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Particulate emission during separation of wood dust by a jet-pulsed filter

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Abstract: *Particulate emission during separation of wood dust by a jet-pulsed filter*. This paper describes the results obtained during the experimental process of cleaning the air from oak wood dust by filtration method. The typical increase of the pressure drop and the significant influence of the formation and properties of the dust cake on the separation efficiency were detected on the basis of these results

Keywords: wood dust, filtration, pulse-jet filter, non-woven fabric

INTRODUCTION

Effective exhaust ventilation system is the very important preventive measure of air dustiness reduction. This is particularly important in the wood processing plants where operations associated with surface finishing are conducted. Workers of furniture factory are particularly vulnerable to the health risks associated with air dustiness due to the fact that the technology of furniture includes sanding operations. Additionally, the wood dust exposure and occupational hazard related to this exposure increase at manual sanding, especially if treated hardwood species are classified as carcinogenic such as oak and beech (Schlunssen et al. 2001, Krysińska-Traczyk et al. 2002).

Recirculation of the air carried in the exhaust ventilation system requires the efficient operation of the separation devices. In condition of wood processing industry it is possible only with use of the fabric filters. Operation and performance of these separators depends on many factors. The most important of them are filtration parameters: filtration velocity and dust loading of filter surface. The crucial factors are also the operating conditions of a regeneration system: the intensity and frequency of pulses of compressed air. This all determines the conditions for the formation of the dust cake on the surface of the filter material. The nature, shape, dimensional and rheological properties of the dust are also important. Wood dust is characterized by a considerable variability of these parameters, which makes the difficulty of design and prediction of the effectiveness of filtration processes. Therefore, experimental research is needed to description of the impact of these factors on the wood dust removal from the air (Calle et al. 1998, Dolny and Rogoziński 2012, Lu and Tsai 2001, Mukhopadhyay 2009, Mukhopadhyay 2010, Rogoziński et al. 2013, Rogoziński and Ockajova 2013).

The aim of this study was to determine the level of particulate emission during the separation of dust from the sanding of oak wood in the pulse-jet filter.

MATERIALS

This paper includes the description and characteristics of an experimental process of air cleaning from dust created at the sanding of oak furniture elements carried out in jet-pulsed filter. The dust used in the experiment came from the furniture factory, in which sanding was carried out by the sanding paper with granulation signed 150.

The standard single-layer, non-woven polyester filter material with area density 500g was used in the filtration process. The experiment was conducted on the pilot-scale filtration unit. Construction and operation of this filter were already many times described in earlier works (Dolny 1998, Dolny 1999). The filtration element was of the form of a bag with length 1500 mm and diameter 150 mm.

The course of the experimental filtration process included 50 filtration cycles. Each cycle consisted 5 min. So long were the intervals between following clearing pulses. Pressure of compressed air amounted 0,5 MPa and pulse duration was 15ms. Filtration velocity was 0,04 m/s and dust concentration at inlet - 30 g/m^3.

The basic characteristic of the course of filtration describes changes in the pressure drop during its time. The pressure drop across the filter material with consideration of dust cake were recorded immediately before and after each cleaning pulse by digital differential manometer. It show the efficiency of dust cake detachment during clearing pulses. Particulate emission were measured by the laser particle counter (LPC). Measurements were done at one-minute intervals. Five measurements were taken during each filtration cycle. It gave the possibility of the estimation of average particle emission and its variability in each filtration cycle.

RESULTS

The results of the pressure drop measurements obtained during the test were show on the graph (Fig. 1). The graph contains two curves. The upper curve describes the pressure drop immediately before and the lower curve immediately after each regenerative pulse. The difference between them is the pressure drop across the dust layer created during filtration cycle and removed by the cleaning pulse. The filtration process is characterized by typical increase of the pressure drop. Initial rapid increase and subsequent stabilization of the pressure drop can be observed.

