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S. Tkachenko
O. Vlasenko

STUDY OF THE RATE COOLING (HEATING) OF SUNFLOWER OIL IN DIFFERENT LAYERS AT HEIGHT IN CONDITIONS OF FORCED CONVECTION

Vinnytsia National Technical University

Abstract
The rate of cooling (heating) of experimental liquids was studied separately for five thermocouples located at different heights of the experimental probe.
The theory of a regular thermal regime has been widely used to solve many practical problems: to determine the rate of cooling (heating) of a body, to study the thermophysical properties of materials, heat transfer and radiation coefficients, thermal resistance, etc. The advantages of this method are that the design of the device and the technique of conducting the experiment are simple, the accuracy of the obtained results is quite high, and the time of the experiment is short.
Key words: cooling (heating) rate, thermocouple, excess temperature, regular thermal regime.

Introduction

Non-stationary thermal conductivity corresponds to a thermal regime unstable in time, created by this or that thermal action on the body or environment. Non-stationary thermal conductivity is characterized by the fact that the temperature changes not only from point to point, but also over time. Non-stationary thermal conductivity occurs during heating or cooling of bodies, as well as when starting or stopping heat exchange devices, power units, etc. [1-3].

The purpose of the work: to determine the rate of cooling (heating) of the experimental liquids separately for each thermocouple located on the probe at different heights, under conditions of forced convection.

Research results

The temperature distribution along the heat exchange surface is studied under the condition of forced convection, the hot liquid is cooled, and the cold one is heated. During the study, probes with five thermocouples were immersed in the inner and outer vessels of the experimental stand [4], which record the temperature values at different heights, namely: 3, 27, 44, 64, 90 mm.

Every 10 seconds, the information of the experiment is recorded and displayed on the computer using the appropriate program. During one series of experiments, 80-100 measurements are recorded. Since the temperature of the experimental stand is recorded using a computer, it is possible to vary the number of points in a series of experiments. The series of experiments ends when the temperature of the hot and cold coolants differs by no more than 5ºC [4]. The curve is built from the points of one series of experiments.

Heat carrier temperatures are measured at five points in the external volume V1, and at five points in the internal volume V2, evenly distributed along the heat exchange surface by resistance thermometers. Temperatures are recorded simultaneously at ten points [4].

In tables 1-2 and fig. 1 – 2 show the experimental results for sunflower oil during heating and cooling, under the conditions of the location of the thermocouple at a height of 3, 27, 44, 64, 90 mm. The curve represents the approximation of the experimental data of excess temperature in the form of a function $\text{Ln}\vartheta = m \cdot \tau + C$, where m is the rate of cooling (heating), C is the coefficient of the equation, R^2 is the coefficient of determination. The obtained curve has a linear character, which corresponds to a regular thermal regime.

