ON THE WAVE CHARACTER OF DEVELOPMENT OF BUBBLE BOILING IN CHANNEL FLOW

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ABSTRACT

The paper describes results of experimental investigations into the development of bubble boiling in a tubular channel. The investigations extend on the early stage of boiling in a single-phase medium where first bubbles of vapour appear, see Fig. 1, as well as on the stage of two-phase flow where boiling in the flow core is replaced by surface boiling. For some favourable conditions, the so-called boiling front forms near the exit from the channel, that is at a location of the maximum liquid superheat [1,3]. The boiling front propagates then upstream, see Fig. 2 and 3, with a velocity V_p that depends on a number of parameters, including void fraction φ, pressure drop Δp, and heat flux density q at the channel wall. The presented results of measurements exhibit the wave character of development of bubble boiling in channel flow [2,5,6].

The experimental investigations are carried out with the help of a computer-aided measuring apparatus operating with a system detectors and electronic transducers of physical quantities describing the process of boiling. A new environment-friendly refrigerant R134a is used in the course of investigations [4].

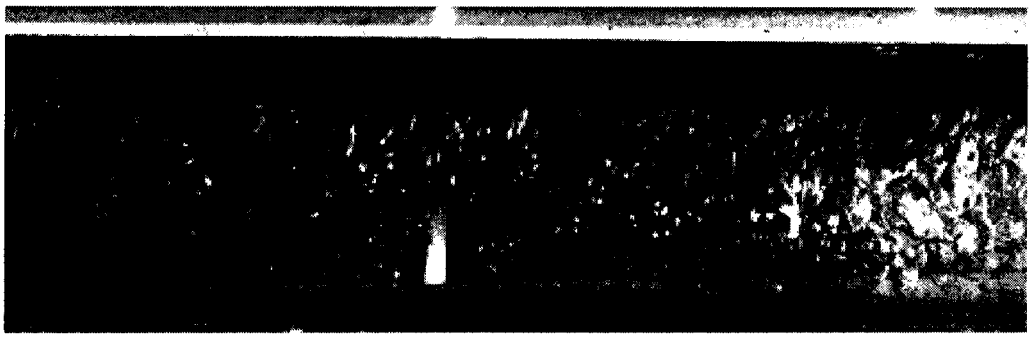

Fig. 1. Sample visualisation of development of bubble boiling in channel flow
$w\rho = 615$ kg/m^{2}s, $q = 15.1$ kW/m^2, $p_1 = 0.51$ MPa, $\Delta p = 0.13$ MPa

