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A Design & Investigation of Cone Section Geometry for Cyclone Separators

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Abstract— The current article provides a new geometry of circular cone as an alternative of vertical cone cyclone separator for improvise the efficiency; which eventually reduces pressure drop of cyclone separator. Examine work is based on performance improvisation of cyclone separator geometry used in flour mill with different motor load condition. The investigate of new model with circular cone section in different flow rate`s and its impact on performance parameters like efficiency and pressure drop. The Reduce of cyclone cone section length for building centrifugal force Higher satisfy primary benefit. Circular cone section collection efficiency are higher than vertical cone cyclone separator and lesser drop pressure are to be investigational proved.

Keywords— Cyclone separator, Circular cone, Cone length, Pressure drop's

I. INTRODUCTION

"Cyclones are mostly used for removing industrials dust from air or process gases". Force at the back cyclone separation is centrifugal force and the variation in specific gravity between the particle and the carrier gas. In a cyclone, the air or vapour contain particulate material is forced into along the tangential axis. A helical flow pattern is place on within the chamber. The centrifugal force causes the particle to travel to the outside of the chamber. Here they dropped to the bottom of the cyclone by earth gravity. The air move up the centre of the cyclone and reaches the top. They are mostly two principal form of gas-solid separator. The collect product remains dry and generally useful. Low initial investment and repairs costs. Its Very compact, No moving parts and very robust. Can be constructed from most any material suitable for the intended service including plate steel, casting metals, alloys, aluminium, plastics, ceramics, etc. Can separate either solids or liquid particulates; sometimes both in combination with proper design.

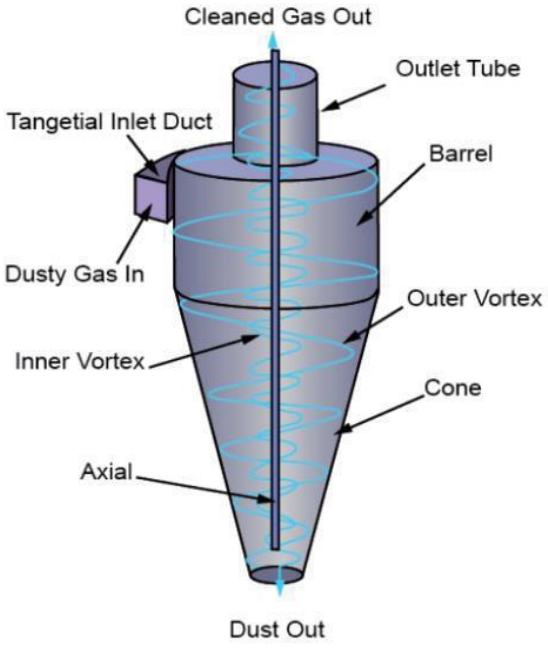


Fig 1.Cyclone separators [1]

1. LITERATURE SURVEY

1. Prachi k. Ithape,et. al[1] In This paper mainly focuses on variations of geometric parameters of a cyclone and analyzing its effect on the collection efficiency and give following conclusion.[1]

TABLE 1. Result Analysis of Cyclone Parameters

No.	Changing parameter	Impact of Collection efficiency
1	Cylinder height decrease	Increase by 25% keeping overall height constant.
2	Cylinder height decrease & keeping cone dimensions constant.	and increase by 25%
3	Cone height increase and & cylinder height constant.	decrease by 25%
4	Cylinder height increase and & dip tube height increase by 30%.	decrease by 25%
5	Dip tube height increase	decrease by 30%.
6	Outlet tube dia.	decrease by 30%.

2. Mahesh r jadhav [2]A small scale cyclone considered for flour mill is evaluate and conclusion are derived. for experiential investigation its conclude that the pressure drop is increases as the inlet velocity increases for same capacity model By changes at inlet geometry of cyclone. In this article Two symmetrical inlets the flow gets divided in to two parts. The investigation performance parameters compare of symmetrical inlet cyclone are optimum than single inlet cyclone. It also conclude that as inlet velocity increase the cyclone efficiency also increases for same capacity model.[2]

3. P.A. Funk [3] Evasés or exit diffusers potentially process could reduce outlet pressure drop without changing collection efficiency. Three rectangular evasés and a radial evasé with a variable opening were tested on two cyclones. Pressure drop was recorded for inlet velocities from about range between up to 10 to 20 m s−1. The radial evasé reduced cyclone pressure drop by between up to 8.7 and 11.9 percent when its exit area was equal to the flow area of the cyclone vortex finder or gas exit. A simple payback based on avoided energy costs was estimated to be between up to 3600 and 5000 h, not counting installation cost[3]

