Development of engineering method for calculation of ejected and recirculated air flow rates during reload of bulk materials

O.A. Averkova*, I.N. Logachev*, K.I. Logachev*, I.V. Kryukov*,

V.A. Uvarov*, E.I. Tolmacheva*, V.A. Tkachenko*

*Belgorod State Technological University named after V.G. Shukhov
(BSTU named after V.G. Shukhov), 308012 Belgorod, Russia, Kostukova str., 46
e-mail: logachev.ki@bstu.ru, web page: http://www.bstu.ru

ABSTRACT

Reload of bulk materials in various industries and agriculture are accompanied by significant dust emissions. The flow of bulk materials in its fall carries air (air ejection). The study of the flow of ejected air is a complex multidisciplinary task [1-2]. The maintenance costs of local exhaust ventilation systems are directly proportional to the flow rate of the ejected air. Consumption of the ejected air can be reduced by: reducing the speed of the falling bulk material flow; increase of aerodynamic drag when ejected air moves; organization of air circulation-recirculation.

The aim of the article is to develop engineering methods of calculation of aspiration systems and shelters on the basis of previously obtained results of theoretical and experimental studies of the laws of ejected and recirculated air flow.

The results and conclusions are as follows.

The technique of engineering calculation of volumes of the aspirated air during reload of dry not heated materials with natural circulation, carried out by means of the combined use of the cylindrical bypass chamber and the perforated trough is developed. Experimental and numerical studies have shown that the proposed method has sufficient accuracy.

Recommendations for the design of the developed aspiration shelter for more efficient operation with lower operating costs are proposed. The economic effect is to reduce energy intensity and the cost of cleaning dust emissions.

The values are proposed for the recirculation coefficients for the calculation of the aspiration system using the bypass chamber and the combined use of the bypass chamber and the perforated trough.

The method of calculation of the ejected air flow rate in telescopic loaders is developed.

The high energy intensity of telescopic aspiration-technological units (ATU) of reloading stations is caused by the ejection ability of gravity flows of bulk material, pumping a large amount of air into the aspiration shelters, which significantly increases the required performance of aspiration systems. Power of ATU can be significantly reduced by the use of coaxial telescopic loading troughs and corrugated impervious wall surrounding the trough and sealing the top and bottom of the cover, adjacent to the troughs.

The analytical flow rates estimation of air, moving inside the cavity of the "chute - bypass chamber", can be carried out by linearization of the dynamics and inter-component interaction equations with the subsequent solution of transcendent equations in the Maple universal mathematical environment.

Numerical studies have shown that the main parameter for reducing the transit flow of ejected air and increasing the volume of recirculated air is the degree of sealing of the upper cover. For example, if the total area of the shelter leaks is reduced from 0.14 m^2 to 0.02 m^2, the flow of transit air will be reduced three times, and the recirculated air will be increased by 2.5 times. The total productivity of the local suction from the lower shelter in this case has decreased by 1.68 times.

REFERENCES

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