The expansion of a fluidized bed with various packings in columns of several dimensions was measured. The average velocity of the bubbles and the influence of the packing parameters on this velocity were estimated.

When a bed of dispersed material is fluidized by a gas, gas cavities (bubbles) rise continuously through it; the existence of these is due to the fundamental instability of the system [1, 2]. All the gas passing through the bed is divided into two fluxes, one of these constituting the bubbles, while the other incorporates the gas filtering between the suspended particles. The two fluxes or flows differ chiefly as regards their time of existence in the bed and their conditions of contact with the dispersed material. With increasing filtration velocity the flow of the bubble phase increases, while the second flow varies very little [3]. This type of flow has a deleterious effect on the intensity of the gas-particle exchange processes and reduces the efficiency of a number of technological processes (catalytic reactions, sorption, etc.).

In order to increase the homogeneity of the system, a collection of immobile elements (packing) may be placed in the fluidized bed; these partly break up the bubbles and greatly increase the efficiency of technological processes [4-6, 10, 17]. The hydrodynamics of a layer containing such packing material have been studied by a number of research workers in recent years, and a considerable proportion of the results have been presented in review articles [4, 5, 7]. Even so, information on this subject is still somewhat sketchy and largely of a qualitative nature.

In this paper we shall set out the results of an experimental investigation into the effects of various forms of packing on the mean velocity of the bubbles in a fluidized bed. This investigation extends earlier-published data [8, 11].

The experimental method was based on a two-phase model of the bed, according to which [9]

\[ u_{ba} = u - u_0 + u_b. \] (1)

This model allows us to relate the bubble velocity to the expansion of the bed [9, 10] by means of the equation

\[ u_b = (u - u_0) H_0 (H - H_0)^{-1}. \] (2)

Since the position of the upper boundary of the bed is hard to measure accurately, especially for high gas velocities, we used [11] the well-known relationship between the height of the bed and its mean porosity:


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Fig. 1. Relative bubble velocity as a function of the gas filtration velocity: 1) free bed; 2) group of rods with longitudinal ribs (Table 2, item 8); 3) cylindrical spirals, \( l_p = 3.06 \text{ cm} \); 4), 5) cylindrical spirals, \( l_p = 0.57 \text{ cm} \). Dispersed material: 1, 2, 3, 4) quartz sand 1; 5) silica gel (see Table 1); \( u \) in cm/sec.

whence from (2) we obtain

\[
H \cdot H_0^{-1} = (1 - e_0)(1 - e)^{-1},
\]

This equation enables us to determine the mean relative velocity of the bubbles in terms of easily measurable quantities.

A number of modifications of the two-phase model have also been considered in the literature [12, 13]. We note that the model described in [12] contains quantities for which no values have yet been obtained, while that proposed in [13] leads to the same results as Eq. (3) for high velocities, which are of chief practical interest.

The rate of gas flow through the continuous phase has been discussed in a number of papers, mostly reviewed in [12]. Most of the authors correctly assume that the velocity of the gas through the continuous phase is usually a little greater than \( u_0 \), being equal to \( ku_0 \), where \( k > 1 \). However, there are at present no reliable values of \( k \) available. It was pointed out in [3, 14] that \( k \) increases with diminishing density and size of the particles. It was assumed in [3] that after reaching filtration velocities at which intense bubble formation began, the value of \( k \) fell rapidly.

Let us estimate the possible systematic distortion associated with the fact that Eq. (3) implies \( k = 1 \). Clearly, the systematic distortion will increase with increasing \( k \). In order to treat the problem specifically we make use of the data of [14] relating to particles with \( d_{uv} = 0.186 \text{ mm} \) and \( u_0 = 1.39 \text{ cm/sec} \) (the silica gel used in the experiments described below has similar parameters); in this case \( k = 1.7 \). For such a \( k \) value, Eq. (3) should overestimate \( u_b \) systematically by no more than 10% for \( N \geq 10 \).