ENTRAINMENT VELOCITY OF DUST PARTICLES FROM WORKING OF PARTICLEBOARDS IN TERMS OF VARIABLE RELATIVE HUMIDITY OF AIR STREAM

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Abstract
This paper presents the testing results of the entrainment velocity of dust particles from mechanical treatment of particleboards. The considerable influence of the air realtive humidity on this characteristics was determined.

Key words: *particleboards, wood dust, air relative humidity*

INTRODUCTION

Depending on the position of the forwarding pipe the displacement of particles of crumbled solid one can happen vertically or horizontally. The behavior of transported particles is in both extreme cases different because the system of main forces conditioning their movement is for the flow horizontal and vertical disparate.

The transportation of particles of the solid in the vertical pipe is considerably more simple than the displacement in the horizontal pipe in consideration of one direction of the activity of the aerodynamic force Fa and gravity force G (fig 1.). Depending on the absolute values of forces G and Fa the particle of the solid being found in the air stream flowing from below upward can behave as follows:

$|G| > |Fa|$ - the particle drops with the uniform motion,

$|G| < |Fa|$ - the particle moves in compliance with the vector of the velocity of the air stream,

$|G| = |Fa|$ - the particle stays in the state of the suspension.

The entrainment velocity is the velocity of the air stream at which happens the equality of the absolute value of the gravity G and the aerodynamic force Fa (Dolny 1999).

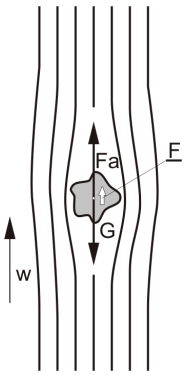

Fig. 1 System of forces influencing on the particle

The entrainment velocity is a very important component of the aerodynamic characteristic of the dust particles transported by pneumatic conveyors. It changes along with the kind of material, dimension- and shape characteristics of particles and is also relative to air parameters (Dolny 1999, Dzurenda 2002). The purpose of this paper is the qualification of the influence of the air relative humidity and the moisture content in waste material on the entrainment velocity of dust particles from the tooling of particleboards from dimension fractions <0,3 mm and 0,3-0,5 mm.

MATERIAL AND METHODS

The measurement of the entrainment velocity was effected with the use of the instrument with the constant diameter of the measuring channel (fig. 2). The velocity of the air stream, in this method, is regulated by valves and the rate of rotation of the fan to obtain required conditions of the flow. After assembling of the set in the suitable order its tightness was checked. On the top of the measuring channel the line joining the filter, regulating valves and the fan was connected. After the realization of these actions the regulating valves were closed and the rate of rotation of the fan was set on the minimum value. Then the measurement procedure was started. The examined sample of material in the quantity about 1 g was placed inside the measuring channel. The switching of the fan and opening the valves cause the negative pressure on the bottom of the measuring channel. The differential pressure causes sucking of the air at the inflow of the channel and consequently its flow in the channel. The opening of the valves and the enlarging of the ratio of rotation of the fan cause the increase of the velocity of the air flowing the examined material. The velocity of the air stream was enlarged to the moment, when it was sufficient to the entrainment of the particles of the waste material. They appeared then on the length of the measuring section fig. 3). The air velocity at which was observed the appearance of first particles is called a minimum entrainment velocity. Not to break the measurement the enlarging of the velocity of air stream was continued to the moment, when in the measuring section the last particles of the same sample were appeared. This velocity expressed the maximum entrainment velocity. Minimum and maximum entrainment velocity mark limiting velocities at which the particles from the given fraction stay in the state of the suspension. The measurement was repeated three times with use of following samples. The average from these measurements was accepted as the final result.

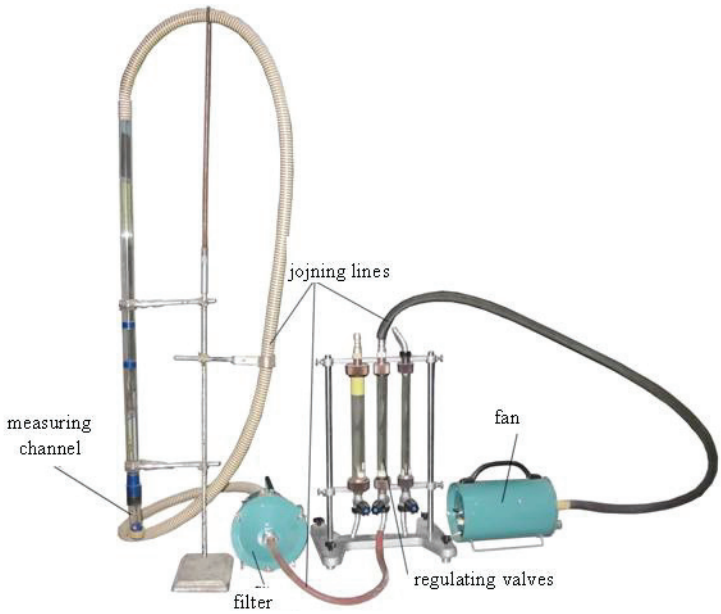

Fig. 2 Measuring device

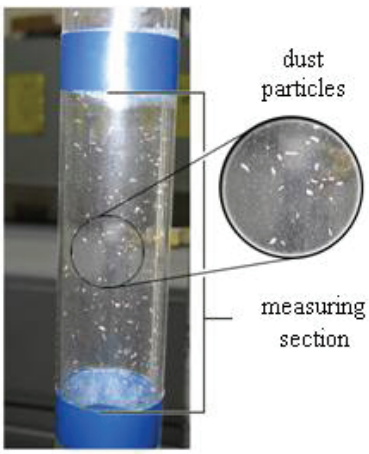

Fig. 3 Dust particles in the measuring channel

RESULTS

The entrainment velocities show different values in dependence on dimensions of the dust particles. Along the increase of the particle size grows the entrainment velocity. Ranges of minimum and maximum entrainment velocities of particles at the air relative

humidity 40%, amounted: 0,78 and 3 53 m/s for the fraction < 0, 3 mm and 1,18 - 4,9 m/s for the fraction 0,3-0,5 mm (fig. 4 and 5).

