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Short Communication

Method of Measurement Isobaric Heat Capacity of the Organic Liquid

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A technique for measuring the heat capacity of liquids on modernized authors the installation of IT-C_p-400 is considered. The results of measurements the isobaric heat capacity of some bromosubstituted n-alkanes is presented.

Keywords: Differential scanning calorimeter, Isobaric heat capacity, Organic liquid.

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A study of the liquid state of matter is one of the most important problems in the physics of condensed matter. In this regard, to obtain reliable experimental data on the thermodynamic properties of liquids with different molecular structure for a wide range of state parameters and compare them with physically a reasonable promising model is an actual problem of modern physics.

Scanning calorimetric method is the quickest and most effective way to determine the heat capacity a substance in a wide temperature range. However, even the most modern, recently developed experimental systems, such as the DSC-500 [1], differential scanning calorimeters company Mettler Toledo [2] and INTERTECH Corporation [3], and others, are not designed to take measurements heat capacity of liquids [4, 5].

Differential scanning calorimeters of this type are mainly used for thermal analysis and measurements heat capacity of solid and granular materials. They are lightweight aluminum crucibles with samples of the test substances are placed in the thermo block unit, where they are exposed to heating in a programmable scan mode. Analysis of existing experimental devices allows us to offer an effective method of measuring the isobaric heat capacity the liquid by the authors of the modernized industrial device IT-C_P-400 [4]. The proposed method allows largely eliminating defects DSC and increasing the reliability and accuracy of the heat capacity measurements from 10 % to 1-2 %.

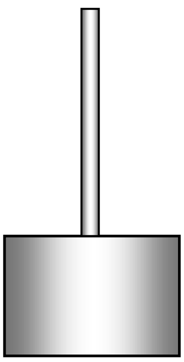

Fig. 1 – The measuring cell

For measurements heat capacity of liquids on the IT-C_P-400, a special design of the measuring cell was used (Fig. 1) and significantly changed the measurement method. The proposed design of the measuring cell allows taking in account a significant expansion of the liquid when heated and minimizes its loss due to evaporation in the measurement zone. To improve measurement accuracy the signal converter is used «Terkon» (Termex, Russia), with which in the scan mode, a continuous record rate of heating and the temperature difference on the heat flow meter (Fig. 2).

The stabilization of the measurement mode and maintain the desired rate of heating is ensured with separate power supply circuits heaters and controlling currents that feed the main and more powerful auxiliary heater, which provides compensation of heat losses.

The temperature of liquid measured by thermocouple (3) on Fig. 2, one of the junctions of that is placed in the test liquid, the other in a Dewar flask filled with melting ice. The free ends of the thermocouples are connected with the «Terkon» channels. The other channel connected with the ends of the differential thermocouple fixing continuously differential temperature of heat meter. In turn, «Terkon» through the COM-port is connected to a computer, with which to record the measured values (the temperature of the sample and the temperature difference on the heat meter), in a continuous mode with fixation of the measured values with a frequency of 135 measurements for each 100 seconds.

Studies have shown that the rate of heating fluid and the cell body are different from each other. Because of the much greater thermal conductivity measuring cell brass body at any given instant has a temperature practically equal to the temperature of the heat meter surface. The same temperature has «adiabatic» shell of the device heating by the auxiliary heater too. This leads to the fact that not only the heat flow controlled by a heat meter heats liquid, but the side heat flow participates in this process. In these conditions the side surface of the measuring cell must be considered as the additional heater and calculation of heat capacity test liquid hold by the formula

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$$c_p = c_p^r \frac{\rho_r}{\rho} \frac{(\Delta t + \Delta t')}{(\Delta t_r + \Delta t'')} + \Delta c .$$

In this ratio of the values $\Delta t'$ and $\Delta t''$ take into account the heat flows coming through the side surface of the measuring cell. As shown by calibration, their values depend on the thermal conductivities of liquid samples and present about a quarter of the total heat flow. The design of the measuring cell minimizes the process of vaporization of the liquid in the heating zone and provides a practically unchanged meaning of heated liquid volume. Because of that corrected factor Δc for evaporation of liquid can be set equal to zero. Fig. 3 shows the results of measurements heat capacity at atmospheric pressure bromosubstituted n-alkanes and their comparison with the data of [6].