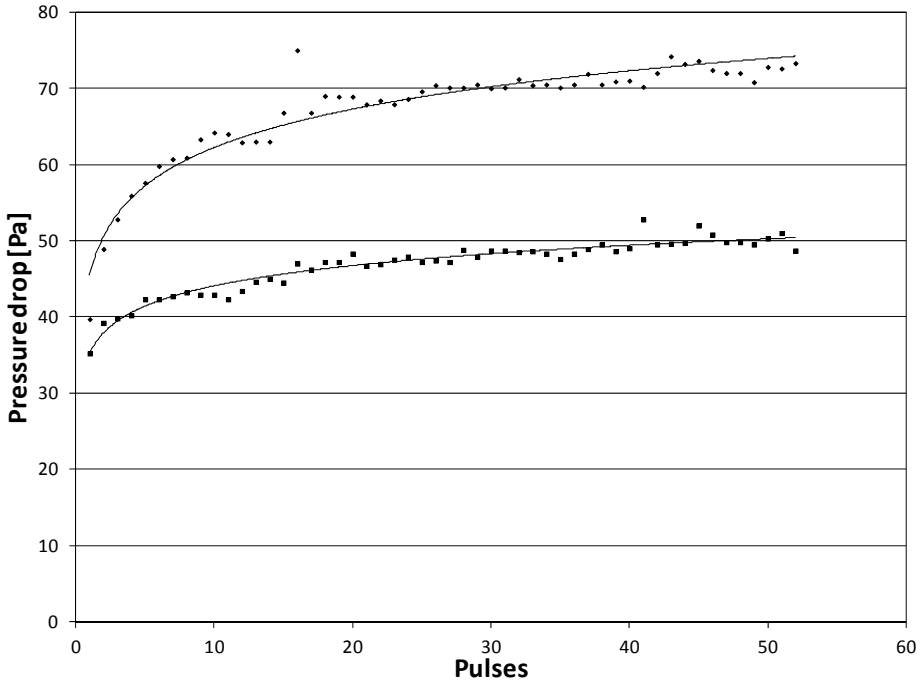

Fig. 1 Pressure drop during filtration

Average number of dust particles penetrating cross the filtering barrier during the filtration cycle decreases along the course of the experiment and the ageing of filtration material (fig. 2). It means that the certain amount of dust permanently binds to the surface of the filter material, forming a filtering barrier. Further parts of the dust carried by the air are deposited on this surface and create the dust cake, which is detached and removed during the cleaning pulse. Changes of the thickness of dust cake during each filtration cycle is a reason of the considerable increase of the filtration efficiency between successive pulses. The average number of particles penetrating the filtering barrier remains on the stable level and decreases slowly with the time of filtration but the momentary values recorded at one minute

intervals during each filtration cycle show substantial differences in this respect. It was shown on the figure 3 which presents the variability of filtration efficiency of dust cake In the 10, 30 and 50 cycle. The dust cake is so efficient filtration structure that the number of particles penetrating across into the cleaned air decreased four times during the five minute filtering cycle.

