INVESTIGATION OF CRITICAL HEAT FLUXES DURING BOILING OF WATER IN TUBES

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The critical heat-exchange is investigated on a uniflow type equipment for pressures of $29 \cdot 10^5$ and $98 \cdot 10^5$ N/m^2 in a wide range of variations of steam content and for circulations with appreciably varying rates. The experimental part of the equipment is a vertical tube ϕ 12 × 2 made of 1Kh18N9T steel with heated length of 370, 500 mm ($p = 29 \cdot 10^5$ N/m^2 and 1570 mm ($p = 29 \cdot 10^5$ and $98 \cdot 10^5$ N/m^2). The tube was heated by passing an alternating current directly along the wall. Both water, underheated to the boiling point, and steam–water mixture were fed into the entrance of the experimental part; the mixture was obtained by preconnecting a single-tube heat-exchanger.

It is found that in the investigated range the regime parameter q_{cr} decreases with the increase of pressure, velocity, and steam content. For the pressure of $98 \cdot 10^5$ N/m^2 the obtained results are in good agreement with those of V. I. Subbotin, B. A. Zenkevich, and O. L. Leskov. The results for $29 \cdot 10^5$ N/m^2, when extrapolated to the region of underheated water, are in satisfactory agreement with those of I. T. Alad'ev and L. D. Dodonov.

The speed of the liquid film, flowing along the wall of the tube, is also investigated as a function of the reduced speed of the liquid and the true steam content. The values of w_f are determined indirectly from the published results of measurement of hydrodynamic drag in underheated two-phase stream in a tube ϕ 8 mm. The results of the analysis for the pressures of $49 \cdot 10^5$, $98 \cdot 10^5$, and 147.10^5 N/m^2 are represented by a single function in the coordinates $w_f/w' = f(Re_0'')$. The values of w_f/w'' decrease with the increase in Re_0''. The obtained dependence $w_f/w' = f(Re'')$ is used in the analysis of experimental data on q_{cr}. Representing the results of the present article, and also the results of numerous investigations for $p = 68.7\text{-}137 \cdot 10^5$ N/m^2 averaged by V. E. Doroshchuk, in the form of function $q_{cr} = f(w_f/w')$, it is found that for each value of the weighted steam content at constant pressure and different body speeds the parameters q_{cr} have the same relationship as the speed of the liquid film at the wall of the tube, i.e.,

$$\frac{q_{cr1}}{q_{cr2}} \sim \frac{\left(\frac{w_f}{w'}\right)_1}{\left(\frac{w_f}{w'}\right)_2}.$$

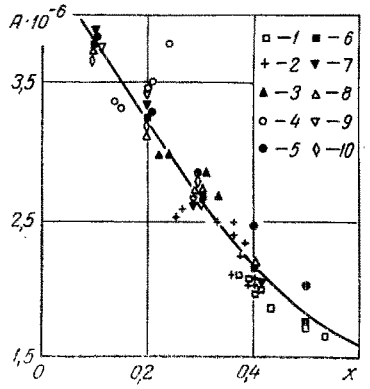

Fig. 1. Values of q_{cr} (W/m^2) for $p = 98.1 \cdot 10^5$ N/m^2 reduced to $\rho w = 750$ kg/m^2 · sec for ρw equal to: 1) 1110, 2) 1600, 3) 2200, 4) 3400 (author's data), 5) 750, 6) 1000, 7) 1500, 8) 2000, 9) 2500, 10) 3000; $A = q_{cr}\frac{\left(\frac{w_f}{w'}\right)_0}{\left(\frac{w_f}{w'}\right)}$

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Using this relation all the values of q_{cr} at a given pressure can be expressed by a single function

$$q_{cr}\frac{\left(\frac{w_f}{w'}\right)_0}{\frac{w_f}{w'}} = f(x).$$

The results of the analysis for $p = 98.1 \cdot 10^5$ N/m^2 are presented in Fig. 1 by way of an example. Almost all the examined data are grouped around the average lines with a scatter not exceeding ±15%.