Comparison of filtration performances between membrane and non-membrane filters

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Abstract

The filtration performances of PE felt and PTFE laminated membrane PE felt are experimentally studied. Although membrane filter give a higher residual pressure drop than the non-membrane filter, the same filtration cycle times are obtained because membrane filter has a lower curvedly pressure drop increasing part resulting from a comparatively homogenous filter surface. The filtration efficiency and cake release of membrane filter are far superior to the non-membrane filter.

Keywords: Filtration, membrane filter, non-membrane filter.

Introduction

PTFE membrane laminated on filtration side of filter media permits air to pass through the filter media while trapping nearly all the particles on the surface. Filtration is done by the micro porous PTFE membrane whereas the substrate fabric provides the physical strength for the filter. The PTFE membrane can be thought of as a primary dust cake that can operate at high efficiency levels even at sub-micro level to realize a superior particulates emission control. The phenomenon is usually termed as surface filtration and has many advantages such as lower outlet emissions, consistently lower pressure drop throughout the life of the filter media and great product recovery.[1-5]

The objective of present work is to investigate and compare filtration performances of PE felt laminated with and without PTFE membrane, in which include resistance characteristics, filtration efficiency and residual dust load.

Experimental

Experimental setup. The schematic diagram of the experimental setup is shown in Fig.1. Test dust is fed by a screw dust feeder and dispersed by an ejector. The dust laden gas is introduced into the top of the vertical duct, and the dust in the gas is collected on the test filter installed at the inlet of the horizontal duct. The pressures upstream and downstream of the filter are recorded by a pressure transducer (VALCOM, VPRN-A4). The filtration-regeneration cycle is controlled by either a prescribed filter pressure or time interval, and the cycle is repeated at a given filtration velocity. When the filter pressure reaches a prescribed value (1000 Pa in the present work), filter regeneration is carried out with compressed air through a solenoid valve connected to a 2.5 L compressed air reservoir. Otherwise, filter regeneration is carried out with a preset time interval for a large number of cycles.

Experimental procedure. In order to characterize the filtration performances of a seasoned filter, we run a pre-test at first. The procedure is as follows:

Step 1: Virgin performance test period: 30 filtration-cleaning cycles with a prescribed cleaning pressure drop (1000 Pa). The filter performances of the virgin filter can be represented by the testing results in this stage.

Step 2: Aging period: 5000 cycles with filter cleaning at a given interval of 5 s. Aging is an acceleration process to obtain a seasoned filter in a short period of time. The service life of filter media usually ranges from 2~4 years depending on their applications, which corresponds to 200,000 to 400,000 filtration-cleaning cycles. The most practical method to find the long-term performance of a filter would be the acceleration of filter degradation with rapid pulse cleaning, which is called as aging or seasoning.

Step 3: Stabilizing period: 10 filtration-cleaning cycles with the prescribed cleaning pressure drop (1000 Pa). After aging, the dust load on the test filter is different from that under the testing condition. Therefore, bag filter is operated for10 filtration-cleaning cycles under the testing condition, which acts as a recovery process.