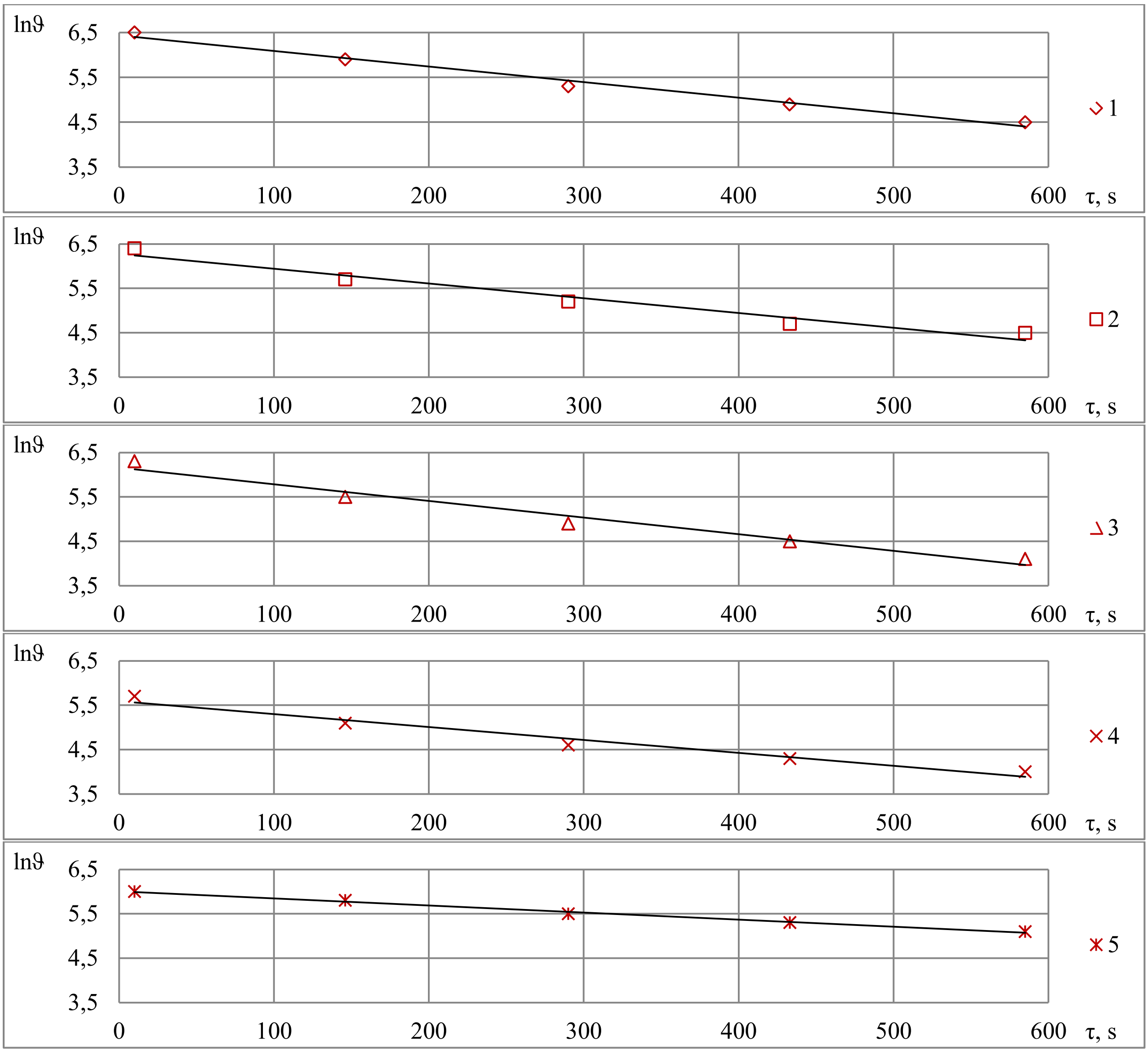

Fig. 1. Comparison of the value of excess temperature for each thermocouple with the average volume value when heating sunflower oil. Location of thermocouples by height: 1 – 3mm, 2 – 27mm, 3 – 44mm, 4 – 64mm, 5 – 90mm.

Table 1 – Heating sunflower oil

№	The height of the location of the thermocouple h, mm	A function of the form Lnϑ=m·τ + C	Coefficient of determination R^2
1	90	y = -0,0035x + 6,4367	R^2 = 0,9852
2	64	y = -0,0033x + 6,2743	R^2 = 0,9611
3	44	y = -0,0037x + 6,1569	R^2 = 0,9689
4	27	y = -0,0029x + 5,5931	R^2 = 0,9678
5	3	y = -0,0026x + 6,0083	R^2 = 0,9931

