International Journal of Engineering & Technology, 7 (4.38) (2018) 1683-1685

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper



Characteristics of TrikotAC as Filter Aids Material for Fabric Filtration System

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Abstract

Filter aids material applied in fabric filtration system does not merely work as a flue gas cleaning agent but also acts as an efficient particles collection barrier. In this study, the characteristics of a formulated filter aids TrikotAC consisting of three different types of filter aids materials, activated carbon, lime, and PreKot™ were investigated in a laboratory scale filtration unit. Three different formulations of TrikotAC were tested in terms of their pressure drop performance across the filtration unit where the best formulation was determined in the study.

Keywords: *Fabric filtration, Filter aids, TrikotAC*

1. Introduction

Fabric filter has a very high collection efficiency of up to 99.9 percent if operating with a proper fabric selection, adequate sizing and design. However, its filtration performance is not always consistent with time when in service. One of the methods that can be applied to improve the filtration efficiency is by applying a pre-coating material that also known as a filter aids material during the filtration process (Pereira *et al*., 2016).

Lihong *et al.*, (2011) stated that filter aids are normally comes in a particulate or fiber material form that can be use either as a pre-coat, body feed or both combination. By applying filter aids material during filtration process, it will form a dense yet porous and highly permeable filter cake that protects the filter media from clogging as well as improving the filtration performance. The properties and performance of a filter aids are determined according to the characteristics of the material used in filtration process. Filter aids effect the effectiveness of the filtration system and determines its filtering \efficiency, pressure drop across fabric filter, as well as filter cake properties (Boittelle, *et al.*, 2008). The characteristics of filter aids such as particle size distribution and morphology play an important role on the structure and detachment of accumulated filter cake.

This paper presents on the characteristics of a newly developed filter aids, TrikotAC of three different formulations. The performance of the three different formulations in terms of their respective pressure drop across a filtration media was observed and compared in the experiment. The most suitable formulation was then selected and further tested in the next study.

2. Materials and methods

2.1 Materials and Formulation of TrikotAC

Three different types of filter aids material, (activated carbon, lime, and PreKot™) were used to formulate the new filter aids material, TrikotAC where the specifications of each material are sum razed in Table 1. Activated carbon and lime work as an adsorbent to remove acid gases, heavy metals, and organic compounds (Woodard and Curran, 2005 and Schifftner, 2013). On contrary, PreKot™ is a pre-coating material that used to increase filtration efficiency besides preventing blinding and plugging of the filter media.

Based on the application in industry, TrikotAC was formulated by mixing a pre-dried activated carbon, PreKot™, and lime in three different weigh ratios as listed in Table 2. All materials were dried in an oven at 105^{0}C for 24 hours prior mixing to discard moisture content.

Table 1: Specifications of raw materials (activated carbon, PreKot™, and lime)

Activated Carbon	PreKot™	Lime
Form, color: Powder,black Origin: Coconut based Surface area: 1095.0 m^2/g Bulk density: 737.2 kg/m^3	Form, color: Powder, snowy white Surface area: 2.5 m^2/g Bulk density: 302.2 kg/m^3	Form, color: Powder, white Surface area: 7.6 m^2/g Bulk density: 908.6 kg/m^3

Table 2: Formulation of TrikotAC

Weigh ratio (dry wt%) PreKot™ : Activated carbon : Lime
10:1:89
10:5:85
10:10:80

2.2 Characterization of Each Formulated Filter Aids

The raw material and formulated sample were in terms of their particle size distribution, and morphology in order to understandits effects towards filtration performance. Particle size distribution was determined using a dry dispersion unit particulate size

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analyzer (Malvern Instrument Mastersizer Model 2000). Morphology of raw materials were observed using LV-SEM (JEOL, JSM-IT300).

2.3 Filtration Test System

TrikotAC was tested in a fabricated laboratory scale fabric filtration system as shown in Figure 1. It was fabricated based on actual filtration test system which consists of dust feeder, filter media test column, pressure manometer, rotameter, vacuum pump and particle detector GRIMM (Model 1.108/9). Airflow passing through the system was controlled by a vacuum pum installed at the end of the system and monitored as well as controlled by a rotameter. Pressure manometer was placed between the two cylinders holding filter media in order to monitor differential pressure of the filter media.

