Design and Analysis of Cyclone Dust Separator to Improve Dust Collective Capacity by Changing Performance Parameters

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Abstract— Cyclone separator is industrial equipment that has been widely used for more than century Due to industrial relevance a large number of experimental, theoretical and computational studies have been reported in literature aimed at understanding and predicting the performance of Cyclone in terms of dust collective capacity. Cyclone performance can be calculated using "computational fluid dynamics (CFD).this CFD analysis focus on the effect of geometrical parameters on the flow field pattern and performance of the tangential inlet of Cyclone. First to determine the most significant factor affecting the Cyclone performance based on the previous studies. second to study each parameter separately to obtain more details about its effect on the flow field pattern and performance .finally to obtain the most efficient Cyclone design for best dust collective capacity. Here geometrical factors have significant effect on the Cyclone dust collective capacity. vortex finder diameter and height, Inlet width, inlet height, Cyclone barrel diameter, Cyclone total height and cone height This main parameters effect predicting by using CFD analysis and then improve dust collective capacity by changing its parameters design.

Keywords: CFD, Cyclone Dust Collector

I. INTRODUCTION

The inertial separators separate dust from gas streams using a combination of forces, such as centrifugal, gravitational, and inertial. These forces move the dust to an area where the forces exerted by the gas stream are minimal. The separated dust is moved by gravity into a hopper, where it is temporarily stored. The three primary types of inertial separators are settling chambers, baffle chambers, and centrifugal collectors (e.g., cy- clone separator). A settling chamber consists of a large box installed in the ductwork. The sudden expansion at the chamber reduces the speed of the dust felled airstream and heavier particles settle down. Settling chambers are simple in design and can be manufactured from almost any material. However, they are seldom used as primary dust collectors because of their large space requirements and low efficiency. A practical use is as pre cleaners for more efficient collectors. Baffle chambers use a fixed baffle plate that causes the conveying gas stream to make a sudden change of direction. Large-diameter particles do not follow the gas stream but continue into a dead air space and settle. They are one of the most efficient types of dust collectors available and can achieve a collection efficiency of more than 99% for very fine particulates. In these systems, the scrubbing liquid comes into contact with a gas stream containing dust particles. The greater the contact of the gas and liquid streams, the higher the dust removal efficiency. The electrostatic Precipitators use electrostatic forces to separate dust particles from exhaust gases. A number of high-voltage, direct-current discharge electrodes are placed between grounded collecting electrodes. The contaminated gases flow through the passage formed by the discharge and collecting electrodes. The airborne particles receive a negative charge as they pass through the ionized field between the electrodes. These charged particles are then attracted to a grounded or positively charged electrode and adhere to it.

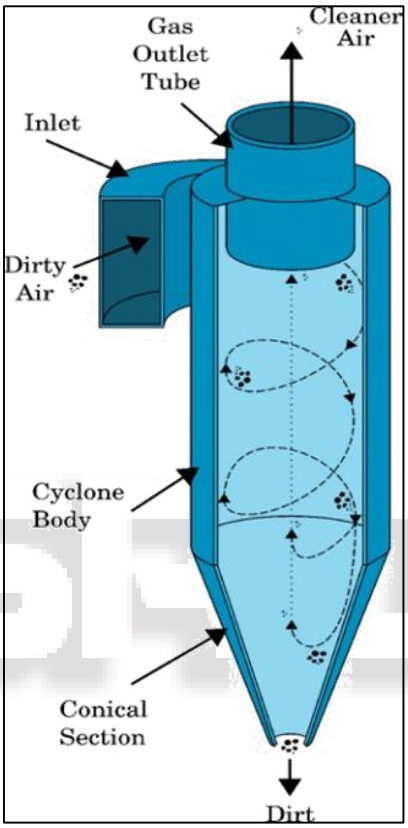

Fig. 1: cyclone dust collector [9]

