The character of the temperature distribution and Nusselt number curves is similar to that of the curves shown in Figs. 2 and 3, i.e., the effect of suction on temperature distribution and heat-exchange coefficient is the same for air and helium flow.

**NOTATION**

- \( G \) is the helium flow suctioned through tube wall, g/sec;
- \( T \) is the temperature, °K;
- \( \text{Nu} \) is the Nusselt number;
- \( \text{Re} \) is the Reynolds number;
- \( l \) is the length of porous tube, m;
- \( T_x \) is the temperature of inner surface of porous tube, °K;
- \( T_0 \) is the temperature of inner surface of porous tube at input section, °K;
- \( q \) is the thermal flux density, W/m²;
- \( U \) is the voltage, V;
- \( I \) is the current, A.

**LITERATURE CITED**


**CALCULATION OF CIRCULATION CHARACTERISTICS OF A TWO-PHASE THERMOSYPHON**

A. G. Beinusov and V. B. Utkin

A new method is described for calculating the circulation characteristics of a thermosyphon with separate vapor and condensate channels. Calculation and experiment are compared.

At the present time, two-phase thermosyphons with separate vapor and condensate channels are widely used for heat transfer purposes [1]. The efficiency of thermosyphons of this sort is largely dependent on the circulation characteristics of the closed hydraulic circuit. The circulation of a boiling liquid in closed hydraulic circuits can be estimated in various ways [1-3].

In the present paper we propose a new method for solving this problem as applied to thermosyphons with separate vapor and condensate channels.

A schematic diagram of the circulation circuit is shown in Fig. 1. Here 1 and 2 are respectively the down- and up-pipes; 3 is the condenser. The vaporizer is located in the up-pipe. In the down-pipe there is only liquid; in the up-pipe there is a mixture of vapor and liquid. The equation of motion of the liquid and vapor in a closed circulation circuit (ignoring the compressibility of the components, energy losses on changing the interphase surface, and oscillations of vapor bubbles) can be brought to the form [4]:

\[
g (\rho' - \rho) L \psi = \sum (\Delta P_{fr} + \Delta P_{acc}) \sin \beta. \tag{1}
\]
Resistance in the down-branch and local resistances are neglected.

A special series of experiments were carried out in order to calculate the components of the pressure losses. The investigations were made on an experimental setup consisting of vertically mounted test thermosyphons and a device for heating part of the heat pipe by an ohmic heater. The test thermosyphons were constructed from brass pipes of wall thickness $\delta = 1$ mm.

The pressure was tapped at three measuring sections through 0.5-mm-diameter holes, the distance between which was varied depending on the length of the up-pipe. The pressure was measured by an inverted U-tube differential manometer connected by small-diameter hosepipes to the pressure takeoff units via compensating vessels.

The inertia of the takeoff system was thereby assured, and losses on friction could be measured with sufficient accuracy.

The liquid flow rate was determined in the down-branch by RS-type rotameters or by the method of calibrated resistances. In the experiments we also measured the power supplied to the vaporizer, the temperature of the liquid at the vaporizer inlet, the temperature of the mixture, and the pressure within the thermosyphon.

The technique of the thermal measurements, the sensors and the thermal control instruments were traditional.

The investigations were carried out in the following ranges of variation of the parameters: length of vaporizer $L = 100, 150, 200$ mm; diameter of vaporizer $d = 4, 6, 8, 10$ mm; length of condenser $l_{cond} = 200$ mm; diameter of condenser $d_{cond} = 50$ mm; pressure in circuit $P = 1-4$ bar. The heat-transfer medium was distilled water.

The results of the experiments were treated in the following sequence. The heater-induced relative vapor conversion in the mixture flow was determined via the formula:

$$X = \frac{i_{mix} - i_{sat}}{r} \frac{Q}{rG}$$

The velocity of the mixture was then worked out:

$$W_{mix} = W_0 \left[ X + \frac{\rho'}{\rho} (1 - X) \right],$$

where $W_0 = G/(\rho'f)$.

The results of the experiments were satisfactorily generalized by the empirical relationship proposed in [5]:

$$\xi = 0.04/W_{mix}^{0.25}.$$