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PE8) Exploratory Design Modifications for Enhancing Cyclone Performance

김현태 · 이규원
광주과학기술원 환경공학과

1. INTRODUCTION

The present study introduces and describes the characteristics of the spiral guide and groove body cyclones for the first time. The spiral guide was set inside the cyclone body or the inside of the cyclone body was grooved circumferentially or vertically. Except for the cyclone body, all configurations were the same. The particle collection efficiency for a conventional cyclone (Figure 1) was measured under a series of flow rates ranging from 15 L/min up to 80 L/min, and was compared with that yielded using existing theories. Then the performance of each modified body cyclone was compared with that of the conventional cyclone in order to evaluate the feasibility of the modifications.

2. EXPERIMENTAL DESIGN AND SETUP

Five cyclones with different cyclone bodies were conceived, designed, and fabricated. All dimensions were made constant for the purpose of specifically examining the effects of the spiral guide or the groove body. The cyclone has a rectangular inlet and circular outlet. The only difference between the conventional cyclone and the other cyclones is that the latter have modified bodies. The crosshatched part shown in the figure represents the cyclone body and it is replaced with different body designs including the conventional smooth surface body, the spiral guide body, the circumferential groove body and the vertical groove body.

The polystyrene latex (PSL) particles used for cyclone performance evaluation ranged from 0.63 to 8.0 ㎛ and were generated by an atomizer (TSI Inc., Model 9302). The material density of PSL is 1.05 g/m^3. For each particle size, five sets of particle concentrations both upstream and downstream of the test cyclone were measured by the Aerosizer/Diluter (API Inc., Model Mach II and LD) combination. The flow rate, which was initially set at 15 L/min, was increased to 40, 65, and 80 L/min for subsequent tests. Cyclone flow was controlled using the mass flow controller (Bronkhorst Hi-Tec Inc., EL-Flow F-112AC). The decline in pressure across the cyclone was measured using a magnehelic gauge (Dwyer Instruments Inc.). To assure that all line losses were either minimized or equalized, short sampling tubes of equal length and diameter were used in the experiments.

3. RESULTS AND DISCUSSION

To illustrate the effects of cyclone body modification on performance more clearly, Figure 2 was prepared depicting the 50% cut diameter as a function of flow rate for all five cyclones together with Dietzs theory. The 50% cut diameter decreased as the flow rate increased as shown in the table and figure. The figure also revealed that the spiral guide cyclones had smaller 50% cut diameters than those of the groove body cyclones. The decline in pressure was measured at flow rates of 15 L/min to 80 L/min for all cyclones. The results are shown in Figure 3. As expected, in cases of all the cyclones, the drop in pressure becomes larger as the flow rate increases. Figure 3 shows that the lowest pressure drop occurred in the case of the vertical groove body cyclone, whereas the conventional cyclone yielded the highest pressure drop.

The spiral guide, which was set inside the cyclone body, plays an important role in enhancing collection efficiency at relatively low flow rates. However, it no longer helps increase the collection efficiency at high flow rates. The experimental results of two cyclones whose bodies were grooved vertically and circumferentially, show that groove body cyclones are not recommended as a means of increasing particle collection efficiency. No matter how the cyclone body is grooved, grooves may cause turbulent flows to prevent particle-laden gas from spiraling. However, the grooves on the cyclone wall reduce the pressure drop. Further investigations using computational fluid dynamics are needed to understand the three-dimensional fluid flow in spiral guide body cyclones and groove body cyclones, and to assess effects of spiral guides and grooves on collection efficiency.

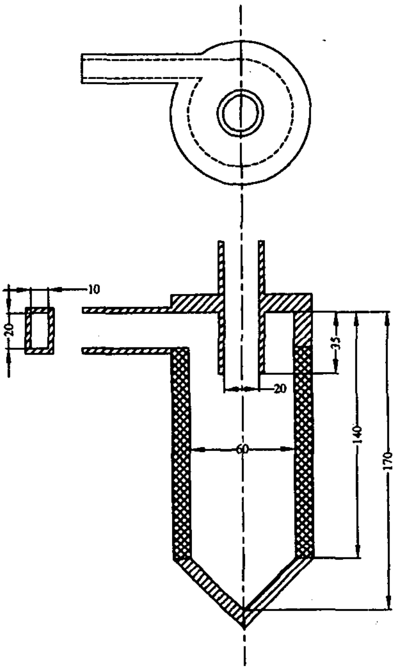

Fig. 1. Conventional cyclones (unit: mm)

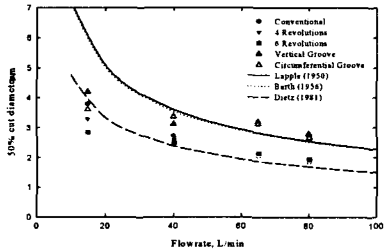

Fig. 2. 50% cut diameter

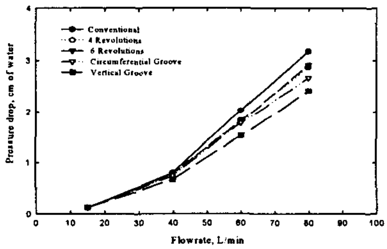

Fig. 3. Pressure drop of cyclones

REFERENCE

Dietz, P. W. (1981) Collection Efficiency of Cyclone Separators. *AIChE Journal* 27:888.