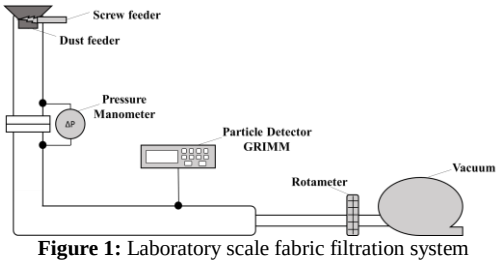


Figure 1: Laboratory scale fabric filtration system

2.4 Experimental Procedures

The filtration performance of the sample was tested using the filtration test system under three different material loadings (0.2,0.4, and 0.6 mg/mm2) and filtration velocities (1, 2, 4 m/min). Table 3 presents the specifications of P84 filter media used in this study. The effects of the material loadings and filtration velocities of each sample on pressure drop was observed. Each experiment was repeated thrice and Table 4 shows the overall experimental conditions.

Table 3: Specifications of P84 filter media

Type	P84 filter media
Weight (g/m^2)	550.0
Thickness (mm)	2.4
Density (g.cm^3)	0.23

Table 4: Experimental conditions

Filter media	P84
Filtration area (mm^2)	755
Material loading (mg/mm^2)	0.2, 0.4, 0.6
Filtration velocity (m/min)	1, 2, 4

3. Results and discussion

3.1 Particle Size Distribution

Figure 2 presents results on particle size distribution of raw materials (activated carbon, lime, and PreKot™) where each material showed distinctiveness differences characteristics. Results showed that PreKot™ has a very course particle size distribution compared to the other two materials where 60 percent of it are particles size bigger than 60 µm. In comparison, more than 60 percent of activated carbon are particles smaller or equal to 60 µm. Lime gives a balance particle size distribution of fine and coarse particles. It was found that equally, around 40 percent of the material be composed of particle size smaller than or equal to 60 µm and bigger than or equal to 60 µm.

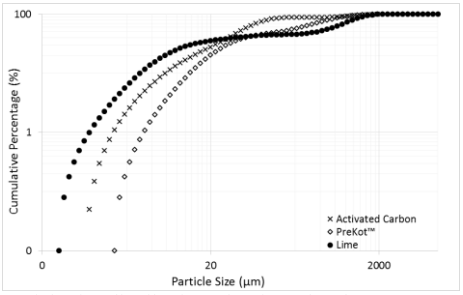
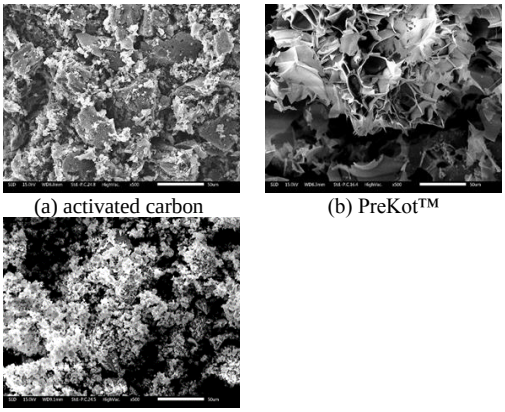


Figure 2: Particle size distribution of activated carbon, PreKot™, and lime

Figures 3 show the micrographs of each raw materials under the same magnification of 500X which proved the wide disparities of each material in terms of its particle size. It was reported that particle size distribution gives a decisive effect towards filtration performance in terms of its pressure drop and particle penetration across the filter media (Ibrahim and Selim, 2011). Thus, by mixing the raw materials into a formulated filter aids material is expected to form a better filter aids material enhancing filtration performance. A filter aids material with a well distributed particle size distribution is expected to form a porous filter cake with less particle penetration and differential lower pressure drop across its filter cake.



(a) activated carbon (b) PreKot™

(c) lime

Figure 3: Micrographs of raw materials

Figure 4 presents the particle size distribution of TrikotAC where it is observed that size distribution of all formulated TrikotAC laid consistently between activated carbon and lime, characterized the properties of both these raw materials. Results showed that as the ratio of activated carbon decreases, it reduces the percentage of fine particles size fraction content in the formulated mixture, which is expected to enhance a better air flow across its filter cake. Lime and activated carbon are used as flue gas cleaning agents for the removal of acid gases and VOCs, respectively. However, they are likely to cause blinding and plugging, forming a dense and compact filter cake on the filter media during filtration process because of higher percentage of fine particle size fraction (Ravert, 2006). Hence, a combination these raw materials into one formulation helps to form a porous filter cake because of its well distributed particle size distribution.