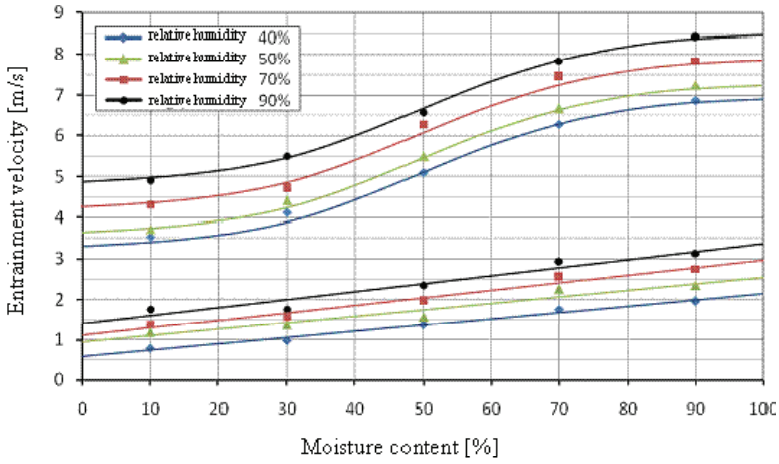

Fig. 4 Entrainment velocities of particles < 0,3 mm

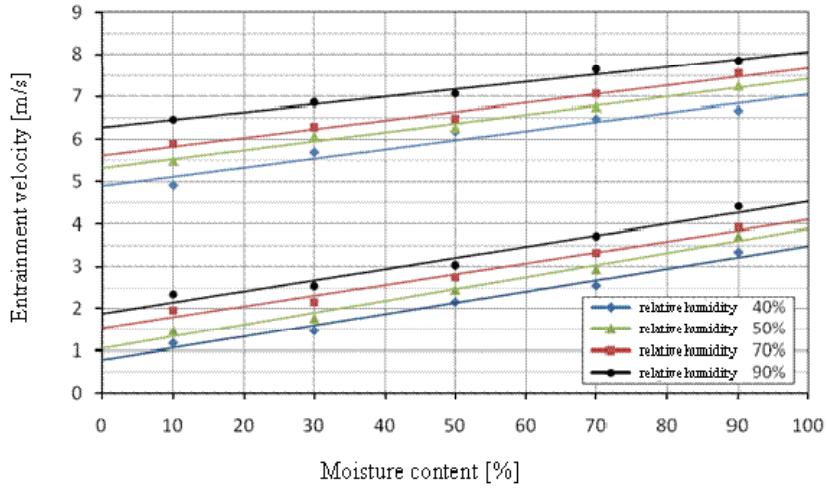

Fig. 5 Entrainment velocities of particles 0,3-0,5 mm

Also the greater moisture content of transported particles of the waste material causes the growth of the entrainment velocity. The increase of the entrainment velocity with reference to growing moisture content of the dust particles has most often the linear character. Only for the smallest particles the different course of this occurrence was observed- visible is here disproportionate growth of the maximum entrainment velocity. In the range of the moisture content in waste material up to 30% the increase this velocity is lineal, similarly as for greater fractions. The sharp increase of the entrainment velocity occurs above moisture 30%.

A reason of this change is the occurrence of the agglomeration of particles in the air stream. After the crossing of the moisture content 30% water begins to accumulate on the surface causing consequently the occurrence of large forces of the adhesiveness. An effect of this is the joining of single particles into greater concentrations. It may suppose that the occurrence is additionally intensified by content of synthetic resins used in production of particle boards.

Courses of aerodynamic characteristics for second of tested fractions are nearing to other of determined in the wood industry. Both obtained entrainment velocity of fractions: 0,3-0,5 mm, and the entrainment velocity of chips from sawing of pinewood from the fraction 0,125-1 mm, investigated by Dolny and Królak (1997) have a lineal course.

CONCLUSION

Chips arisen during the tooling of particle boards are characterized by the variable proprieties dependent on many factors. Most important of them are the particle size, the moisture content and air relative humidity. The whole results obtained from effected research lets on the expression of the conclusions describing resultant dependences:

The entrainment velocity increases along with the growth of the particle size. Ranges of the minimum and maximum entrainment velocity amounted at the moisture of chips 10% and the air relative humidity 40% 0,78 m/s and 3,53 m/s for the fraction < 0,3 mm and 1,18 - 4,9 m/s for the fraction 0,3-0,5 mm.

The entrainment velocity increases along with the growth of the moisture content in chips. This course is generally lineal. The exception is the most small fraction, < 0,3 mm. There appears the occurrence of the agglomeration, that is the joining of single particles into greater groups. As a result of this the particles with the bigger volume and the mass come into being. An effect of this is the considerable increase of the entrainment velocity.

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