THE ATP-65V TYPE AUTOMATIC INSTRUMENT FOR DETERMINING
THE MELTING POINT OF PETROLEUM PRODUCTS

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The Leningrad Branch of the Special Design Bureau for Automation in the Petroleum Processing and Petrochemical Industries (LF SKB ANN) has developed and tested the ATP-65V instrument for automatic determination of the melting point of petroleum products in process streams.

Earlier, in the ATP-61 type instrument [1,2] use was made of a two-point potentiometer, which made it complicated to take melting point readings. Besides, the blowing of compressed air through the body of the instrument did not ensure the necessary explosion safety.

The sensor of ATP-65V is of the explosion-proof VZG type, and the secondary instrument is a single-point electronic potentiometer provided with standard converters to obtain current and pneumatic signals. The TK-6 type contact thermometers were eliminated from the instrument circuit; this ensured clear and uninterrupted operation under increased vibrations and at high ambient temperature.

Furthermore, this made it simpler to ensure explosion safety of the instrument.

The principle of measuring the melting point of petroleum products used in developing the instrument was based on the extremum dependence of the value of the luminous flux leaving a measurement vessel when the substance in the vessel changes from one aggregate state into another. The obtaining of this dependence is ensured by the special design of the measurement vessel, which comprises a diaphragm and an opaque screen. These are placed in the path of the light rays passing through the substance being measured from the light source to the photoreceiver.

During measurement a beam of light from an incandescent lamp is passed through the molten substance. The strength of the light beam leaving the measurement vessel is checked with the help of a photoreceiver. The temperature of the substance is measured by means of a thermocouple, the hot junction of which is located inside the vessel.

The luminous flux attains its maximum value at the moment the substance changes its aggregate state, i.e., at its melting point.

The dependence is valid for paraffins and gatches, in whose case divergence from standard measurements by the Zhukov method does not exceed 1°C. If the instrument is used in ceresin or petrolatum streams (of which the drop point is more characteristic), it also ensures good agreement with the results obtained by the standard method (to within 1°C). The instrument needs a very simple adjustment in this case.

In accordance with the block diagram (Fig. 1), the instrument works as follows. After the instrument is switched on with the help of the KIP-12U type electropneumatic command instrument, valves K1, K2, and K3 of the PRK-1-6 type open simultaneously, ensuring supply of water into the vessel's jacket and of molten petroleum product taken from the pipeline to the measurement vessel. The time for which the valves remain open is about 2.5 min, and is determined by regulating the relay circuit RC in the instrument's control block. During this time the product which was in the vessel melts and is displaced from the vessel by the new batch entering under overpressure from the pipeline.

After the above-mentioned valves close, valve K4 opens, feeding cold water to the vessel jacket, and the product in the vessel begins to solidify.
Thermocouple TC, which measures the temperature of the product inside the vessel, is connected permanently to the input of the secondary instrument but the latter's motors (carriage and tape feeder) remain disconnected from the relevant power sources for most of the cycle.

The voltage from the photoresistor PR is supplied to device RB consisting of a rheochord and a bridge circuit with a stabilized power source as well as dc amplifier DCA and reversible motor RM, the shaft of which is connected with the rheochord slide.

At the time of filling the vessel with petroleum products and during the latter's solidification, the luminous flux incident on the photoresistor is quite small and the bridge circuit is balanced in such a way that the rheochord slide remains near its extreme position (the deviation from which is determined by the initial temperature and color of the petroleum product). As the petroleum product solidifies, the luminous flux leaving the vessel increases, leading to an increase in the voltage which goes from the photoresistor to the bridge circuit. This disturbs the latter's balance and motor RM of the device moves the slide to a position that ensures the circuit's equilibrium.

At the instant the petroleum product in the vessel changes into the solid state (i.e., at melting point), the luminous flux incident on the photoresistor, after uninterrupted increase, begins to decrease sharply. At this time, the rheochord slide reverses its direction, actuating thereby the special contact group CG, which is mechanically connected with it, and continues to move toward its initial position.

The electrical signal corresponding to the actuation of the contact group switches on the motors of the secondary instrument for 3 sec through relay circuit RC. During this time the pen of the secondary instrument traces a line which corresponds to the melting point of the petroleum product. The length of the line is 8 mm (at tape speed of 9600 mm/h).

It should be pointed out that the contact group CG is actuated only at the instant the rheochord slide changes its direction, regardless of the angle by which it has turned from its initial position. This excludes, to a considerable extent, the effect of "transparency" (chromaticity) of the petroleum product being measured, a factor which can vary within certain limits for technological reasons.

After the recording of the melting point is completed (i.e., 3 sec after it started), product valves K1 and K3 and heating valve K2 are opened with the help of electropneumatic command instrument KÉP-12U, which receives the necessary signal from relay circuit RC. The measurement cycle starts afresh.

Since the motors of the secondary instrument are switched on only for a limited time of melting point recording, unnecessary use of tape is eliminated and the instrument's recordings can be read off conveniently.

Structurally, the instrument is designed in the form of three separate blocks: sensor block, control block, and secondary (recording) instrument block.

The basic unit of the sensor block is the measuring vessel, which is mounted on a metal frame with the system of valves supplying the product, hot and cold water. The power supply block and the electropneumatic command instrument are also mounted on the same frame. The individual units of the sensor are contained in explosion-proof housing. The sensor block is installed near the pipeline, the product from which is analyzed.

The control block and the secondary instrument are installed in the operator's room at a distance of 100 m from the sensor.

The secondary instrument is the single-point electronic potentiometer ÉPP-09IMZ of the spark-proof type with 8 sec carriage running time and with an "XK" scale from 0 to 100°C. An additional rheochord is fixed in the potentiometer body. It sends voltage to converters NP-T and ÉPP-63, which ensure the production of standard current (0.2-1 mA) and pneumatic (0.2-1 kgf/cm²) signals. This enables the instrument readings to be transmitted to the information computer IVM and be used for pneumatic control.