RATE OF MINIMAL BED FLUIDIZATION IN LOW VACUUM

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It is proposed to determine the minimal fluidization rate of a bed of polydisperse material in low vacuum from data of a single experiment, for example, at atmospheric pressure.

In investigating the gas dynamics of a fluidized bed, a formula was proposed in [1] for determining the minimal fluidization rate in low vacuum. However, its use for engineering calculations is difficult, since the formula includes initial quantities that are known only very approximately for many cases. Therefore it is expedient to determine the dependence of the minimal fluidization rate on the pressure above the bed for a polydisperse material from experimental data obtained in a single experiment at a single pressure, for example, atmospheric pressure.

As shown by new experimental data and analysis of the results of [1], fluidization begins at gas velocities such that the kinetic component of the energy-flux density of the fluidizing gas reaches a definite, pressure-independent value. In other words, the interaction between the fluidizing gas flow and the bed particles leading to fluidization begins at a definite value of the kinetic component of the energy-flux density of the fluidizing gas, and its magnitude does not depend on the pressure above the bed, that is

$$\rho w^3 = A. \tag{1}$$

Using the equation of an ideal state of the gas and Eq. (1), it is simple to show that the dependence of the mass velocity of the onset of fluidization on the pressure is given by the expression

$$\rho w = \rho_0 w_0 \left(\frac{p}{p_0}\right)^{2/3}. \tag{2}$$

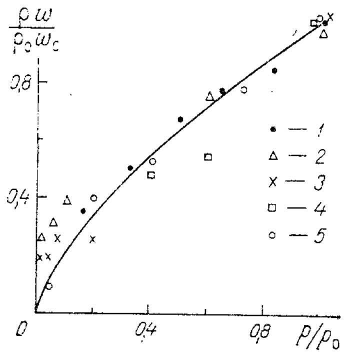

Fig. 1. Dependence of the mass velocity of onset of fluidization on the pressure: the curve corresponds to Eq. (2); 1-4) data of [1]; 1, 2) glass spheres of diameter 0.775 and 0.1 mm; 3, 4) sand of dimensions 0.118 and 0.187 mm; 5) new data, sand fraction from −0.315 to +0.2 mm.

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Experimental results of [1] and new experimental data obtained on an apparatus analogous to that in [1] are shown in Fig. 1. The experimental results lie close to the curve corresponding to Eq. (2). The coincidence is completely satisfactory, since the animal fluidization rate cannot be determined without an error due to the presence of the transitional region on the experimental curve of bed resistance vs gas velocity [2].

The new law in fluidized-bed hydrodynamics derived from the experimental results — that the kinetic component of the energy-flux density of the fluidizing gas at which fluidization of the material begins is independent of the gas pressure above the bed — has a clear practice physical meaning and may be used not only for practical purposes but also in the theory of fluidization.

NOTATION

ρ, p, w, current density, pressure, and minimum fluidization velocity of the gas; ρ_0, p_0, w_0, density, pressure and minimum fluidization velocity of gas in the conditions of a single experiment; A, constant for the given material.

LITERATURE CITED

1. S. S. Zabrodskii and Ya. P. Shlapkova, in: Heat and Mass Transfer in Disperse Systems [in Russian], Minsk (1965), pp. 9-14.
2. S. S. Zabrodskii, High-Temperature Equipment with Fluidized Beds [in Russian], Moscow (1971).

DYNAMIC PROPERTIES OF A LOOSE GRANULAR BED

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A dynamic model of a loose granular medium is developed, and with its help the process of sudden arrest of the bed is studied. The model is compared with experiment.

In industrial processing loose media usually pass through a stage characterized by loose packing of the particles. Because of the low mechanical stability of loose systems dynamic elasticity, similar to elasticity in a concentrated dispersed medium, can arise in them [1].

An example of the manifestation of dynamic elasticity is the effect of sudden arrest, similar to hydraulic shock in a liquid, of a loose bed when, owing to an increase in the pressure on the barrier for a short time, damped oscillations of the granular mass develop in the bed, whose frequency corresponds to the resonance frequency of the vibrating bed [1]. The spontaneous appearance of this situation, for example, accompanying the collapse of loose material in a vertical channel, mine, pneumatic transport and release or bulk materials from containers can be accompanied by collapse of the protective surfaces, dust formation, etc. [2]. Deliberate excitation of free oscillation facilitates the removal of "obstructions" and sticking in pneumatic transport [3]. It can also be employed to determine the dynamic characteristics of a loose granular bed by the impact method.

These phenomena always appear when conditions are formed in the system under which dynamic elastic forces predominate over dissipative forces. It is easy to formulate them starting from the general relations of the hydromechanics of heterogeneous systems. These include the existence of the initial loose packing, dynamic "impassibility" of the bed and impact loads exceeding the mass forces in the system. Taking into account the region of extension and application of the phenomena, we shall study the behavior of the system in a gravitational field.

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