

## **Influence of air relative humidity on pressure drop during separation of pine wood dust by pulse-jet filtration**

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**Abstract:** *Influence of air relative humidity on pressure drop during separation of pine wood dust by pulse-jet filtration.* The values of the correction factor for air relative humidity related to the pine dust were calculated in this work. The essential data for this calculation were obtained from tests conducted on the pilot-scale laboratory stand. The pressure drop of the clean filter bag and the dust loaded filter bag were measured.

*Keywords:* wood dust, pulse-jet filtration, air relative humidity

### **Nomenclature**

$K_p$	specific resistance coefficient of the dust cake
$P_o$	pressure drop across the clean filter bag
$P_f$	pressure drop across the dust loaded filter bag
$s'$	mass areal density of the dust cake
$w_f$	filtration velocity

### **INTRODUCTION**

The presence of moisture in the gas cleaned from dusts by filtration method is one of the most important factors influencing the course of separation processes. Moisture condensing from the air stream strongly influences the system of forces governing the cohesion of the dust cake and also the adhesion of dust particles to the fibers of a filtering medium. The phenomena of condensation and sorption occurring in the dust cake influence its internal structure and permeability. Liquid bridges can appear between the dust particles accumulated on the surface of a filtering medium. They reduce the available pores openings for air flow increasing the pressure drop across the filtering layer. The dust cake is then considerably more difficult to removal from the surface of a filtering bag as a result of increase of the adhesion forces. The superficial hydrophobic treatments of the needlefelts are often used in order to their protection before this unfavorable influence of moisture condensed in the filtering layer. They are put on the surface of the needlefelt in the form of finishing during the production process.

The hydrophobic treatments are also applied to polyester needlefelts used in separation processes of the wood dusts. Their effectiveness in the range of limiting the unfavorable increase of the pressure drop was until now estimated in the very low degree. Hitherto executed investigations related only to the dust from the processing of the beech wood. They showed the favorable influence of the use of the hydrophobic finishing of the filtering material surface on the setback of the increase of the pressure drop across the filter.

The aim of the present work was to determine values of the correction factor for air relative humidity related to the pine dust. This factor is used to computational foresight of the pressure drop in conditions of changing air relative humidity.

## MATERIAL AND METHODS

The calculation of values of the correction factor for air relative humidity requires earlier experimental determination of the specific dust resistance and its possible changes caused by the air relative humidity. Three experimental filtering processes on the pilot-scale lab stand were conducted with use of the polyester needlefelt. The construction, mode of operation and measuring methods of this unit were detailed described in the previous works (Dolny 1987, Dolny 1998, Dolny1999).

The air relative humidity during these processes amounted 20, 50 i 80%. The experiments were conducted at the filtration velocity 0,04 m/s and the dust concentration  $12\text{g/m}^3$ . The value of  $K_p$  which was achieved at the end of each process was calculated on the base of obtained values of the  $P_f$  and  $s'$ . The difference between the weight of the bag at the end and at the start of the process gave the value  $s'$ . It amounted  $85\text{ g/m}^2$ ,  $88\text{ g/m}^2$  i  $94\text{ g/m}^2$  adequately to particular air relative humidity during the filtering processes.

Experimental determination of the course of the function  $P_o = f(w_f)$  was necessary too. It enabled to calculate the value of the  $P_o$  for the filtration velocity 0,04 m/s used in this study.

## RESULTS

Direct findings of conducted tests include the dependence of the  $P_o$  of tested medium on the filtration velocity (fig2) and the results of the pressure drop measurements in each filtering process (fig. 1). The increase of the pressure drop has a typical character of its growth and stabilization which is always observed during the wood dusts separation. The increase of the pressure drop resulting from the humidity causing unfavorable changes of adhesion forces between the dust particles was noted.