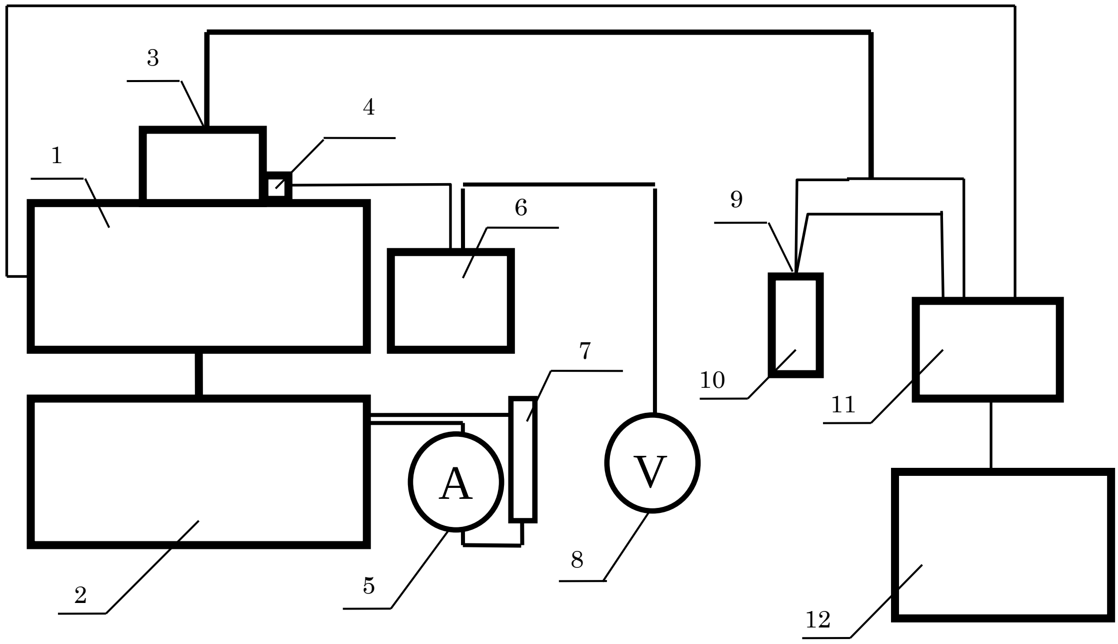

Fig. 2 – Block diagram of the experimental device. 1) Heating unit IT-C_P-400; 2) The power supply and control; 3) Junction chromel-alumel thermocouple placed in the test liquid; 4) Electromagnetic relay; 5) Ammeter; 6) The power supply auxiliary heater; 7) Resistor; 8) Voltmeter; 9) Junction chromel-alumel thermocouple, dropped in the ice melting; 10) The Dewar vessel filled with melting ice; 11) The signal converter «Terkon»; 12) The computer

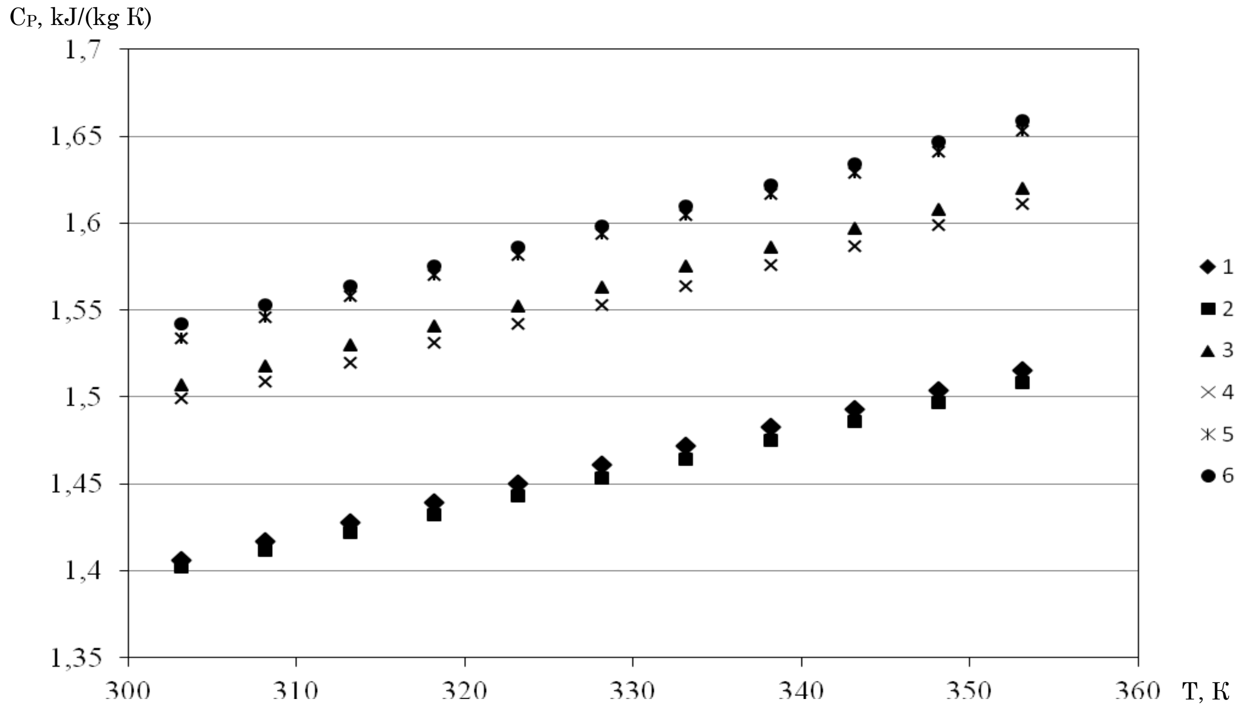

Fig. 3 – The dependence of the isobaric heat capacity on the temperature of hydrocarbons bromo substituted. Bromoheptane: 1 – authors, 2 – [6]; bromononane: 3 – authors, 4 – [6]; bromodecane: 5 – authors; 6 – [6]

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