INFLUENCE OF PRESSURE ON HYDRODYNAMIC INSTABILITY (THERMAL OSCILLATIONS) IN A FORCED FLOW BOILING OF NITROGEN IN A CHANNEL.

Klimenko A.V., Sudarchikov A.M.

High Technology Center, Moscow Power Engineering Institute (TU),
Krasnokazarmennaya 14, 111250, Moscow, RUSSIA

The results of an experimental investigations of conditions of origin and development of hydrodynamic instability - thermal oscillations are presented, at forced flow boiling of nitrogen in a channel in a wide range of pressure variation. In experiences the temperature variations of wall superheat $\Delta T_s = T_w - T_s$ considerable on magnitude and much exceeding a value ΔT_s, applicable to developed nucleate boiling of nitrogen in a channel were captured.

The experience were conducted on the test apparatus described in [1, 2]. In the given work as a test specimen is a tube made of stainless steel (Cr 18%, Ni 10%, Mn 1.5%) with the inner diameter equal to 11.9 mm, length 1447 mm, and wall thickness 0.3 mm was utilized. Orientation of a specimen - vertical.

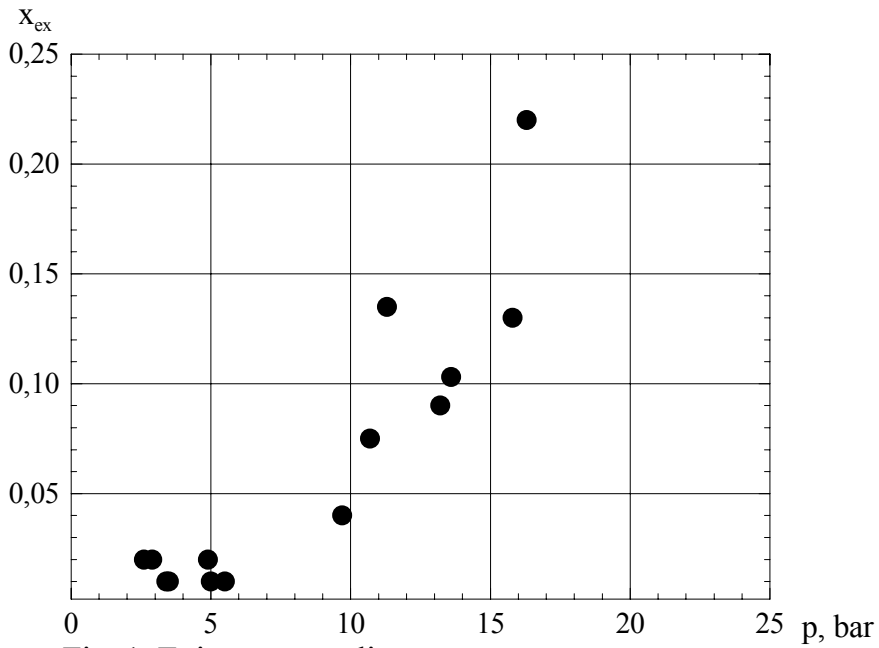

Fig. 1 Exit vapor quality versus pressure at G = 340 - 440 кg/(m^2 sec).

The main regime parameters in the experiments varied in the following ranges: mass flow rate G = 100 ÷ 700 kg / (m^2 sec); pressure p = 2,6 ÷ 16,3 bar; liquid subcooling at a inlet experimental specimen ΔT = 2,6 ÷ 16,9 K; heat flux q = 0 ÷ q_{cr} kW/m^2.
In experiences are shown, that with increase of a pressure a nature of oscillations in a forced flow boiling of nitrogen in a channel varies.
The thermal oscillations captured in experiences, arose at positive values vapor quality in output cross-section of a channel and is apparently were are caused by structural modification of a two-phase flow of nitrogen in a heated channel.
A vapor quality in output cross-section of a channel x_{ex}, was calculated on a balance equation:

$$x_{ex} = \frac{i_{in} - i'(p_{in})}{r} + \frac{4l}{d} \cdot \frac{q}{r \cdot G}, \qquad (1)$$

As are shown in experiences, exit vapor quality x_{ex}, applicable to beginning of thermal oscillations in a heated channel, is a strong function of value pressure. With increase of a pressure a value exit vapor quality x_{ex}, at which one the thermal oscillations in a channel occur is augmented, see the fig. 1. In paper [3] are shown, that there is a limiting value of pressure, at reaching which one in a forced flow boiling of nitrogen of thermal oscillations disappear. Apparently $x_{ex} = f(p)$ in a fig. 1 asymptotically comes nearer to this value of pressure the graph of relation. Thus increase of pressure in a system appears by the factor stabilizing flow of a boiling nitrogen in a channel.

CONCLUSION

The experimental investigation of thermal oscillations is held at forced flow boiling of nitrogen in a channel. Are shown, that increase of a pressure stabilises flow of a boiling nitrogen. With increase of a pressure the moment of beginning of thermal oscillations displaces in area of higher values exit vapor quality.

NOMENCLATURE

T - temperature,
i - enthalpy,
p - pressure
r - latent heat of vaporization.

Subscripts

w - wall
s - saturated
in - input
ex - exit
$'$ - corresponds to a fluid

REFERENCES

1. Klimenko V.V., Sudarchikov A.M., Investigation of forced flow boiling of nitrogen in a long vertical tube, *Cryogenics*, 1983, Vol. 23, No. 7, p.379-385.
2. Klimenko A.V., Sudarchikov A.M., Berezov F.B., Berezov V.B. Peculiarities of Two-Phase Forced Flow of Nitrogen in Long Heated Channel. *Proc. of the Int. Symp. on the Physics of Heat Transfer in Boiling and Condensation*, 1997, Moscow, p.73-78.
3. Klimenko A.V., Sudarchikov A.M. Investigation of Hydrodynamics Instability at a Forced Flow Boiling of Nitrogen in a Channel at High Pressures. *Heat Transfer 2002. Proc. of the 12th Int. Heat Transfer Conf.*, Grenoble, France, August 18-23, p. 827-832.