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Original Research Paper

Investigation to rectangular flat pleated filter for collecting corn straw particles during pulse cleaning

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ABSTRACT

This work investigated the amounts of dust residual of a rectangular flat pleated filter for collecting corn straw particles during pulse cleaning and attempted to explore the causes of incomplete cleaning. In this study, dust residual, filter's pressure drops and static peak pressures were obtained across flat pleated filter during the pulse cleaning. The optimum parameters were obtained that the pulse electromagnetic valve size was one inch, the pulse pressure was 0.2–0.3 MPa, and the filtration velocity was 0.6 m/min for the nozzle type with 7 holes with a diameter of 7 mm (7 × Φ7 mm). Under this condition, the experimental results show that the dust residuals were 198.4 (64%), 52.7 (17%), 58.9 (19%) g for initial collected dust residual 310 g at top, middle and bottom areas of the filter panel, respectively. The dust residuals were major on the top area of the filter panel, especially on the gap locations between the two-adjacent pulse airflows. Meanwhile, the more pulse interval or dust concentration was increased the dust residuals of the filter panel and the pressure drops of the filter were increased. Moreover, the static peak pressure distribution can give guidance to the dust residual distribution.

1. Introduction

Fiber filtration is a cost-effective scavenger for fine particulates, and may help prevent their emissions from escaping into the ambient environment [1,2]. Safe and efficient cleaning of processing equipment is an important demand in the industries. To remove particles from dust-laden air before it is expelled from or recycled into workplaces, baghouse dust collectors are frequently used combined with aspiration systems [3–5]. Despite the favorable separation characteristics of bag filters, they cause significant pressure drops in industrial application and the filter media are easily destroyed during clogging and cleaning cycles. Recently, the use of pleated fabric filter cartridges in dust collectors has attracted great attention because the pleated filter offer a larger filtration surface compared to flat-sheet filter bags (if both filtration areas are used in housing of the same size) [6–9].

The filtration cycles consist of alternating clogging and cleaning stages [10,11]. On-line pulse cleaning has been frequently used to dislodge the dust cake from the filters [12–14]. The pleated filter cartridges can increase the filtration area and decrease the filtration surface air velocity compared to flat-sheet filter bags. An increase in the filtration area of filter cartridge can lead to a decrease in the overall separator size and in the cost of replacing the filter bags at regular intervals of time. However, the cleaning of pleated filter cartridge is more difficult compared to this of the flat-sheet filter bag [7,9]. In our previously research, for the cylindrical pleated filter cartridges, many methods [9,15–18] have been proposed to improve the cleaning efficiency during pulse cleaning process. Yan et al. [9] examined the static pressure distribution along the surface of filter cartridges during the pulse cleaning; they reduced incomplete cleaning and realized a more stable operation of the dust collector using a supersonic nozzle and an air diffuser. Ju et al. [15,16] found that an induced nozzle can enhance the pressure distribution inside the filter cartridge and improve pulse-cleaning efficiency. Qian et al. [17] found the optimized relationship between jet distance and nozzle diameter of a pulse-jet cartridge filter. Li et al. [18] found that the peak pressure can give guidance to the residual dust of a pulse-jet cartridge filter.

Recently, we found interesting results for the newly rectangular flat pleated filter panel. The dust residuals on the rectangular flat pleated filter panels were different from those in our previously situation for the cylindrical pleated filter cartridges or the filter bags. The dust residuals were major on the top area of the filter cartridge, especially on the gap locations between the two- adjacent pulse airflows. Fig. 1 shows that a rectangular flat pleated

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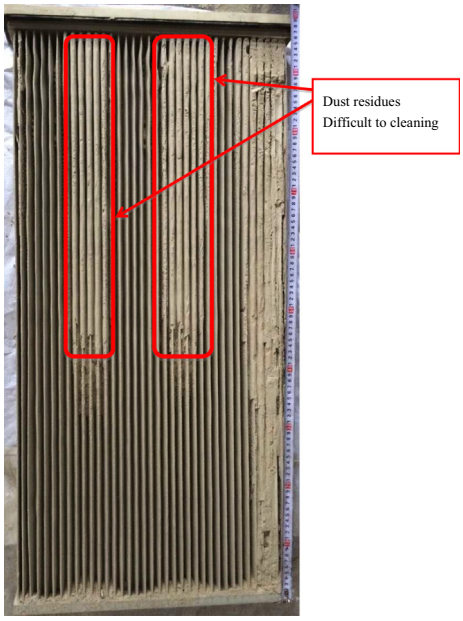

Fig. 1. Patchy cleaning of rectangle flat pleated filter for collecting corn particles.

filter panel for collecting corn straw particles was incomplete cleaning in industrial factory. In order to investigate the cleaning performance of the newly rectangular flat pleated filter panel for collecting corn straw particles and attempt to explore the causes of incomplete cleaning, a series of experiments were carried out on a filter panel to discuss dust residual, pressure drops and static peak pressure on the filter panel during the pulse cleaning. These results are fundamentally important for the application of a rectangular flat pleat filter to the industries.

