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PrekotAC as Filter Aids for Efficient Dust Separation in a Fabric Filter

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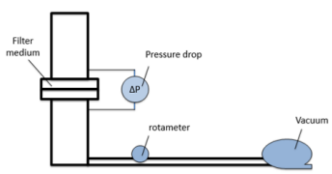
Graphical abstract



Abstract

Fabric filters are extensively used as an air pollution control system for its high efficiency to collect particles from gaseous stream. The system is commonly installed in many incineration plants as the means to control dust and gaseous emissions. Unfortunately, their applications in these facilities are short lived due to wear and tear of the fabric media. This is because the fabric filter is not adequately conditioned before it is put up into service. A simple technique is to apply so called 'pre-coat' material to coat a layer of inert material onto the surface of the fabric as a 'barrier' for protection as well as to allow a uniform air flow passing through the filter media. In this regard, a newly formulated filter aids material known as PrekotAC, not merely acts as an adsorbent for flue gas cleaning but also an efficient dust separation agent in a fabric filter system. A mixture of PreKot^{TM}:Activated Carbon of 40:60 (%weight) was found to be the most preferable combination with its particle size distribution between 75 and 600µm, which is bigger size fraction than the original materials.

Keywords: Fabric filter; filter aid; precoat; air pollution; pressure drop

1.0 INTRODUCTION

Fabric filter or baghouses have been utilized for more than a century to control particulate emissions. It is typically installed in incineration plant where a high degree of removal efficiency of particulate emission is needed to meet the regulatory requirement [1]. Basically, fabrics filter whether fibers or felt, is formed into the cylindrical or envelope bags and suspended in baghouse. The dirty gases pass through the fabric leaving the dirt in a form of a cake onto the outside surface of the fabric [2]. The layer of cake provides or acts as an additional filtering medium which further increases the performance of collection of pollutant. Thus, having a coating material that helps to increase the collection of particle (or gaseous and organic pollutants alike) and at the same times increase the filtering efficiency against plugging and blinding of fabric filter is highly warranted in this regard.

Filter aids as 'precoating' material can be used to coat a layer of inert material onto each of a fabric as a 'barrier' for protection as well as to allow a uniform air flow passing through the filter media [3]. Filter aids consisting of a group of inert materials can be used in filtration pre-treatment or improvement in filtration. This is commonly referred to as 'pre-coat'. Over long period of time, activated carbons have been extensively used as a filter aids in variety of environmental applications such as adsorbents, gas purification, solvent recovery, and waste water treatment. They are used in various application depending on their porous properties for example, activated carbons with many micropores are used for gas adsorption, mesopores are necessary for the adsorption of large molecules [4]. Prekot^{TM} is another commercially available filter aids material which directly apply into the flue gas stream to bond with generated dust forming a well uniform and distributed dust cake onto the surface of a fabric filter.

The study is to formulate and characterize a pre-coating material to be utilized as a pre-coating material that is not merely improving fabric filtration but also acts as flue gas treatment agent. The physical characteristics of admixture will be evaluated based on its pressure drop across the fabric filter in a laboratory scale filtration unit developed specially for the experiment.

2.0 METHODOLOGY

2.1 Activated Carbon

The coke based activated carbon was used in this study due to its low cost and easily available in terms of supply compared to the others [5]. The adsorbent was in a powder form with its properties listed in Table 1.

Table 1 Specification of the activated carbon

Origin	Coke based
Moisture	15%-max
Bulk density	~440 kg/m^3
pH value	9-11
Ash content	8.0% -max
Particle size	Less than 75 up to 600 µm

2.2 PreKot™

PreKot™ is a commercially available filter aids material. It is presently used as filtering aids apply directly into the flue gas stream to bond with generated dust forming a well uniform and distributed dust cake onto the surface of a fabric filter. Table 2 presents the properties of the PreKot™.

Table 2 Specification of PreKot™

Fusion point	~1300°C
Softening point	~900°C
Bulk density	~120 kg/m^3
Thermal conductivity	Less than 0.0500 kcal/mh°C at 0°C
Moisture content	Less than 1.0% wt
Particle size	Less than 75 up to 600 µm

Note : PreKot™ is a proprietary of AMR Environmental Sdn. Bhd.

PreKot™ is a safe and inert coating powdered material used as filtering aids to increase filtering efficiency and to prevent blinding and plugging of fabric filter media. This material has the properties of a good filter aids material. Its fusion temperature is well above 200°C, the normal operating conditions of fabric filter in flue gas treatment environment. Also the material has the advantages of significantly having very low thermal conductivity properties as well as with less than 1% in terms of moisture content that makes it a reliable pre-coating material.