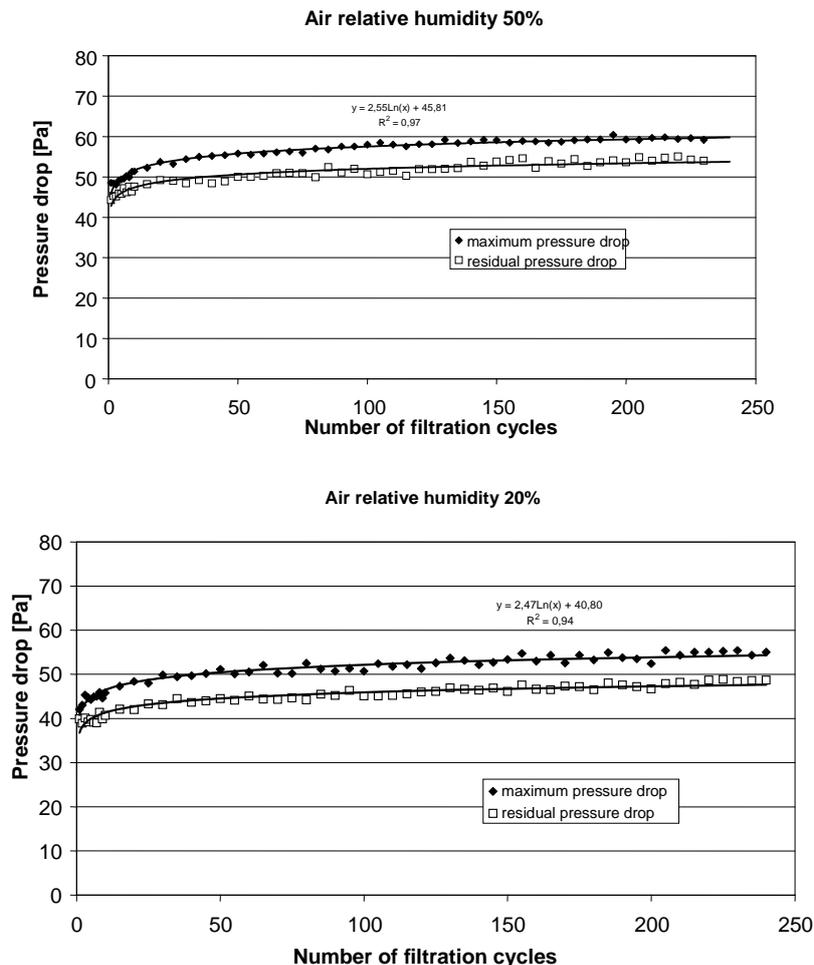


Fig. 1. Pressure drop across the dust loaded filter during the process

The figure 3 shows the values of specific dust resistance calculated on the base of the pressure drop in filtering processes. In case of the pinewood dust this dependence could be determined by linear regression differently from that one in case of the beech wood dust investigated in previous research (Rogoziński 2006). The more intensive increase of the pressure drop was here. It is connected with different shape and size characteristic of the particles created at the softwood working. The correction factor for air relative humidity was determined regarding to the level of 65% just as in the previous works (fig. 4).