2. Materials and methods

2.1. Experimental apparatus

Fig. 2 shows a schematic view of the test rig (Designed by Mianyang, Liuneng, Powder Equipment Co., Ltd.). The test rig in Fig. 2 was originally designed to test cyclical filter cartridges. Now, we have modified it to test rectangular filter panels. Fig. 3 shows the photos of the pulse nozzle and the rectangular flat filter panel. The dimensions of the powder collector were Φ 650 × 1600 mm. A rectangular flat pleated filter panel (length 460 × width 64 × h eight 1000 mm, 36 pleat counts) was installed in the powder collector. The rectangular filter panel dimensions were shown in Table 1. The experiment also included a pulse valve (DMF-ZM-25 type with diameter 25.8 mm, Shanghai Bag Filtration Equipment Co., Ltd), a frequency transformer (ATV303HU30N4, Schneider Electric Co., Ltd), six high precision pressure transducers (S130100, precision is 0.05%, data acquisition rate is 1 kHz, Mianyang Qishiyuan Science and Technology Co., Ltd), an electric charge amplifier (QSY7709, Mianyang Qishiyuan Science and Technology Co., Ltd), a portable data acquisition instrument (QSY-USB-8512E, Mianyang Qishiyuan Science and Technology Co., Ltd), an anemoscope (SwemaAir50, Sweden Swema Co., Ltd), a compressed

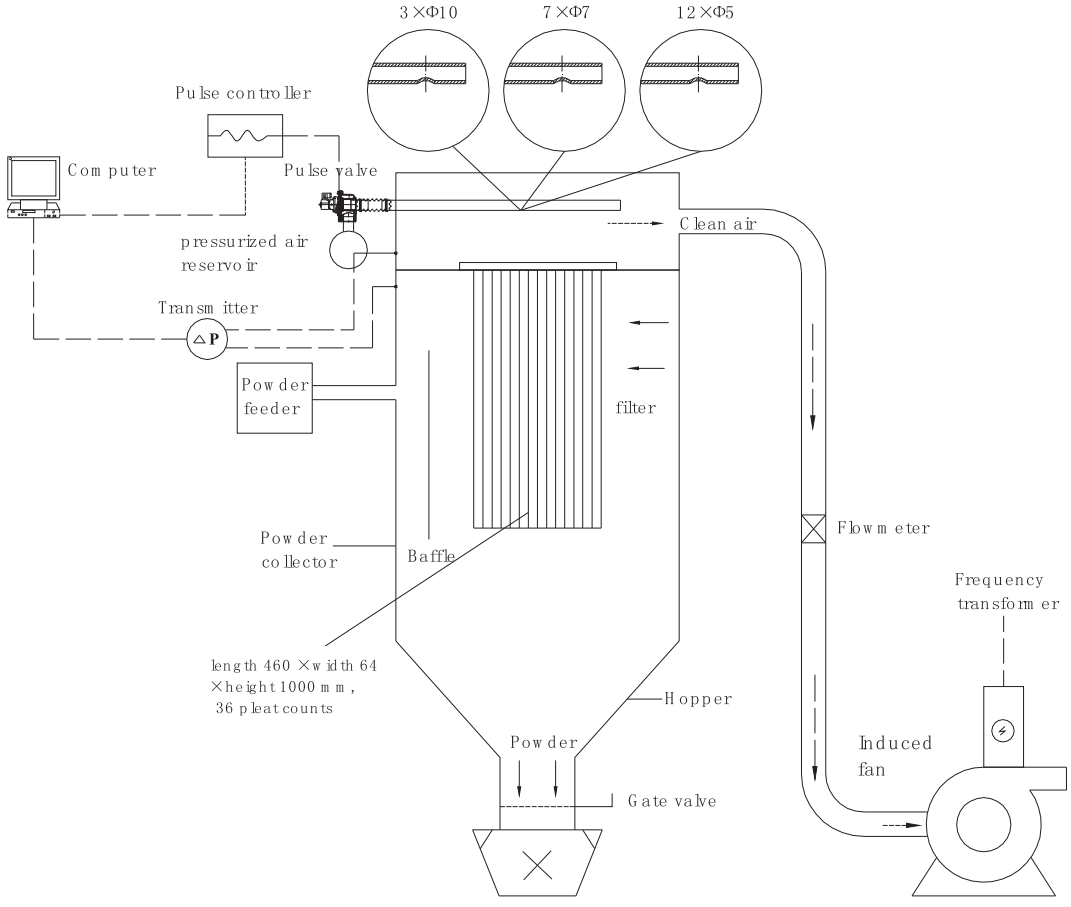

Fig. 2. Systematic diagram of the test rig with the rectangle flat pleat filter.

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