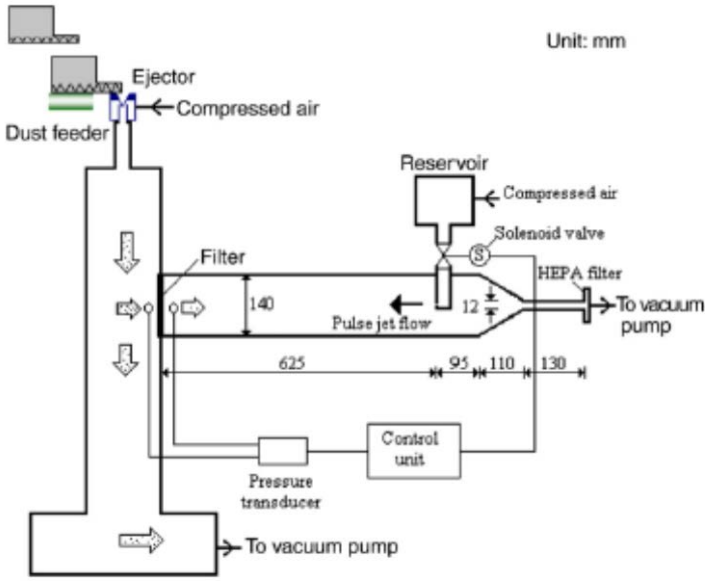

Fig. 1 Experimental setup for filter performance test

After the above pre-test, a well seasoned filter sample can be obtained. Then the performance test will be conducted.

Step 4: Performance test period: 30 filtration-cleaning cycles with the prescribed cleaning pressure drop (1000 Pa). We usually utilize this result to represent, compare and evaluate the filtration performances of the filters.

Two important parameters of residual pressure drop and filtration cycle time are taken as our indicators for the filter performance. The pressure drop after the filter cleaning is referred to as the residual pressure drop. The period between two consecutive filter cleanings is the filtration cycle time.

Experimental conditions. The test conditions are listed in Table 1.

Table 1 Testing conditions

Dust			Filtration velocity [m/min]	Pulse jet pressure [kPa-gauge]	Pressure before cleaning [Pa]
Name	Median Diameter (μm)	Dust concentration [g/m^3]			
fly ash	4.84	5	2	500	1000

Results and Discussions

PE felt laminated with and without PTFE film are tested respectively and the results are compared in Figs.2-5. In Figs.2 and 3, during the virgin situation, the membrane filter shows an obvious higher residual pressure drop and lower filtration cycle time than the non-membrane ones. However, during the performance test period by which filter is in a well seasoned condition, the filtration cycle times are nearly the same for both the membrane and non-membrane filters although the membrane filter still gives an obvious higher residual pressure drop than the non-membrane ones.

In Fig.4, the testing results of outlet concentration are compared between the membrane and non-membrane filters. In the virgin test period, the outlet concentration of the membrane filter is nearly two orders of magnitude lower than that of the non-membrane one. In the performance test period, although the difference between the membrane and non-membrane filters reduces, the outlet concentration of non-membrane filter is still twice higher than that for the membrane ones. It is verified that the filtration efficiency of membrane filters is far superior to the normal conventional non-membrane filters.

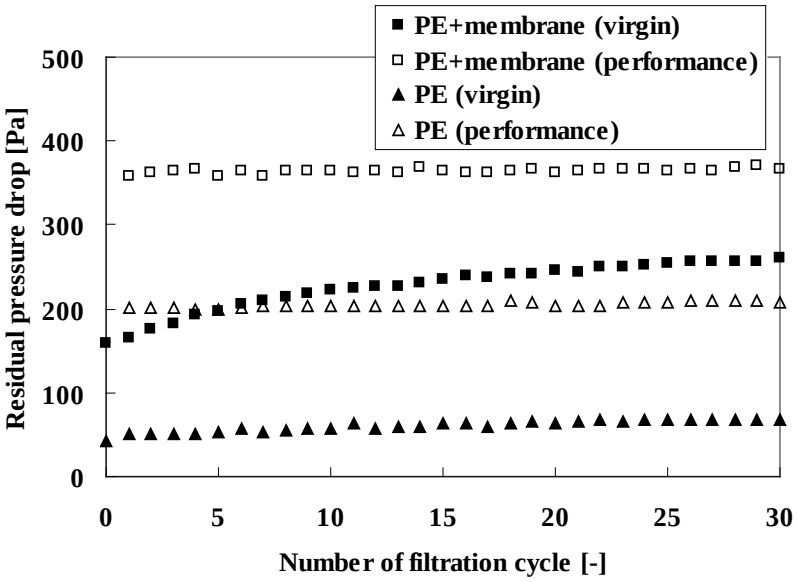

Fig. 2 Comparison of residual pressure drops between PE felt with and without PTFE membrane

