A chip black body model.

M. Fidali*, M. Mikulski*

**Department of Fundamentals of Machinery Design – Silesian University of Technology, Gliwice, Poland*

Abstract

Black body is fundamental idea in thermographic measurements. Physical model of black body is necessary in calibration of thermovision devices and also is used as a reference of emissivity. Perfect model of black body with emissivity ε=1 is difficult to make. There are devices with known emissivity closer to unity eg. ε= 0,95 [2]. The devices are made as an radiators and its construction based on different ideas. Common feature for commercial solutions is high price. In [1] simple idea of high emissivity black body reference was presented. The idea is based on conical geometry. Detailed explanation and discussion can be found in the article [1].

On the basis of presented idea authors decided to design and build physical model of black body.

First step was analysis of conical geometry and selection of such cone dimensions which make it possible to manufacture. In Fig. 1a. is presented the conical geometry which computational emissivity is ε_{app}=0,9747 with assumption of emissivity of cone internal surface ε=0,9. On the basis of theoretical model a real cone was manufactured Fig 1b.

a) b)

Fig. 1. Conical geometry and its computational emissivity a) and manufactured cone b)

The cone was build in thermo isolated steel vessel which was filled the water. In the vessel were also located a heater and mixer. All this things was necessary to get isothermal condition and uniformly temperature on cone internal surface. Internal surface of the cone was painted black in order to get surface emissivity closer to 0,9.

In order to change temperature of conical radiator microprocessor temperature controller was built. Diagram of main parts of the controller is presented in Fig. 2b. Main part of the controller was microprocessor Atmega8 with implemented temperature regulation algorithm. Controller was based on signals from four temperature sensors DALLAS DS18B20 located on external surface of the cone. Controller allows temperature regulation in range from room temperature to 80°C. Narrow temperature range results from narrow measurement range of applied temperature sensors as well as boiling temperature of water. All components including power supply were build in old computer housing as shown in Fig. 2a

a) b)

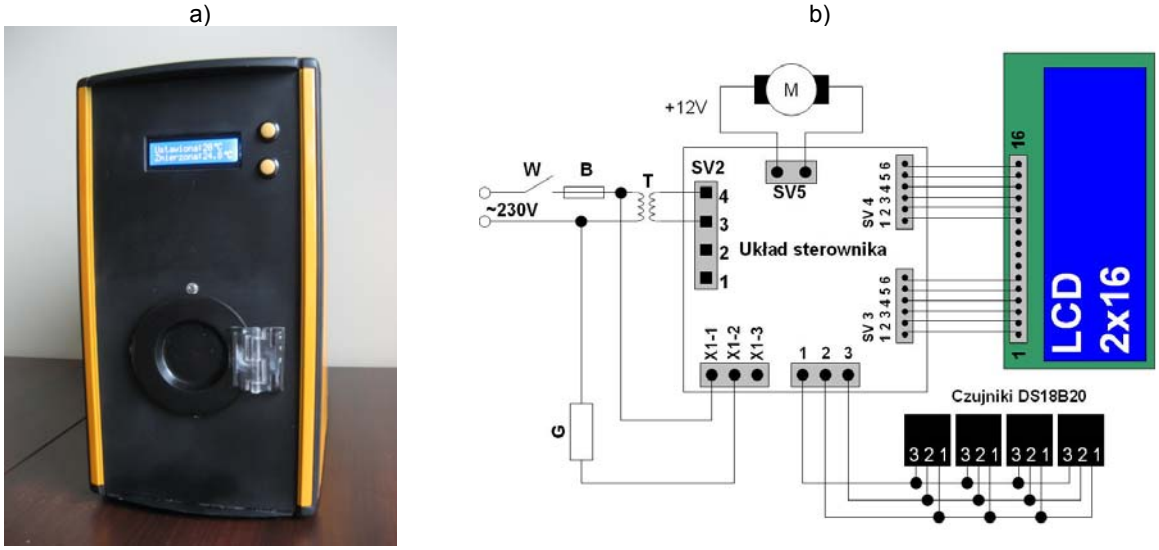

Fig. 2. Black body model a) and diagram of its temperature controller b)

Model of the black body was investigated with use of themovision camera. Series of measurements were done in case of check whether real emissivity value agree with computational one and also in case of estimation of quality and accuracy of the device. In Fig. 3 exemplary thermovision image of the conical radiator with temperature profile and some of characteristic points is presented.