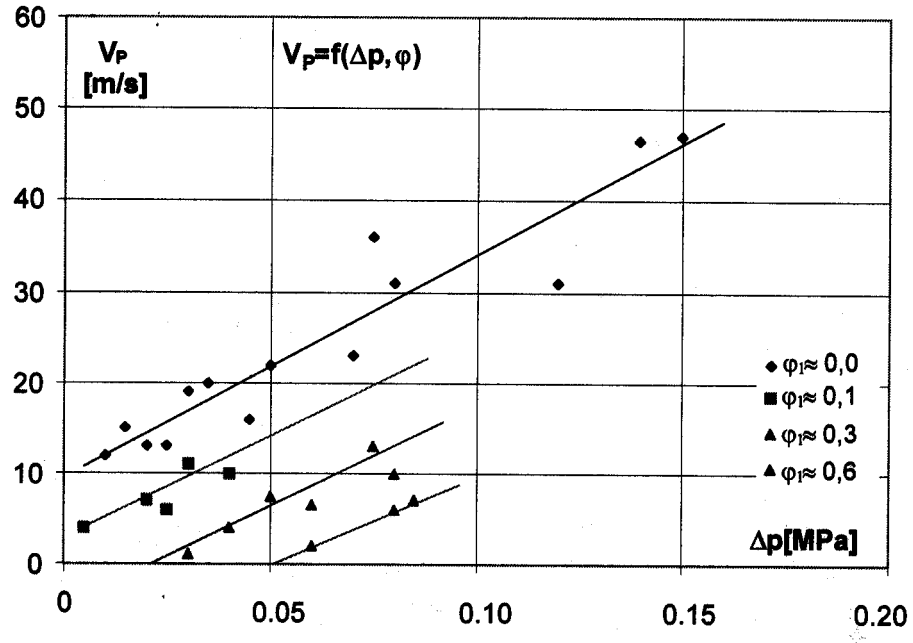

Fig. 2. The effect of pressure drop Δp in the channel on the velocity V_p of propagation of the pressure wave that gives rise to surface boiling
$q = 10 \div 20$ kW/m^2, $w\rho = 400 \div 600$ kg/m^{2}s, $T_s = -5 \div 3$°C.

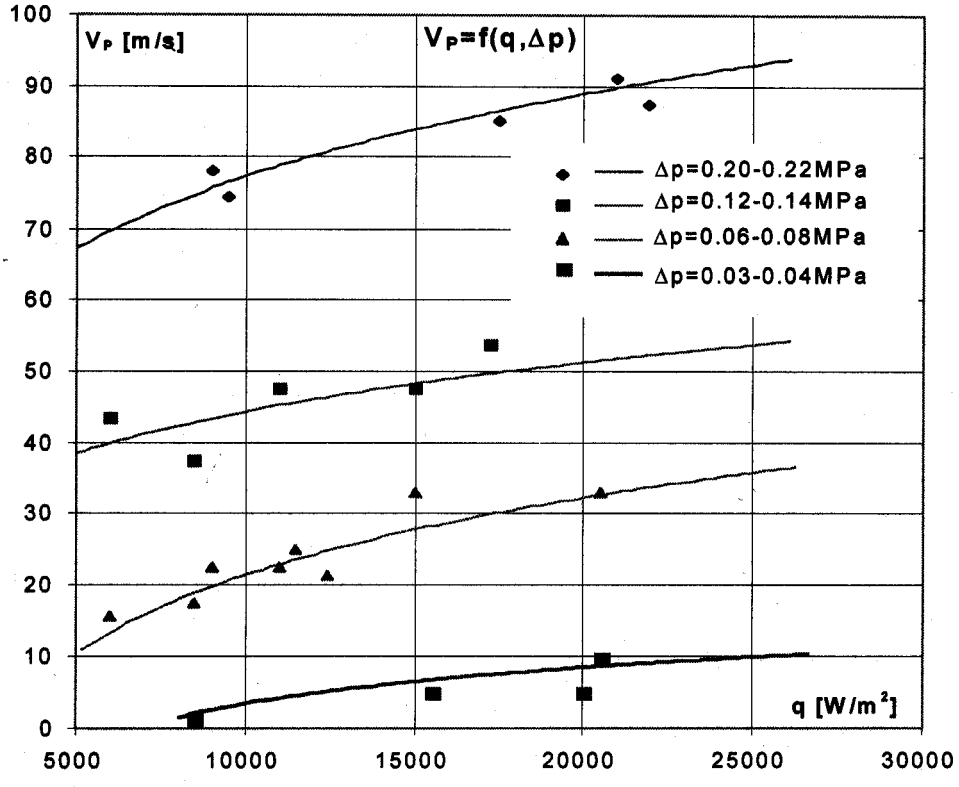

Fig. 3. The effect of heat flax density q at the channel wall under the constant levels of pressure drop Δp on the velocity of the pressure wave V_p that gives rise to surface boiling in the channel (φ_1=0)

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NOMENCLATURE

q	- heat flux density, W/m^2
p	- pressure, MPa
T	- temperature, ^0C
V	- velocity, m/s
$w\rho$	- mass flux density, kg/m^2s
Δp	- pressure drop, MPa
φ	- void fraction

Subscripts indicate:

p	- pressure
s	- saturation
1	- beginner value