

Principles of pulse-jet filters used in the woodworking industry

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Abstract: *Principles of pulse-jet filters used in the woodworking industry.* The pulse-jet filters used to separate wood dust and factors influencing their operation were described in this paper. The analysis of the possibility of the use of pulse-jet filters for wood dust separation presented in this work was based on two basic quantitative criteria. These are the separation efficiency and the pressure drop in the filtration process performed in a dust collector. The influence of wood dust type, filtration velocity and air relative humidity the separation efficiency and the pressure were described.

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

INTRODUCTION

Pulse-jet fabric filters, despite being one of the oldest types of dust collecting devices, are widely used in the industry. This is due to the high level of separation efficiency of these filters while maintaining the low costs associated with filter operation, in comparison to other dust collectors which may provide similar effectiveness. These advantages resulted in a significant extension of the initially limited range of filter dust collectors. This is connected with significant progress in the construction of pulse-jet baghouses and the development of fibrous media, which allows them to be used for the cleaning up gases with a wide range of temperatures and humidity from dust created a variety of industrial sources (Mukhopadhyay 2009, Mukhopadhyay 2010). Recirculation of the air in the dust extraction system in a woodworking plant is possible only due to the use of highly effective filter dust collectors equipped with separating bags using made of fibrous filtration media (Simon et al. 2014). The analysis of the possibility of the use of filter dust collectors and the evaluation of the effects of their application in specific industrial conditions should be based on two basic quantitative criteria. These are the separation efficiency and the energy consumption of the dust collector, which is the primary source of the costs associated with its operation. The energy consumption is mainly due to the pressure drop during the air flow through the filtration layer. The proper and rational use of filter dust collectors in the industry requires balancing these two opposite requirements. It aims to program the filter performance in such a way that the filter achieves the greatest possible efficiency of dust separation while avoiding excessive pressure drops. Under constant load conditions of the filter dust collector, with constant filtration velocity and dust concentration at the inlet, both the separation efficiency and the resistance of the flow depend on the properties of the dust cake formed during filtration on the surface of the filter medium.

The aim of the paper was to describe the influence of selected factors, which are the most important from the point of view of the use of filter dust collectors in the wood industry, on the processes of wood dust separation based on the previous research.

METHOD

The research described in this paper were conducted using the stand in which has been designed for pilot-scale testing of wood dust separation. It enables testing of filtration bags with a diameter of 150 mm and an active length of 1485 mm, which gives a filtration surface of 0.7 m². Therefore, the bags are filter elements with dimensions used in relatively small dust

collectors used in the industry. The bag is placed on a metal tensioning cage, which has a Venturi nozzle on the upper part, which strengthens the intensity of the pneumatic cleaning impulse. Construction and operation mode of the stand was described in a detailed way by Dolny et al. (2019) and Rogoziński (2018).

RESULTS

Wood dust type

Influence of wood dust type on the performance of pulse-jet filter was tested by Rogoziński (2018). Three types of wood dust (pine, beech, particleboard) and three levels of filtration velocity were used in this investigation. The results were summarized in table 1.

Table 1. Influence of dust type and filtration velocity on the pressure drop conditions in pulse-jet filter (values of Specific dust cake resistance coefficient K_2 [s^{-1}]).

Filtration velocity [$m \cdot s^{-1}$]	Wood dust type		
	Beech wood	Particleboard	Pine wood
0.0405	26157	22443	21778
0.0484	23028	20489	20085
0.0538	26728	28592	24215

Filtration velocity

Filtration velocity is the main factor which determines the filtration system operation. The first visible effect of increasing the filtration velocity is the increase in pressure drop. therefore, when constructing filters, the filtration velocity should be as small as possible in order to reduce operating costs. On the other hand, at lower filtration velocity filter baghouses are largely due to the need to increase the filtration area (number of bags) with a constant volume of cleaned air. The increase of pressure drop with the filtration velocity during the separation of dust created during particleboard working is shown on fig. 1.

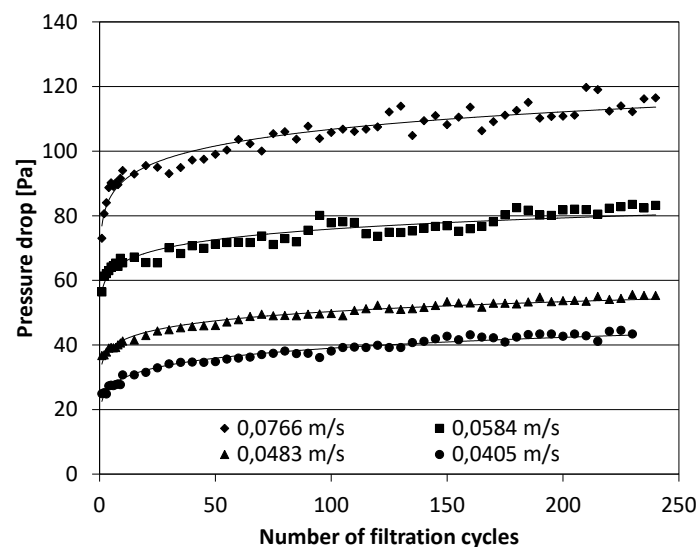


Figure 1. Influence of filtration velocity on the pressure drop during filtration.

