

Long-Term Experiment in Cryogenic Chamber

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Abstract: This article deals with the experiment involving monitoring of human being vitality and environment measurement in the cryogenic chamber through long-term stay. The aim of this work was to design and build a device with proper sensors that allows data measurement and transmission to the computer under extreme environmental conditions as very low temperature in the chamber mentioned above. For vital functions measurement and monitoring there were used commercial ECG and pulse oximetry devices with software driver and visualization software realized on Technical University of Ostrava. For process data there was used a new realized device and software too, given for this specific task. First the fundamentals of cryogenic chamber therapy are described. Furthermore importance of individual quantities measurement to the wireless transfer of data using bluetooth technology. Results of the experiment and medical conclusion are evaluated.

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1. INTRODUCTION

The basic task of this experimental work was to prepare a life support measurement. But this experiment was primary focused to gain funds and financial support for trip in deep frozen parts of the world. The answer for question who needs is very easy. Adventurer, walker, fireman, volunteer (and patient) in the following text. If you want to sleep in the one of most cold place on the Earth you must be ready. It is not about boots and clothes only. It is about inner strength and health. And if you want to prove it, you must find right physician and right place for the verification.

The right place for the experiment was found after on year. It is cryogenic chamber in Teplice nad Bečvou, Czech Republic or exactly it is staff with resolve to support this experiment. In this chamber is temperature about -120°C and enough place even for lying patient, its monitoring and environment variables measurement, the chamber roof is transparent. Cryogenic chamber team agrees with experimental long-term stay of human being inside. The time of stay is set to eight hours.

The right physician agrees with experiment too but he needs to prepare basic conditions for smooth course of experiment - monitoring of vital functions (temperature, ECG, level of oxygen of human) and environment inside cryogenic chamber, respectively monitoring of the living bag where is volunteer lying (level of carbon dioxide, temperature, humidity, see Rajmanova et al. (2015)). The living bag is isolated by ground with woody bed.

The fundamental question is set and it waits for an answer. Is it possible to be eight hours or more in such very low temperature space?



Fig. 1. Cryogenic chamber entrance.

2. CRYOTHERAPY AND ITS BENEFITS

The cryotherapy or extreme cold treatment is a therapeutic method which involves the application of a dry deep freezing (at a temperature from -110°C to -130°C) on the outer surface of the human body for a period of 2-4 minutes, causing physiological response of the organism to cold.

Cryotherapy is particularly effective against pain and increases mobility in the affected limbs. Cryotherapy overall effects on the entire human body is accompanied by a significant strengthening defenses against acute and chronic illnesses. Cryotherapy is also used as part of a after sport and additional reconditioning activities.

The late 70s of the 20th century introduced the icy cold treatment gas or air. Then physicians began to use the stream of icy gaseous nitrogen at -180°C which was applied for up to one minute on painful knuckle-bones.

Nowadays they are also used instruments based on the carbon dioxide (-75°C) or icy cold air at temperatures about -30°C , which is applied to the affected area for 3 minutes. The lower temperature is below freezing point, it's decreasing time for application but the main indicator is the cold subjective perception of patient.

The aim of whole-body cryotherapy is a short stay in cryogenic chamber, see figure 1, with optimal treatment temperature from -110°C to -130°C as mentioned in previous paragraph. After cryochamber leave it is needed to complete aerobic physical exercise that lasts about 15 minutes. Cryogenic chamber contains modified dry air inside, technically absolutely free of humidity, so deep frost will not harm the patient. This procedure does not reduce the body temperature, but it is quenched its surface, so there is a huge peripheral congestion, metabolism speeds up and the healing processes begin.

3. CRYOGENIC CHAMBER ENVIRONMENT MEASUREMENT

For the successful progress of the experiment, it was necessary to measure some physical quantities that could endanger the human health. These values must be available in real time and also there was mandatory condition indication of exceeding the limit values (Walendziuk and Sawicki (2014)).

3.1 Carbon Dioxide Level Measurement

This measurement is very important for a human inside the cryogenic chamber or living bag with human being respectively. The truth is that normal time of treatment is in numbers of minutes and that's why there is natural replacing air in the chamber, moreover the chamber is ventilated automatically with chamber control system during certain period. However for a long stay we can not rely on the automatic control yet. Therefore it was used for measuring carbon dioxide sensor that was connected to a monitoring system and a long-term alarm would mean the end of experiment.

CDM4160-H00 pre-calibrated module with TGS4160 (figure 3) sensor was used for carbon dioxide measurement

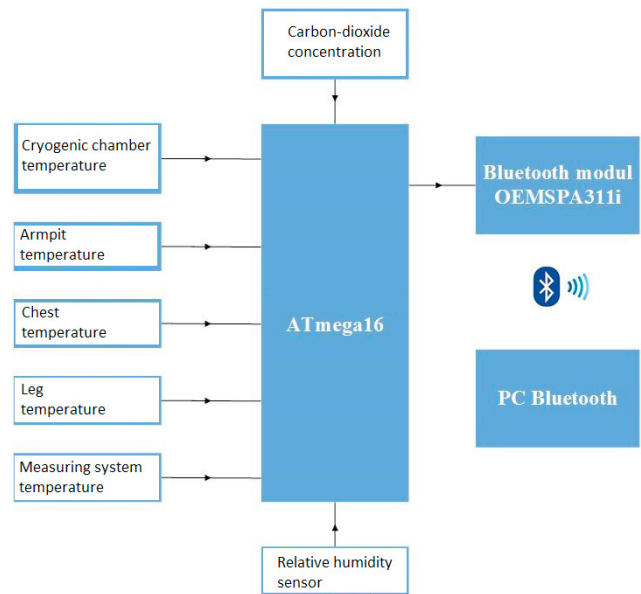


Fig. 2. Block scheme of measurement system.



Fig. 3. CDM4160-H00 pre-calibrated module for carbon dioxide measurement.

from FIGARO company. CDM4160 is resilient electrolytic sensor with DC supply 5V and it has an analog output voltage proportional to the concentration of carbon dioxide, see Prauzek et al. (2015); Konecny et al. (2013). Its operational temperature range is from -10° to 50°C . Last interesting information is the power consumption which is about 1.3W!

The module is placed inside the box, which concentrates sensor outputs and converts messages for Bluetooth wireless communication. Given the working conditions, the entire box is stored in the living bag with the human being and the concentration was measured in a small space close to the measured person. The small fan was used for easy periodic ventilation of sensor. The manufacturer strongly recommended to refresh the sensor without blowing into it, this may result in irreversible deformation. CDM4160-H00 module is capable of measuring the concentration of carbon dioxide (Hajovsky et al. (2013a,b); Hajovsky and Pies (2015); Pies et al. (2013)) in air in the range from

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