2.3 PreKot™ and Activated Carbon Admixture Formulation

The admixture of PreKot™ and activated carbon (also known as PrekotAC) was prepared in different ratios as presented in Table 3. Initially, both activated carbon and PreKot™ were dried in oven with temperature at 105°C for at least 24 hours to discard moisture content. The particle size distribution of each of the admixture sample was determined using a shaker (ENDECOTTS Model 2000/2).

Table 3 The formulated ratio of PreKot™ and activated carbon admixture

Ratio (dry wt%) PreKot™ : Activated Carbon
10 : 90
20 : 80
30 : 70
40 : 60

2.4 Experimental Procedures

Figure 1 presents the basic apparatus used in the filtration test, consists of a filtration system, pressure manometer, a rotameter and a vacuum pump. The filtration system composed of two glass cylinders with a filter holder in between. At constant surface velocity, suspended dust particles were filtered by 47 mm clean fabric filter. As a preliminary test, a normal 47 mm diameter glass type membrane filter was used as the filtration media. The filtering velocity of filter media was set by manipulating the flow rate of the vacuum pump and monitored by the rotameter.

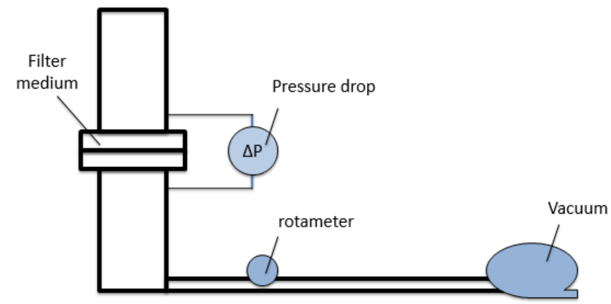


Figure 1 Sketch of filtration test apparatus

The pressure drop across the filter media was measured using a heavy duty differential pressure manometer (Extech Instruments model HD755). The maximum pressure drop can be measure via this instrument was approximately 3.5kPa. The pressure drop was recorded with different thickness of admixture added with a constant filter velocity of 6 m/min.

3.0 RESULTS AND DISCUSSION

3.1 Particle Size Distribution

Figure 2 presents the particle size distribution of the basic raw material i.e activated carbon and PreKot™ before mixing which showed that their distinctive difference in the particle size distributions. The activated carbon has a very fine particle size distribution predominantly lies between 75 µm and below. On the contrary, PreKot™ has a coarser particle size compared to activated carbon where it is mainly lies between 75 µm to 150 µm. Their distinctiveness difference in the size distribution seems ideal for the purpose of mixing as a one component material in this respect [6].

Figure 3 presents the particle size distribution of each formulated mixture which supports the particle size distribution of the combined material laid between their original sample. As shown in Figure 3 the particle size distribution of the formulated mixture is not too fine nor too coarse compared to the original material. Thus, it is expected that the mixture would form a porous cake on a filter media, which is a prequisite for a good filter aids. Each combination of the formulated mixture presents a deviation in different particle size distributions of non-uniform particle size fraction. As a very fine particle lead to a small surface area that reduce the volumetric air flow passing through the filter cake. Coarse particles give poor clarity, less resistance and high permeability cake where fine dust particles can easily penetrate through the cake [7]. The proposed formulated admixture will present the the compromised between these properties.

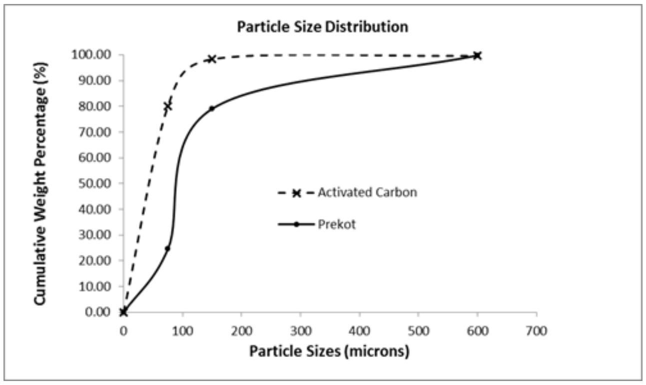


Figure 2 Particle distribution of Prekot™ and activated carbon

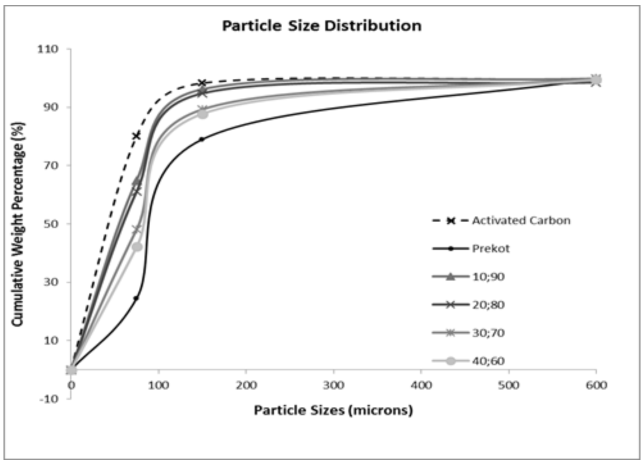


Figure 3 Particle size distribution of formulated mixture of activated carbon and PreKot™