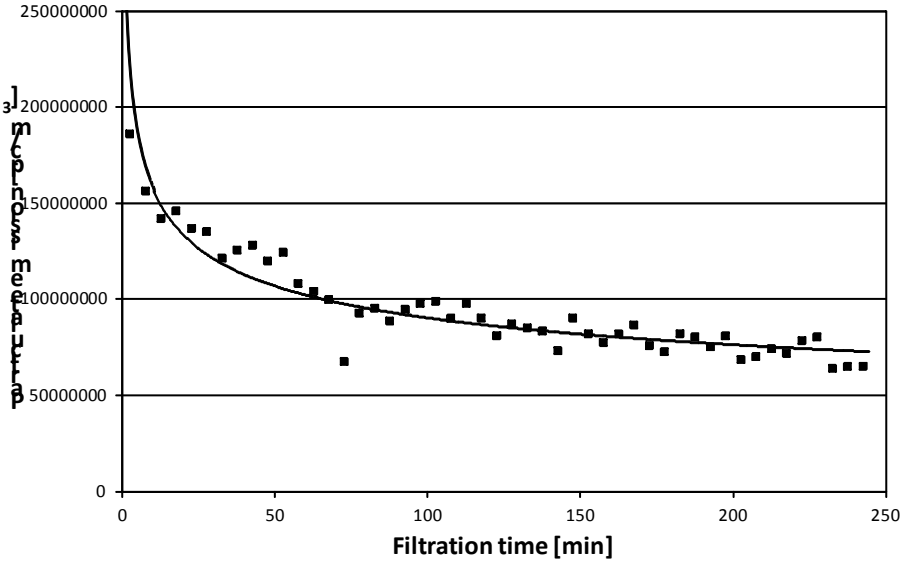

Fig. 2 Average emission

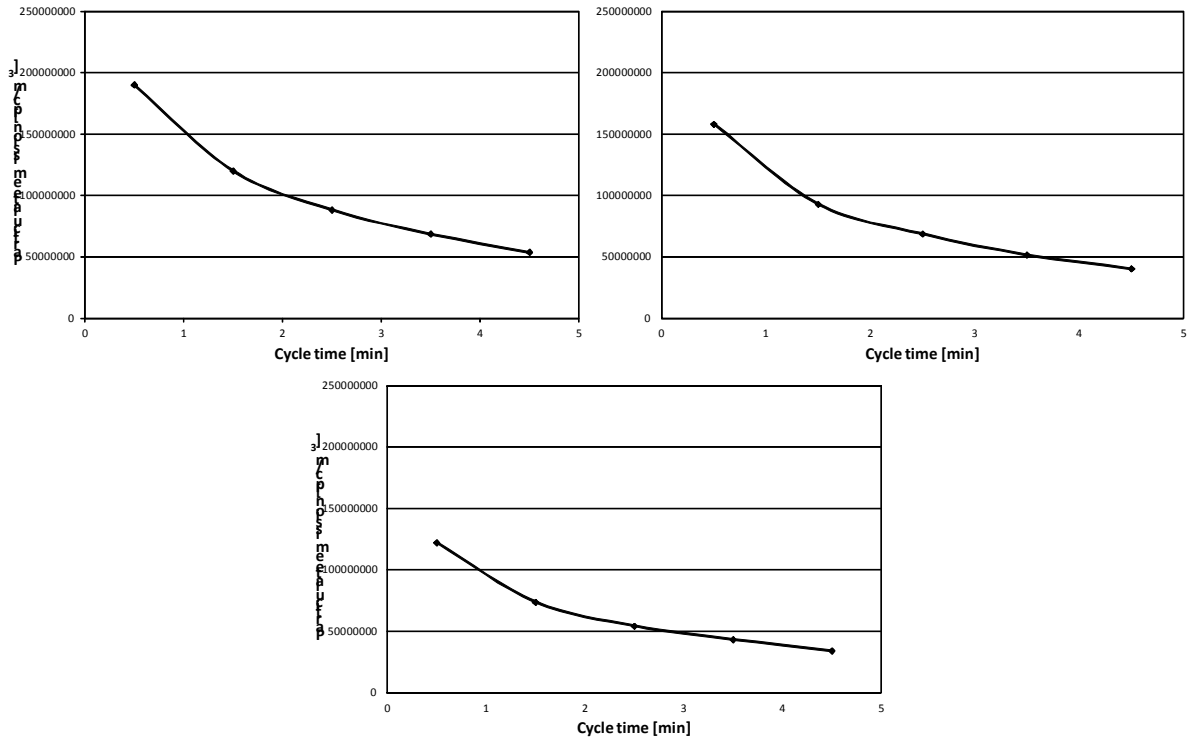

Fig. 3 Particulate emission during 10 ,30 and 50 cycle

CONCLUSION

The experiment carried out in this work showed the typical course of the wood dust filtration process. The obtained results indicate that the greatest influence on the filtration efficiency have the dust cake created of the dust particles captured on the filter surface. The estimation of the dust layer creation and its properties gives a possibility of prediction of the efficiency and energy consumption of the filtration process in furniture industry. It is an

essential information for developing an designing of filtering units which may be used in this industry.

REFERENCES

1. CALLE´ S., BE´MER D., THOMAS D., CONTAL P., LECLERC D. 2001: Changes in the Performances of Filter Media During Clogging and Cleaning Cycles. Ann. occup. Hyg., 45, 115–121.
2. DOLNY S. 1999: Transport pneumatyczny i odpylanie w przemyśle drzewnym, AR Poznań.
3. DOLNY S. 1998: Badania oporów przepływu podczas filtracyjnej separacji pyłów powstałych w procesach przerobu materiałów drzewnych, AR Poznań.
4. DOLNY S., ROGOZIŃSKI T. 2012: Filtering separation of pine wood dust under variable conditions of intensity of pulse-jet cleaning, Ann. WULS-SGGW, For and Wood Technol. 77.
5. KRYSIŃSKA-TRACZYK E., SKÓRSKA C., CHOLEWA G., SITKOWSKA J., MILANOWSKI J., DUTKIEWICZ J. 2002: Exposure to airborne microorganisms in furniture factories. Ann Agric Environ Med 9, 85-90.
6. LU H-C., TSAI C-J. 1998: A pilot scale study of the design and operation parameters of a pulse-jet baghouse. Aerosol Sci. and Technol. 29:510-524.
7. 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).
8. 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).
9. ROGOZIŃSKI T., KOPECKÝ Z., HLÁSKOVÁ L, VESELÝ P., ROUSEK M. 2013: Dust creation during mahogany wood sawing. Ann. WULS - SGGW, For. and Wood Technol., 81.
10. ROGOZIŃSKI T., OČKAJOVÁ A. 2013: Comparison of two methods for granularity determination of wood dust particles. Ann. WULS - SGGW, For. and Wood Technol., 81.
11. SCHLUNSSEN V., VINZENTS P.S., MIKKELSEN A.B., SCHAUMBURG I. 2001: Wood Dust Exposure in the Danish Furniture Industry using Conventional and Passive Monitors. *Ann. occup. Hyg.*, Vol. 45, No. 2, pp. 157–164

Streszczenie: *Emisja cząstek podczas filtracyjnej separacji pyłu drzewnego w filtrze pulsacyjnym*. W pracy opisano wyniki uzyskane podczas eksperymentalnego procesu filtracyjnego oczyszczania powietrza z pyłu dębowego. Na ich podstawie stwierdzono typowy przebieg narastania oporów przepływu powietrza oraz znaczący wpływ czasu tworzenia się i właściwości warstwy pyłowej na skuteczność separacyjną.

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