EVALUATION OF SPECIFIC HEAT CAPACITY AT CONSTANT PRESSURE FROM THE DEFORMATION ENERGY OF SOLID BODY

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SUMMARY
In this paper, we present the experimental results from the determination of c_p [J/kgK]. The method has been tested on the copper samples as well as the HDPE (high density polyethylene). We obtained very good agreement of all obtained experimental results with those of comparative ones.

Keywords: high-density polyethylene, specific heat capacity, tensile test

1. INTRODUCTION

The creation of heat in the process of material deformation contains information about thermal properties of the material under investigation which is relatively shielded. It is necessary to find a proper method complementary applied to tensile test which discovers these parameters.

Population dynamics is often *exponential* (up or down), as well as many physical processes such as heating/*cooling*, radioactive decay, etc. This is the type of exponential decay, which is described in a logarithmic equation. This means that, although the temperature of a body will get closer and closer to that of its surroundings, the two temperatures will never be equal. Fundamentals of heat transfer theory are described in [1].

Tensile test is old but useful method for the determination of “critical” mechanical material’s parameters. Tensile test is formally standardized by *ISO 527-1-2* [2].

In this paper we deal with presentation of results (for two materials) of determination of thermal material´s parameters from the tensile test. The values of specific heat capacity c_p *[J/kgK],* were measured and evaluated.

2. EXPERIMENTAL TECHNIQUE

The experimental apparatus consists of thermovision camera *VIGO THERM V-20* system with the sensitivity in investigated temperature span equal to *0.01* degree of Celsius. The mechanical deformation of the sample was realized by tensile test machine *Hounsfield H20K-W*. The deformation of the sample was recorded by extensometer *PS25C from Tinius Olsen*.

The thermovision camera was in the perpendicular direction to the deformed (pulled) sample (see Fig. 1).

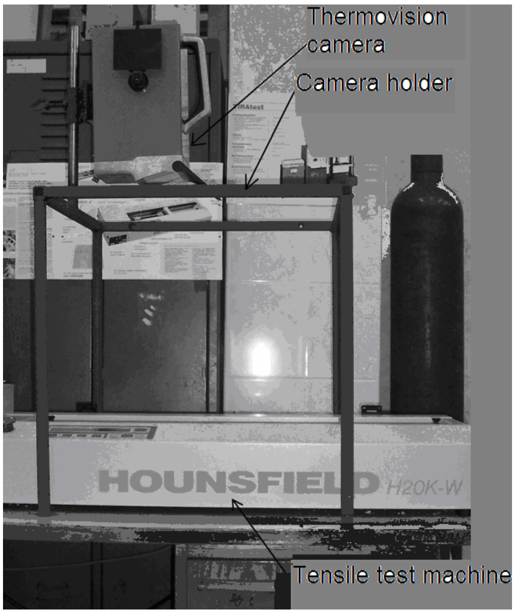

Figure 1. The experimental setup

The sample is pulled and maintained at standard length. The sample temperature rises because of deformation. From the temperature monitoring by thermovision camera the specific heat capacity c_p *[J/kgK],* is obtained according to relations

$$c_P = \frac{W}{m.dT_{\max}}, \tag{1}$$

$$W = \int_0^{dl_0} F.dl, \tag{2}$$

where F is the force and dl is an extension, dl_0 is the maximum extension, m is a sample mass, $dT_{\max}$ is the maximum sample temperature immediately after deformation.

To test our method for the thermally high conductive samples, in the first step we would like to present the results of thermal parameters for samples of copper. As a second tested material we used sample of *HDPE.* We have used the commercial *HDPE* described by material list presented in the Table1.

Density of samples was measured by application of *Arhenius law* in isopropanol alcohol. Observed density value was equal to *968.4* kg/m^3.

Metallic samples for the tensile test were prepared according to *STN 10002-1*. *HDPE* samples for the tensile test were prepared according to *STN ISO 37*.

Table 1. The HDPE material list [3]

HDPE 5502	method	unit	typical value
Melt flow rate(190C/2.16kg)	ISO 1133/D	g/10 min	0.2
ESCR Antarox 100%	ASTM D 1693B	h	F50 = 50
Notched Charpy Impact Resistance 23°C	ISO 179-1	kJ/m^2	16
Density	ISO 1183	g/cm^3	0.954

3. RESULTS AND DISCUSSION

As we can see form the Table 2, the obtained result for c_p is in excellent agreement with the table value.

Table 2. Thermal specific heat capacity of copper [3]

Copper	$c_P \left[J.kg^{-1}.K^{-1}\right]$
Table value	385
Experimental value	385

By the same way we measured the value of c_p for the *HDPE* sample. Results are presented in the Table 3

Table 3. Thermal specific heat capacity of HDPE

HDPE	$c_P \left[J.kg^{-1}.K^{-1}\right]$
Table value	2350,0
Experimental value	2208,5

Obtained results are in a very good agreement with those obtained from comparison with table values.

The presented method is quick and reliable method for evaluation of mechanical and thermal parameters of solid materials. Actually the presented method is under development for evaluation of thermal diffusivity α $[m^2/s]$ and thermal conductivity λ $[W/m.K]$.

4. REFERENCES

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[3] HDPE 5502-material specification, TOTAL PETROCHEMICALS RESEARCH FELUY Zone Industrielle C B-7181 Feluy Belgium.