The aerodynamics of a jet of particles in a channel

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ABSTRACT

The main cause for dust discharge is ejection, i.e. formation of directional air flows in a stream of a bulk material due to the dynamic interaction of bombarding particles with air. Discovery of induced air flow occurrence regularities enables both forecasting the level of air pollutions with aerosol emission and choosing the optimum engineering solutions of air containment and dedusting [1-3].

So far we have studied solid particles flowing in a chute and a jet of loose matter [1]. Both situations represent extreme cases of the more general problem of material flowing through a duct with different distances between flow boundaries and duct walls. Without detriment to generality of the problem we shall consider a flat flow limited by vertical walls.

It was demonstrated that when a free stream of particles is enclosed with impenetrable walls air inflow is hindered and, hence, closed circulation flows occur in $1 < r < 2$ ($r = b_0 / b_n$, b_0 – half-width of a plane jet of particles, b_n .– half-width of chute). As far as the distance between the walls and the stream surface becomes shorter ($r \to 1$) the length of these whirls and the velocity variation amplitude in the external stream is reduced to zero while flow velocity in a stream of particles tends to a constant value equal to the initial velocity. As far as the distance to the channel walls becomes longer the whirls become longer too and with r >there is only an external reverse flow which area is decreased inversely as r.

It was demonstrated that when the channel section is partially filled with a stream of particles averaged integral equations for a boundary layer may be used as a basis for making one-dimensional equations that describe the motion of two-component stream (internal flow) and the air flow in a cavity limited to the stream surface and the channel walls (external flow). The general solutions of these equations may be used to derive particular solutions for one-dimensional problems regarding a chute with the pseudo-uniform distribution of particles and regarding a free jet of freely-falling particles which creates the base for development of a universal methodology of computation of the induced air volumes.

REFERENCES

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