bazarnova Y. G., Polyakov K.Y., Accelerated Control of Storage terms of Refrigerated Meat Products. FOOD and PROCESSING (In Russian) Theoretical magazine 2, 2008

[3] V. Videkov, V. Manoev, S. Tabakov , C. Lazarov, **CALIBRATINING DIGITAL CHIP SENSOR FOR TEMPERATURE** Measurement and measurement equipment 2007 XVII-th National Scientific Symposium with International Participation, Sozopol, September10-14, 2007, Proceedings ISBN 978-954-334-061-3 pp. 253-256