Turbulent mixing at gas-liquid interface with the width of mixing zone up to 200 mm

N.V.Nevmerzhitsky, V.I.Dudin, A.A.Nikulin, E.D.Sen'kovsky, V.V.Marmyshev, E.A.Sotskov, O.L.Krivonos , A.A.Polovnikov, E.A.Polovnikov, S.A.Abakumov

Russian Federal Nuclear Center – VNIIEF

607190, Russia, Sarov
E-mail: root@gdd.vniief.ru

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ABSTRACT

The authors present results of experiments with study of growth of turbulent mixing occurred at Rayleigh-Taylor instability at gas-liquid interface with the width of the mixing zone H up to 200 мм.

The liquid layer (water) with the mass of 3.3 kg was accelerated by compressed air in transparent cylindrical channel with the section of ∅ 210 mm. The pressure of compressed air reached 8,4 gauge atmospheres, the acceleration – $g = (0.5 \div 1) \cdot 10^3 g_0$ (where $g_0 = 9.8$ м/с^2), the layer displacement S – up to 350 mm, the depth of penetration of gas front in liquid $h_{лт}$ – up to 50 mm, Reynolds number of the flow reached $\mathrm{Re} = \frac{H \cdot \sqrt{A \cdot g \cdot H}}{\nu} = 5 \cdot 10^6$ (where $A \approx 1$ – Atwood number, ν - kinematic viscosity coefficient of water).

It was obtained that:

- Coefficient $\beta_{лт}$, describing the average rate of penetration of gas front in liquid ($\beta_{лт} = \Delta h_{лт} / \Delta 2S$), equals $\beta_{лт} \approx 0.11$ over the range of layer displacements 10 mm < S < 50 mm (at Re up to $5 \cdot 10^4$);
- Coefficient $\beta_{лт}$ falls approximately 35% down when the displacement of the liquid layer increases from ≈ 50 mm to ≈ 100 mm (with the growth of Re from $5 \cdot 10^4$ to $5 \cdot 10^5$), and then, at the further growth of the layer displacement to 350 mm (with the growth of Re to $\approx 5 \cdot 10^6$) – doesn't change and equals $\beta_{лт} = 0.06 \div 0.08$, moreover it is observed some pulsation of penetration of gas front in liquid;
- Separate bubbles of the mixing zone become unstable with the lapse of time – the development of secondary bubbles occurs on them.