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RESEARCH OF HYDRODYNAMICS OF BEAMS OF LONGITUDINAL-FRINNED, PROFILED PIPES IN COARSE DISPERSED FLUIDIZED SALT

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Abstract

“The results of exponential studies of hydrodynamics of coarse particulate fluidized bed with immersed beams longitudinally profiled finned tubes”.

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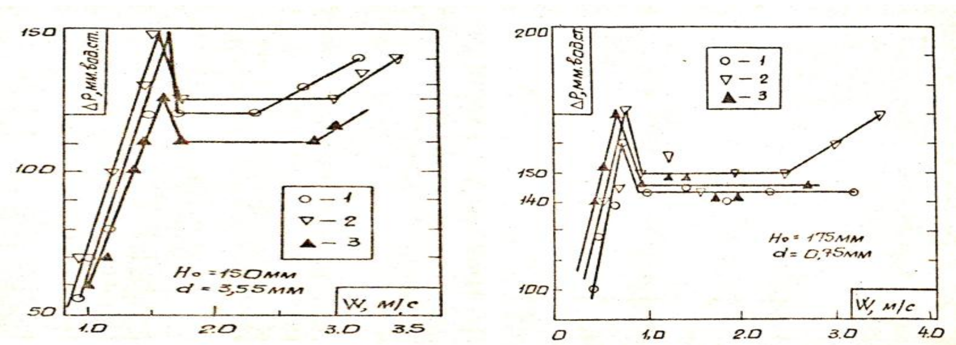
This paper presents the results of experimental studies of the hydrodynamics of a coarse-dispersed fluidized bed with bundles of longitudinally finned tubes. The studies were carried out for pipes of round, elliptical and semi-oval flattened cross-section.

The pressure drop across the tube bundle in the layer was measured at a point located at a distance of 75 mm from the gas distribution grid, and at a point above the tube bundle, taking into account the change in vertical pitch, regardless of the initial height of the layer, i.e. there may be cases where the upper row of pipes was not immersed in the fluidized bed.

The pressure drop was measured using an MMN-10 micro monometer. For visual observation of the process of fluidization and photography, one of the side walls of the chamber is made of glass. In the experiments, the initial height and the height of the expanded layer were measured using a scale bar. As a dispersed material, glass beads with a diameter of 0.75.... 3.55 mm were used.

The speed of the fluidizing air was measured by Pitot tubes and referred to the total cross section of the chamber. A control damper was used to change the air velocity.

At the same time, for each experiment, a complete picture of real fluidization was taken. $\Delta p = f(w)$in the studied speed range. The nature of the change in the aerodynamic resistance of the layer for tube bundles of various profiles and for various combinations of influencing factors is shown in (Fig. 1 a, b).



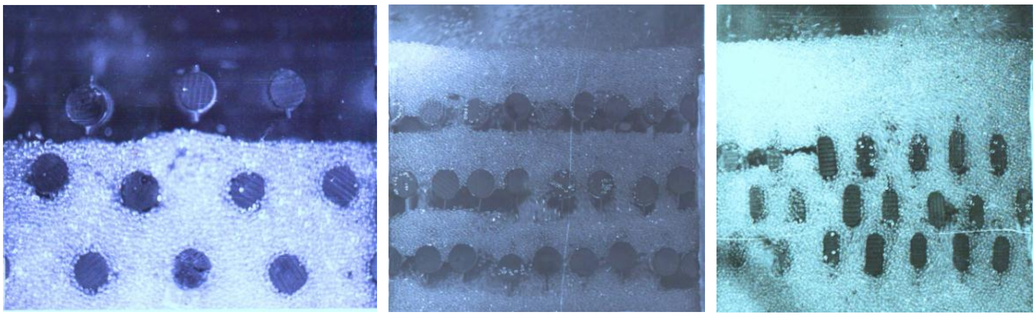
A b

As can be seen from the figure, the real fluidization curve is qualitatively preserved in the presence of finned tube bundles in the layer. The actual values of the fluidization onset rate slightly differed from the calculated one, depending on the initial packing of the particles.

An analysis of the results of pressure loss as a function of velocity $\Delta p = f(w)$shows that the pressure loss in the fluidized bed mainly depends on the weight of the particles in the volume of the chamber. The influence of other factors is insignificant, which can be seen from where $\Delta p$the calculation increases with the height of the layer. At the same time, the presence of finned tube bundles with different tube cross sections significantly affects the hydrodynamic pattern of the fluidized bed, which is important from the point of view of heat transfer. In this regard, the analysis of the characteristic features of the movement of dispersed material in the annular space was carried out on the basis of visual observations, partially recorded by a photographic method.