Air relative humidity

The results of the study on the influence of air relative humidity of pulse-jet filter operation during wood dust separation were described by Dolny and Rogoziński (2012). The tests were conducted using beech wood dust at the air relative humidity 30% and 90%, filtration velocity 0,0405 m/s and the dust concentration at filter inlet 10 g/m^3 . The results of these tests indicate

a significant influence of air relative humidity on the separation efficiency of wood dust in pulse jet filter (fig. 2.). On the other hand, this is done at the cost of increasing the air flow resistance defined by the pressure drop during filtration (fig. 3.).

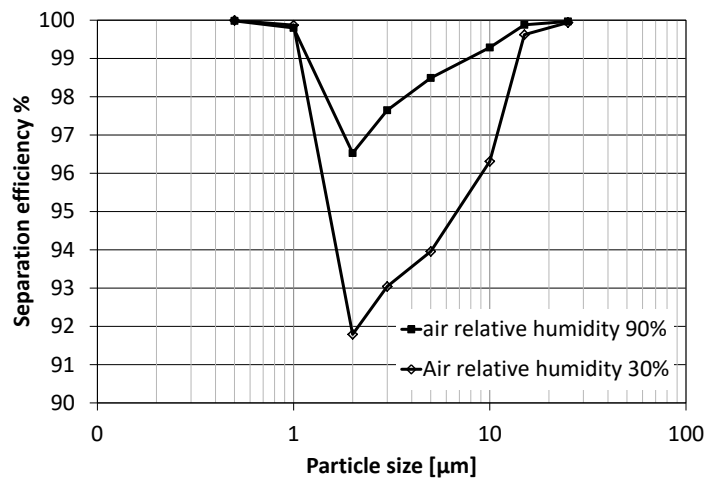


Figure 2. Influence of the air relative humidity on the wood dust filtration efficiency.

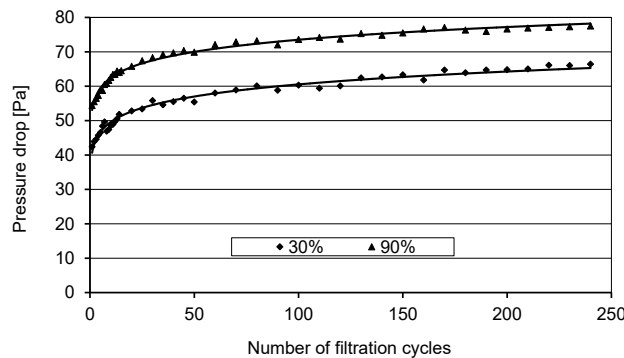


Figure 3. Influence of the air relative humidity on the pressure drop during filtration.

CONCLUSION

The influence of selected external factors on the course of wood dust separation processes was determined by the improved method used in the research consisting of the use of filter bag. Research results related to various values of filtration velocity shows that the filtration velocity is a very important factor determining the filter operation. At the same time, different types of wood dust with different technological origin were tested in various filtration velocity conditions. The type and properties of wood dust should be taken into account when optimizing the performance of baghouse dust collector because the resistance of the filter essentially affects the energy consumption in the filtration process assuming the compressibility of wood dust cake. The separation efficiency of wood dust and air flow resistance are also strongly influenced by the air relative humidity.

REFERENCES

1. DOLNY S., ROGOZINSKI T., DOBAK S., 2019: Methodology of pilot-scale studies on pulse-jet filtration of air polluted with wood dust. *Wood Research*, 64(2), 325–334
2. MUKHOPADHYAY A., 2009: Pulse-jet filtration: An effective way to control industrial pollution Part I: Theory, selection and design of pulse-jet filter. *Textile Progress*, 41(4), 195–315

3. MUKHOPADHYAY A., 2010: Pulse-jet filtration: An effective way to control industrial pollution Part II: Process characterization and evaluation of filter media. *Textile Progress*, 42(1), 1–97
4. ROGOZIŃSKI T., DOLNY S., 2012: Efficiency of beech wood dust separation from air with increased relative humidity. *Proceedings of the 8th International Science Conference Chip and Chipless Woodworking Processes*, 6-9 September 2012, Zvolen, p. 73-78
5. ROGOZIŃSKI T., 2018: Pilot-scale study on the influence of wood dust type on pressure drop during filtration in a pulse-jet baghouse. *Process Safety and Environmental Protection*, 119, 58–64. <https://doi.org/10.1016/j.psep.2018.07.016>
6. SIMON X., BÉMER D., CHAZELET S., THOMAS D., 2014: Downstream particle puffs emitted during pulse-jet cleaning of a baghouse wood dust collector: Influence of operating conditions and filter surface treatment. *Powder Technology*, 261, 61–70. <https://doi.org/10.1016/j.powtec.2014.04.028>

Streszczenie: *Zasady stosowania filtrów z regeneracją pneumatyczną w przemyśle drzewnym.* W artykule opisano problematykę wykorzystania filtrów z regeneracją pneumatyczną do oddzielania pyłu drzewnego oraz zasadnicze czynniki wpływające na ich działanie. Przedstawiona w niniejszej pracy analiza możliwości zastosowania filtrów z regeneracją pneumatyczną do separacji pyłu drzewnego opierała się na dwóch podstawowych kryteriach ilościowych: skuteczności separacyjnej i spadku ciśnienia w procesie filtracji w kolektorze pyłu. Opisano wpływ rodzaju pyłu drzewnego, prędkości filtracji i wilgotności względnej powietrza na skuteczność oddzielania pyłu i następujący przy tym spadek ciśnienia.

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