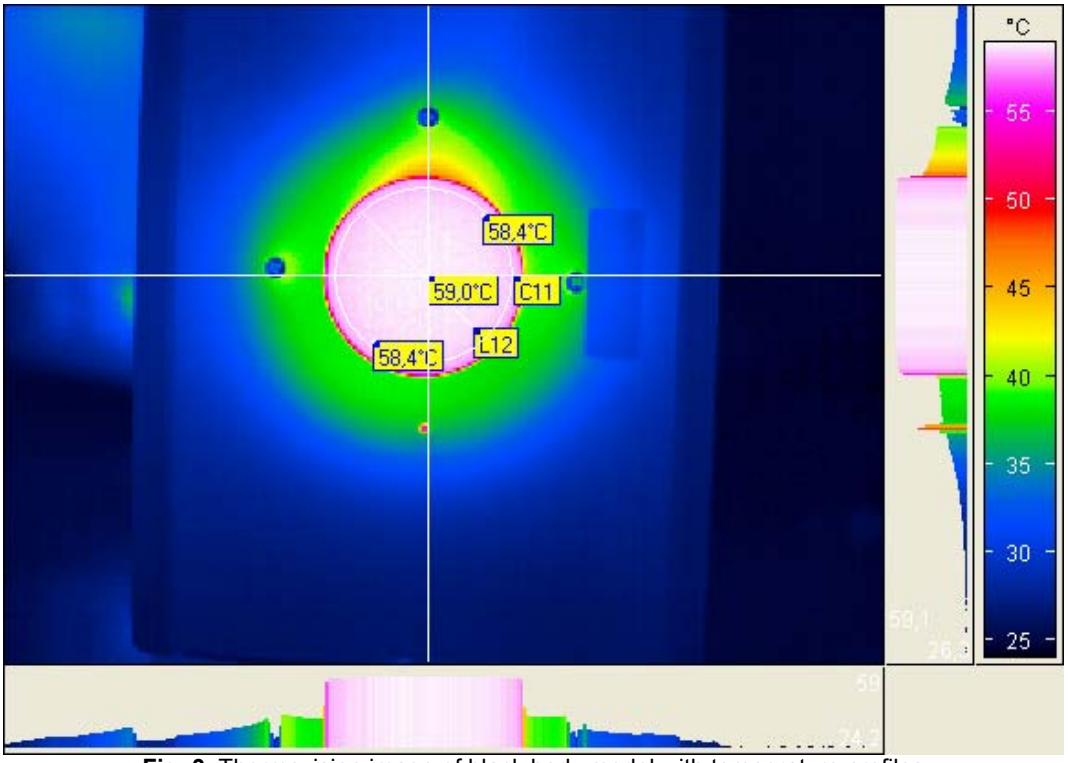

Fig. 3. Thermovision image of black body model with temperature profiles

In Fig. 4. plot of emissivity of the device values as function of temperature set in controller is presented.

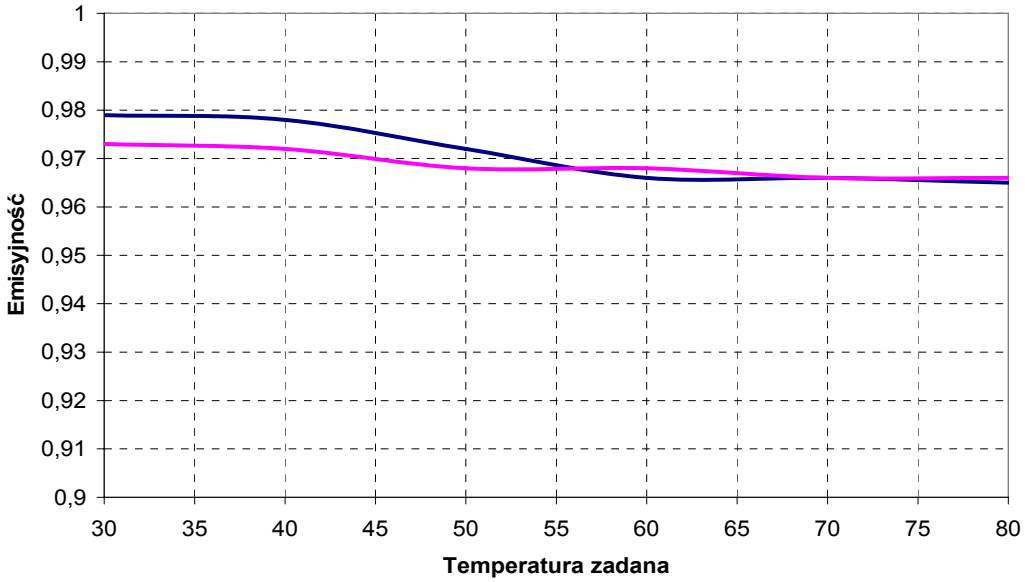

Fig. 4. Real values of emissivity of designed black body model

It can be stated that designed and built black body model has quite good parameters. Its emissivity in whole temperature range is higher than 0,96. Temperature distribution on bottom surface of the cone is flat. If we consider that total cost of the device was about 50 euros we can say that we got chip and useful reference of emissivity.

REFERENCES

[1] G. De Mey, B. Więcek. How to design a black body?. Proceedings of VII ConferenceTermografia i Termometria w Podczerwieni TTP 2006, Ustroń-Jaszowiec, 16-18 November 2006, Poland.

[2] Web page http://test-therm.com.pl/ir/blackbody.htm