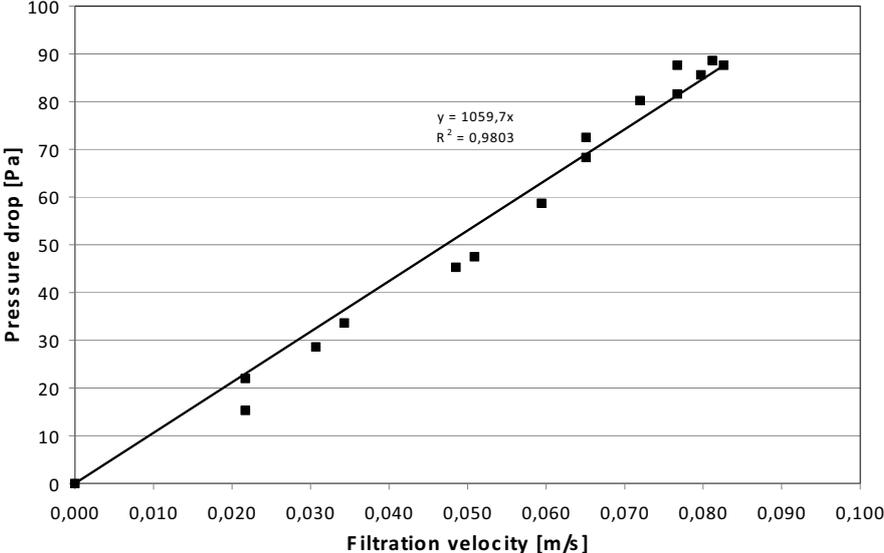


Fig. 2. Pressure drop across the clean filter

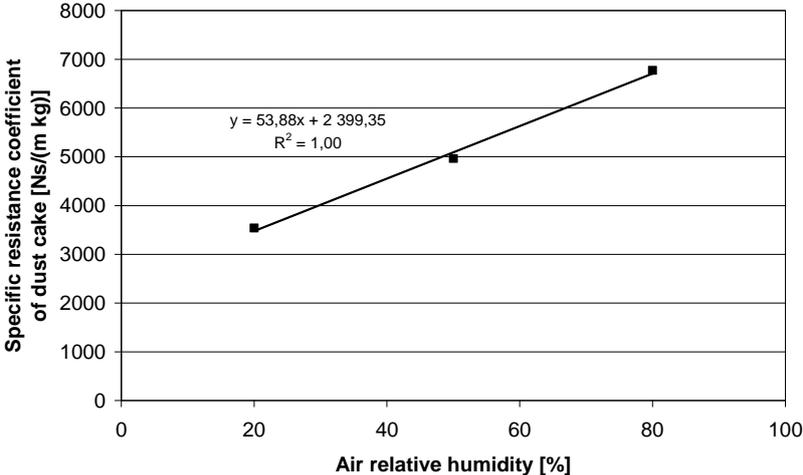


Fig. 3. Specific resistance coefficient of the dust cake

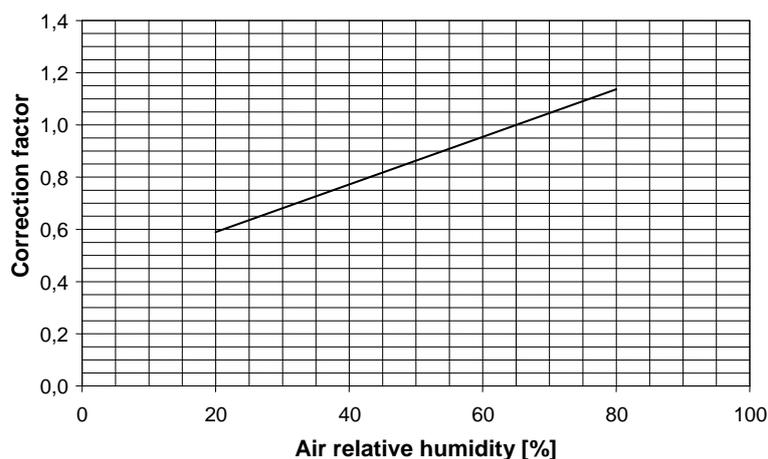


Fig. 4. Correction factor for air relative humidity

## CONCLUSION

The results of investigations the pressure drop in varied conditions of air relative humidity allow to calculate the values of correction factor. The air relative humidity has a more intense influence on the pressure drop in case of the pine wood dust than in case of the beech wood dust.

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**Streszczenie:** *Sprawność filtracyjnego oczyszczania powietrza o podwyższonej wilgotności względnej z cząstek pyłu sosnowego. W pracy przedstawiono obliczenia wilgotnościowego współczynnika korygującego wartość oporów przepływu podczas filtracyjnej separacji pyłu sosnowego. Niezbędne do obliczeń dane – opory przepływu przez czysty materiał filtracyjny i charakterystykę kształtowania się oporów w procesie filtracji uzyskano z doświadczeń przeprowadzonych w skali zwiększonej.*

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