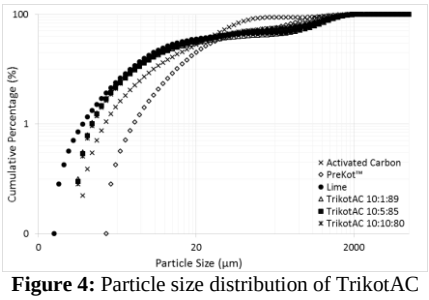


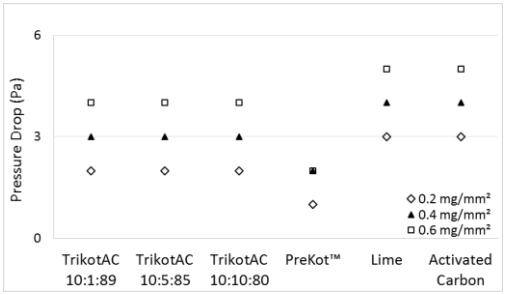
Figure 4: Particle size distribution of TrikotAC

3.2 Pressure Drop across Filter Cake

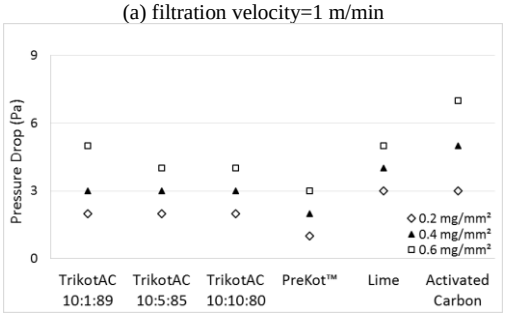
Figure 5 illustrates the effect of filtration velocity and material loading of formulated TrikotAC and raw material on pressure drop which showed that higher filtration velocity and material loading lead to higher pressure drop across filter cake.

As observed in Figure 5, TrikotAC consistently gives a lower pressure drop compared to its raw materials activated carbon and lime. But, there is no significant difference between each formulation especially at the lowest material loading of 0.2 mg/mm^2. However, it was found that the changes in the amount of activated carbon content in the formulation tends to influence the pressure drop across the filter cake especially at the highest material loading. Activated carbon which predominantly consists of higher percentage of fine particles size fraction has a greater tendency to form a compact filter cake, resulting in higher pressure drop (Mayerhofer *et al.*,2011).

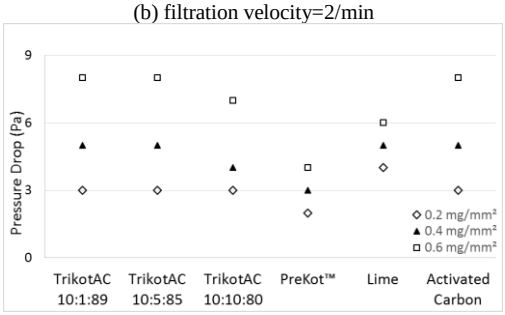
Results also showed that higher material loading and filtration velocity lead to higher pressure drop across the filter cake. These two parameters influence the characteristics of the accumulated filter cake in terms of its porosity that affect the filtration quality in fabric filtration process. A higher material loading leads to a thicker filter cake and reduces porosity of the filter cake that reduce an airflow from passing through the system. In addition, a compacted and densed filter cake is formed at higher filtration velocity resulted in higher pressure drop across the filter cake (Chen and Hsiau, 2009).



(a) filtration velocity=1 m/min



(b) filtration velocity=2/min



(c) filtration velocity = 4 m/min

Figure 5: Effect of material loading on pressure drop across a filter cake at a constant filtration velocity

Leung *et al.*, (2010) reported that filtration quality can be improved by either increasing the filtration efficiency or reducing the pressure drop across the filter cake without altering other property. The results showed that the formulated TrikotAC is a better filter aids material compare to its raw materials lime and activated carbon alone, since it has the it improves the filtration performance in terms of its pressure drop across the filter cake.

4. Conclusion

The newly formulated TrikotAC is a promising filter aids material compared to its original raw material lime and activated carbon. It is characterized as a well-balanced particle size distribution material with better filtration peformance in terms of pressure drop across its filter cake as compared to its original materials.

Acknowledgement

Ms. Hajar and Ms. Masdiana, are both PhD candidates who wish to express their gratitude to MJIIT, Universiti Teknologi Malaysia for the financial fellowship support.

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