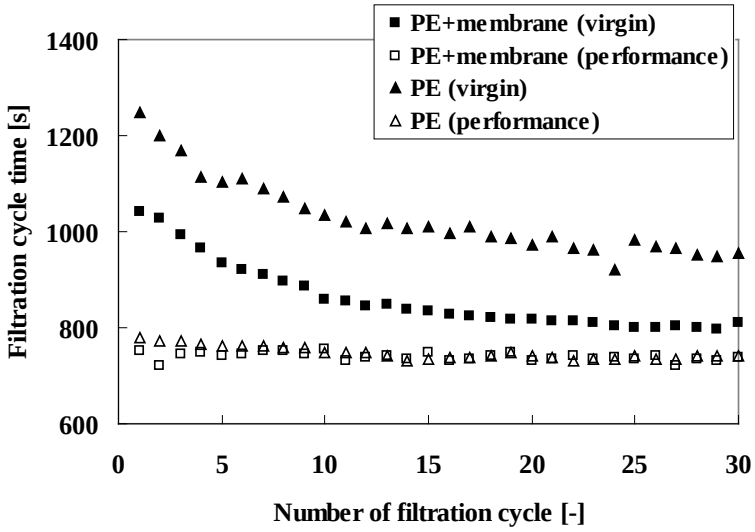

Fig. 3 Comparison of filtration cycle times between PE felt with and without PTFE membrane

In Fig.5, the testing results of residual dust load are compared between the membrane and non-membrane filters. The residual dust load for the membrane filter is 14 g/m2, which is much lower than that of 100 g/m2 for the non-membrane ones. As the dust is collected on a surface that is smooth, the cake release of the membrane filters is also far superior to the normal conventional non-membrane filters.

Conclusions

1. Although membrane filters give a higher residual pressure drop than the normal fabric filters, the same filtration cycle times are obtained because membrane filters have a lower curvedly pressure drop increasing part resulting from a comparatively homogenous filter surface.

2. The filtration efficiency and cake release of membrane filters are far superior to the non-membrane filters.

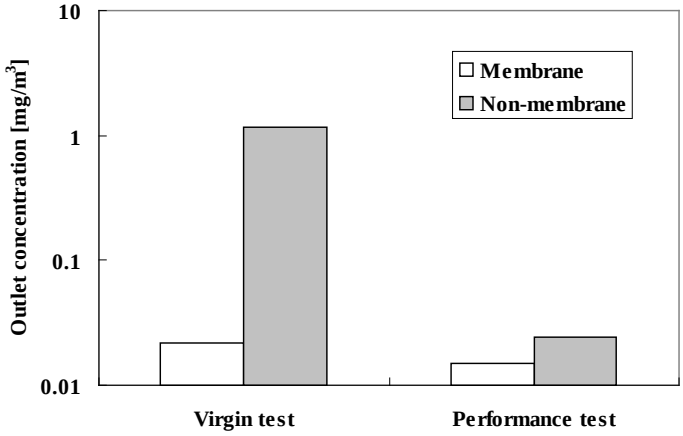

Fig. 4 Comparison of outlet concentrations between PE felt with and without PTFE membrane

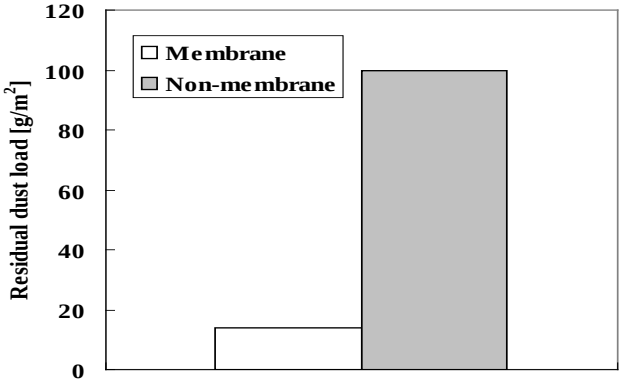

Fig. 5 Comparison of residual dust loads between PE felt with and without PTFE membrane

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