MASS TRANSFER BETWEEN A SOLID PARTICLE AND A LIQUID IN THE FIELD OF OSCILLATIONS EXCITED BY SPARK DISCHARGES

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An attempt was made to obtain a theoretical solution of the problem of the kinetics of mass transfer between solid particles and a liquid in which oscillations were excited by high-voltage spark discharges between electrodes [1, 2].

It is shown in [3, 4] that, in the case of direct flow of a liquid past solid particles, the mass transfer kinetics is described by the following relation

$$\mathrm{Nu} \sim \sqrt{\mathrm{Re}}. \tag{1}$$

The relative velocity of the liquid in the expression for the Reynolds number is found from the theory of underwater point explosions [5] on the assumption that a fraction of the energy released in the spark-discharge channel is transformed into the kinetic energy of the liquid.

This leads to the Reynolds number, which characterizes the hydrodynamic situation at any point within the liquid, in the following form:

$$\mathrm{Re_a} = \frac{E\omega d}{pr^2\nu}. \tag{2}$$

If the coefficient of conversion of electrical energy of the discharge into the kinetic energy of the liquid is constant, the external mass-transfer kinetics must be described by

$$\mathrm{Nu} \sim \sqrt{\mathrm{Re_a}}. \tag{3}$$

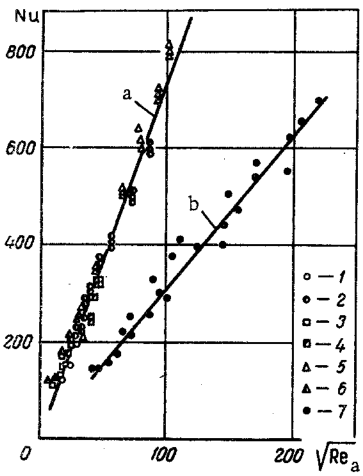

Fig. 1. Correlation function K [1) $K = f(l_p)$; 2) $K = f(r)$; 3) $K = f(p)$; 4) $K = f(d)$; 5, 7) $K = f(\omega)$; 6) $K = f(E)$].

The mass-transfer kinetics was investigated with the aid of the spark discharges, taking as an example compacted cylindrical specimens, of KNO_3 in water at 291°K. The experiments were carried out on an experimental installation consisting of the following basic components: a container for the solvent, high-voltage current pulse generator, heating system, water supply system, and control-measuring equipment.

As a result of an analysis of the experimental data, a graph was obtained for the correlation function $\mathrm{Nu} = f\sqrt{\mathrm{Re_a}}$ shown in Fig. 1.

The straight line a corresponds to the following experimental data: E = 50-300 J, ω = 0.5-5 Hz, p = (0.5-4) $\cdot 10^5$ N/m^2, d = 0.4-1.4 cm, r = 6-22 cm.

The straight line be corresponds to experimental data obtained with the setup described previously in [2] under the following conditions: E = 0.5-2 J, ω = 15-205 Hz, p = 10^5 N/m^2, d = 0.8 cm, r = 1.5-3 cm.

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It is clear from Fig. 1 that Eq. (3) is in satisfactory agreement with experimental data. The different slopes of the two straight lines are due to different coefficients of transformation of electrical power into kinetic energy.

NOTATION

Nu	is the Nusselt number;
Re	is the Reynolds number;
Re_a	is the modified Reynolds number;
E	is the discharge energy;
ω	is the discharge repetition frequency;
d	is the solid-particle diameter;
r	is the distance of solid particle from discharge gap;
ν	is the kinematic viscosity;
p	is the hydrostatic pressure at a depth in the discharge;
K	is the mass transfer coefficient.

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