3.2 Pressure Drop

Figure 4 presents the pressure drop across the filter media against the cake thickness under a constant surface filtering velocity of 6 m/min which showed that the activated carbon has the highest pressure drop compared to PreKot™ which has the lowest pressure drop across the filter at various cake thickness. On the other hand, the various admixture of PreKot™: activated carbon presents a uniform and consistent pressure drop across the filter media with 40:60 gives the lowest among the combinations. The addition of various weight of PreKot™ experiences a lower pressure drop compared to activated carbon material alone confirming that PreKot™ has the capability of increasing the porosity of the filter cake during the filtration process. It is observed that the particulate size distribution also contributes a substantial decrease in pressure drop particularly for higher content of PreKot™ in the mixture. Similarly, a considerable decrease in pressure drop was observed due to the effect of deviation in different particle size distributions of non-uniform particle size fractions for the PrekotAC mixture. Furthermore, the porous and fluffy structure of PreKot™ has led to the increase in the permeability of the filter cake that allows easy gas flow across the medium with reduce pressure drop. Since pressure drop is one of the most important criteria of a gas cleaning equipment in terms of its operating cost, it appears that a considerably amount of savings could be achieved with the use of PrekotAC by extending the life span of the fabric filter in service.

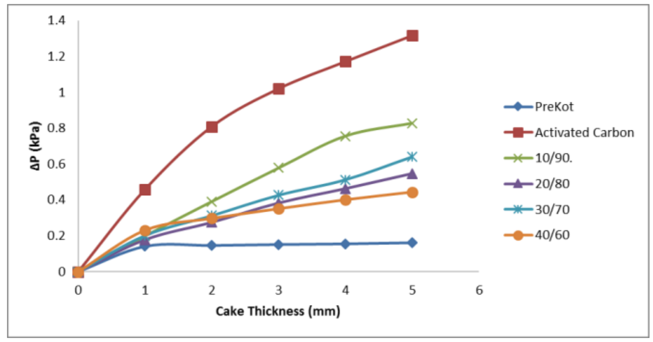


Figure 4 Pressure drop against cake thickness of formulated mixture of PreKot™ : activated carbon

4.0 CONCLUSION

A newly formulated filter aids material for flue gas cleaning application consisting of PreKot™ and activated carbon (known as PrekotAC) showed that pressure drop decreases substantially with increased of PreKot™ content in the mixture. It appears that substantial savings could be achieved in the terms of maintenance costs with the application of PrekotAC in the industry. Furthermore, the newly formulated mixture not merely works as a pre-coating material to enhance the life span of the fabric media but also acts as a flue gas treatment agent with better filtration and removal efficiency of organic contaminants in the flue gas streams.

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References

[1] Pham M., C. Clark, J. McKenna. 2012. The Evolution and Impact of Testing Baghouse Filter Performance. *Journal of the Air and Waste Management Association*. 62(8): 916–923.

[2] Hesketh H.E. 1979. *Air Pollution Control*. Ann Arbor Michigan Science Publisher. Inc.

[3] Hajar, S., A. Nurnadia, M. Rashid and M. Ammar. 2013. Precoating material as Filter Aids and Flue Gas Cleaning Treatment for Fabric Filter. *Article Berita Ensearch April-June 2nd quarter*. 4–9.

[4] Nakagawa, K., S. R. Mukai, T. Suzuki and H. Tamon. 2002. Gas Adsorbtion on Activated Carbons from PET Mixtures with Metal Salt. *Carbon*. 41: 823–831.

[5] Knaebel, K. S. *Adsorbent Selection*. Adsorption Research, Inc.

[6] Hajar, S., M. Rashid, A. Nurnadia and M. Ammar. 2013. Formulation of a New Pre-coating Material for Fabric Filtration in Air Filtration System. *MJIIT-JUC International Symposium 2013*. Tokai University, Hiratsuka, Japan. November 6-8.

[7] Leppla, P. W. 1962. Filter Aids to Improve. *Industrial and Engineering Chemistry*. 54(5).