II. DESIGN OF CYCLONE

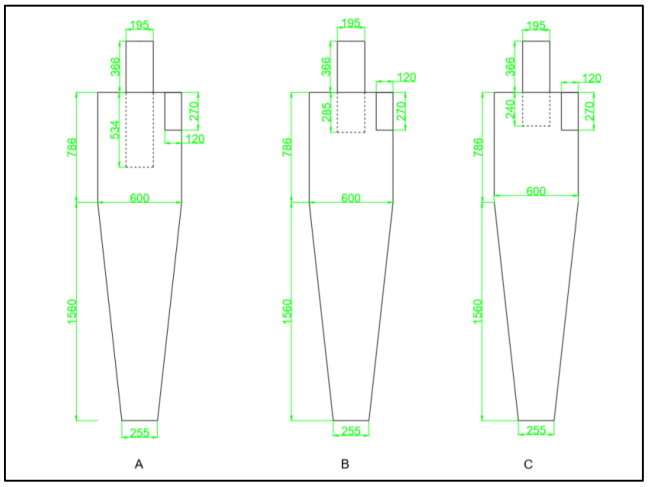

Fig. 2: cyclone dust separator dimension

From the above dimensions show that three different type cyclone dimension. Here three different size of vortex finder

height 534mm, 285mm and 240mm. here cyclone diameter, cyclone total height, cone height and inlet dimension are same for A, B, C cyclone.

III. ANALYSIS OF CYCLONE

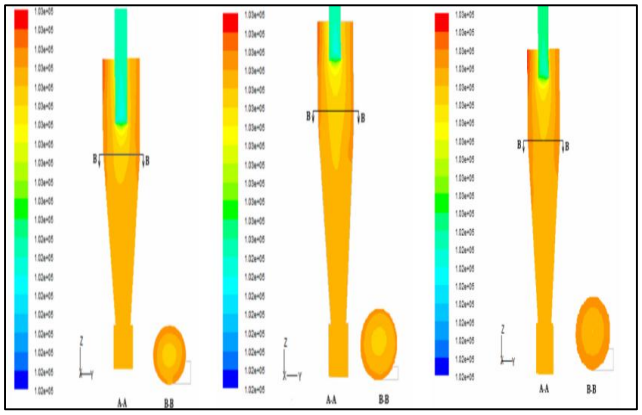

Fig. 3: static pressure at the velocity of 15 ms^{-1} and at vortex finder height A) 534mm B) 285mm C) 240mm

Fig.3 shows a static pressure at the velocity of 15 ms^{-1} and three different size of vortex finder. Here two section A-A and B-B section. B-B section is inlet plane. Here static pressure is maximum at the cyclone inner wall and minimum at vortex finder core area.

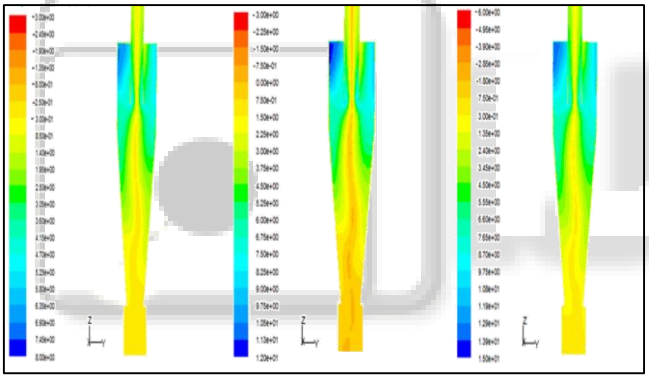

Fig. 4: tangential velocity at vortex finder height 534 mm and inlet velocity 8 ms^{-1}, 13 ms^{-1} and 15 ms^{-1}

Figure 4.2 we can show that tangential velocity for vortex finder 534mm length here take three different inlet velocity from above figure we can see that maximum tangential velocity at inlet pipe and minimum at vortex finder.

Sr. no	Inlet velocity(m/s)	Total pressure drop(Pa)
1	15	442
2	13	435
3	8	429

Table 1: inlet velocity vs. Pressure drop

Size (micro meter)	Efficiency (%)
1	2 %
2	9 %
3	10 %
5	30 %
9	67 %
10	85 %

Table 2: particle size vs. Efficiency

IV. CONCLUSION

After CFD of cyclone dust collector we conclude that pressure drop is increase by increase inlet velocity here we take three inlet velocities so result show that highest pressure drop at highest inlet velocity.

Increase number of turns by increase length of body and cone.

Cyclone dust collective capacity is increased by increase inlet velocity but problem is that also increase pressure drop here we take here three different size of vortex finder after CFD conclude that 534mm height vertex finder have less pressure drop so if we increase in this height of vortex finder then increase in the cyclone dust collective capacity.

Cyclone dust collective capacity is also depends on particle size. Small size partial have less efficiency then bigger size particle.

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