The most significant features of the movement of dispersed material in the annular space of the bundle, which is of particular importance in the analysis of heat transfer processes, is the formation of "caps" on the aft zone of the pipes.

On (Fig. 2- a, b , c) photographs of the characteristic types of such formations are presented. In bundles of round pipes, the “cap” occupies a significant part of the surface of the cylinder, while in oval flattened pipes, its size is much less.



(Fig. 2- a, b , c)

The influence of the shape of the pipe is also significant for washing its frontal part. The zones in which particles are generally absent for flattened pipes are smaller than for round and elliptical pipes. This type of pipe bobbling is of fundamental importance for heat transfer, since for a flatter flattened pipe, the area of the working part of the lateral surface is greater than for round and elliptical ones .

Of particular interest is the study of the dynamics described above picture. With an increase in the speed of the fluidizing agent, the qualitative pattern of the flow remained unchanged, however, the rate of destruction of the "cap" for pipes of various shapes was different. So for round pipes with an increase in gas velocity, the upper part of the caps collapsed. Much faster than for elliptical and flattened ones . While the entire "cap" as a whole, collapsed at approximately the same rate for all pipe shapes. This nature of the movement of the fluidized system near the pipe took place with minor quantitative changes for all particles used in the experiments. More intensive destruction of the "caps" of the dispersed material for round pipes, apparently, should be explained by the local value of the speed of the fluidizing agent over the speed of entrainment of particles.

A characteristic feature of fluidized beds with submerged tube bundles is the formation of stagnant zones that occupy the entire cross section of the channel. The breaking of such zones leads to the fact that some of the particles seem to hang on an air cushion between the rows. The formation of such zones is apparently due to the fact that in the annular space the fluidizing agent velocity exceeds the entrainment velocity, and then. Due to the sharp expansion of the cross section, it falls, which, in turn, leads to deceleration of the particles. These considerations are confirmed by the influence of the horizontal step on the formation of such zones. So, with an increase in the horizontal step, the picture described above was observed in experiments only with an increase in the gas velocity. Here it should be canceled that such a picture of the movement of a dispersed material is especially characteristic of particles with d = 2.5 mm. With a change in the shape of the cross section of the pipe immersed in the layer, the main described features of the movement of material were preserved. However, for flattened pipes, the formation of stagnant zones took place at a much smaller horizontal step than for the round one.

The presence of longitudinal ribs has a favorable effect on the circulation of particles, they destroy the bubbles moving up between the pipes of the previous row, direct the particles in such a way that they contribute to the destruction of the inactive zones of the "caps" on the aft part of the pipes, and improve the washing of the side surfaces of the pipes. In this case, the best hydrodynamic picture was observed in those cases when, a larger vertical pitch corresponded to a larger rib height. This circumstance explains some deterioration in heat transfer with an increase in the vertical pitch, which is consistent with the conclusions of works [2,3]

According to the plan of the experiments, the particle diameter was varied in the experiments. In all experiments with particles d = 1 mm at air speed v = 2 m/s, a strong expansion of the layer and their intensive movement, strong vibration of the pipes were observed. In this case, the particles were expelled from the beam zone and were fluidized in the zone located above the tube bundle. Zones with a reduced concentration of dispersed material were formed inside the beam. However, since these zones were continuously deformed, decreasing and increasing in size, the particles quickly changed from each other near the pipes. As the particle diameter increased, the qualitative picture remained the same. However, due to the low mobility of particles in the flow area close to the surface of the pipes, they replaced each other less often.

A qualitative analysis of the characteristic features of the movement of the fluidized bed shows that at $\vartheta =$ 3m/s, d = 1 mm, H_o = 200 mm, particles are carried out of the beam zone, which leads to some deterioration in the intensity of heat transfer. These considerations lead to the need to search for such an initial filling of H_o dispersed material , which would make it possible to avoid the removal of particles outside the beam.

It was found in the experiments that for a given section of the chamber, the change in the height of the expanded layer was mainly determined by the velocity of the fluidized agent and the particle diameter, and practically did not overestimate the geometry of the beam.

Thus, the analysis of the experimental data shows that the particles in the annulus mostly move in batches. However, there are modes in which the formation of stagnant zones is observed, occupying the entire cross section of the apparatus. The use of oval longitudinally finned tubes improves the structure of the fluidized bed, allowing the creation of a homogeneous layer in the annulus. This increases the efficiency of using the volume of the chamber, and H about the layer is reduced.

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