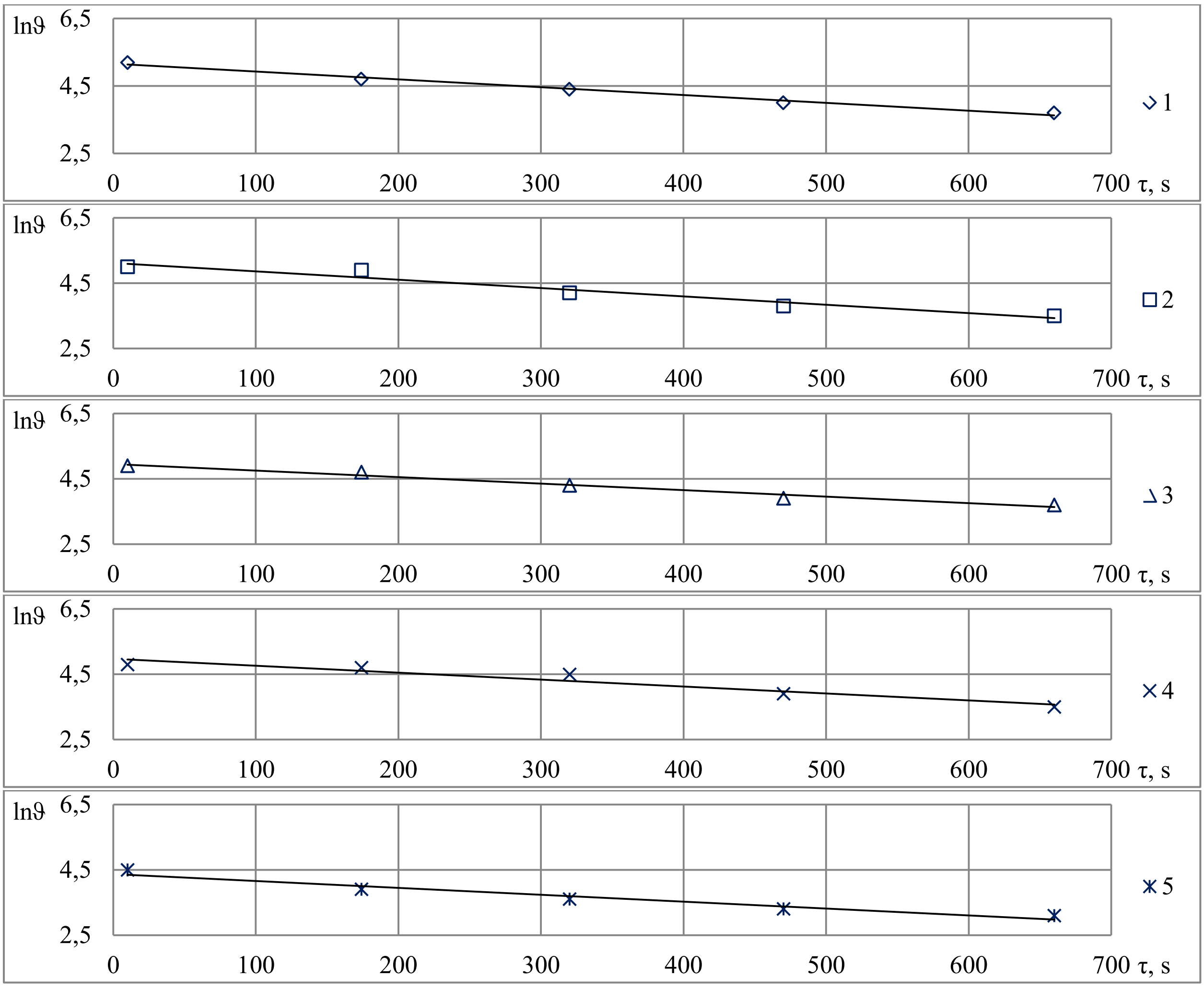

Fig. 2. Comparison of the value of excess temperature for each thermocouple with the average volume value during cooling of sunflower oil. Location of thermocouples by height: 1 – 3mm, 2 – 27mm, 3 – 44mm, 4 – 64mm, 5 – 90mm.

Table 2 – Cooling of sunflower oil

№	The height of the location of the thermocouple h, mm	Функція вигляду Lnϑ=m·τ + C	Coefficient of determination R^2
1	90	y = -0,0023x + 5,155	R^2 = 0,9874
2	64	y = -0,0025x + 5,1133	R^2 = 0,9495
3	44	y = -0,0020x + 4,9508	R^2 = 0,9735
4	27	y = -0,0021x + 4,9773	R^2 = 0,9313
5	3	y = -0,0021x + 4,3719	R^2 = 0,9474

The value m is positive and has a constant value, and is determined by the size and shape of the body, the values of thermal parameters: thermal conductivity coefficient a, thermal conductivity coefficient, specific heat capacity , density and heat exchange conditions - temperature tп and heat transfer coefficient .

The theory of the regular regime provides a simple and fairly accurate method of determining the thermophysical coefficients of a substance and the heat transfer coefficient. The method is based on two theorems of Kondratiev.

Conclusions

The temperature distribution along the heat exchange surface under the condition of forced convection was studied, the hot liquid is cooled, and the cold liquid is heated. During the study, probes with five thermocouples were immersed in the inner and outer vessels of the experimental stand, which record the temperature values at different heights, namely: 3, 27, 44, 64, 90 mm.

The experimental results are presented on the study of the rate of cooling (heating) of experimental liquids separately for five thermocouples located at different heights of the experimental probe under conditions of forced convection.

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Tkachenko Stanislav – Dr. Sc. (Eng.), professor of the Department of Thermal Power Engineering, Vinnytsia National Technical University, Vinnytsia, e-mail: stahit6937@gmail.com.

Vlasenko Olha – Researcher of the Department of Thermal Power Engineering, Vinnytsia National Technical University, Vinnytsia, e-mail: olgakytsak7@gmail.com.