4. Khairy elsayed, et. al [4] The most significant geometrical parameters are: vortex finder diameter, inlet section width, the inlet section height and cyclone total height. There are strong interaction between the effect of inlet dimension and the vortex finder diameter on the cyclone performance. The latest cyclone design results in nearly one-half the pressure drop obtained by the old design at the similar volume flow rate condition.[4]

5. Selamidemir, et al [5] An experimental study regarding the effects of vortex finder diameter and height, conical height and barrel height on cyclone pressure drop was performed. Pressure drops were measured at six different inlet velocities in the range between up to 10 to 24 m/s. The dimensions of vortex finder, conical height, and barrel height were in the range up to D to 2D, 2D to 3D, and 0.5D to 0.7D, correspondingly. The experimental results recommended that the pressure drop decreases with an increase in barrel height and conical height, while it increases vortex finder increases. Ratios of predicted to measured pressure drops for the novel model up to 0.388 and 1.785. The middling value was 1.059. The residuals from the novel model were normally spread around the mean value of zero with a minor positive skewness. The novel model can be with assurance used for estimate clean pressure drop with R^2= 0.976.[5]

6. W.I. Mazyana, A et al [7] this article practical investigates the effect of addition tangential chambers on the efficiency of solid-gas separation in cyclone separators used in gas treatment. To examine the effect of such an addition on the cyclone performance, the size division of the solid particles escaping with the clean gas is compared between the conventional cyclone design and that with the proposed addition. It is shown that the tangential chamber enhances the separation efficiency by 21% in the conventional cyclones, particularly for 4-μm particles. The addition of the tangential chamber to enhance the efficiency of the overall solid-gas separation in cyclone scrubbers was experimentally investigated. The experimental results indicated that the implementation of an additional tangential chamber can first further increase the particle division efficiency mostly for smaller particles, and second filter traces of large size particles. Ultimately, the proposed method provides a powerful tool for enhancing the solid capturing efficiency, contributing significantly to cost saving, maintenance, and safe keeping of the downstream equipment in the oil and gas, refinery, aircraft, chemical and polymer industries.[7]

i. SETUP FOR PERFORMING EXPERIMENT

The industrial visits then experimental set up to be developed. For The experiments the both cyclone separators to be developed. Then vertical cyclone was modified by providing new geometry of circular cone section (cone Length). The research paper reduced the cone length of the cyclone separator and what is impact of collection efficiency are to be investigation. The model with maximum collection efficiency is then selected. For the study of research paper and observation we can seen that decrease in the cone length what is reaction on the efficiency of cyclone separator . So the objective of this research article a design of cyclone separator with minimum required Cone length for same capacity.

Fig. 2. Experimental setup of vertical cone cyclone separator

In this paper the actual cyclone separator model was first validated by using experimental results compare. The actual model was then modified by changing its geometrical parameters cone section body diameter. Collection efficiency obtained from the analysis was then used as a means to select the final design of the cyclone separator. The model with maximum collection efficiency is then selected. For the study of research paper and observation of effect of parameter of cyclone separator to the collection efficiency and what is impact of efficiency to reduce dimension of cyclone separators. So the main objective of these researches a design of cyclone separator with minimum required diameter for same capacity.

Table 1. Dimension of vertical cyclone separator

No.	Parameter	Diameter
1	Cyclone diameter	400
2	Cone length	550
3	Barrel height	285
4	Dust exist	50
5	Vortex finder diameter	120
6	Vortex finder length	150
7	Inlet section	90
8	Outlet section	90

Fig 3.vertical cyclone separators

Table. 2 Dimension of Circular cone cyclone separator

No.	Parameter	Diameter
1	Cyclone diameter	300
2	Cone length	400
3	Barrel height	285
4	Dust exist	50
5	Vortex finder diameter	120
6	Vortex finder length	150
7	Inlet section	90
8	Outlet section	90

Fig 4. Circular cyclone separators

Table 3. Boundary Condition for Simulation

Properties		**Value**	**Unit**
Gas Phase	Material	Air	-
	Viscosity Of Gas	0.0000181	Kg/m.s
	Density Of Gas	1.225	Kg/m3
Atmospheric	Temperature	20	◦C

iv. RESULTS AND DISCUSSION FROM EXPERIMENTS

For the experiment device are to be used like anemometer, DC speed controller, Ampere Meter, induction motor. The used of anemometer collect data of inlet and outlet section of the Both Cyclone separator.

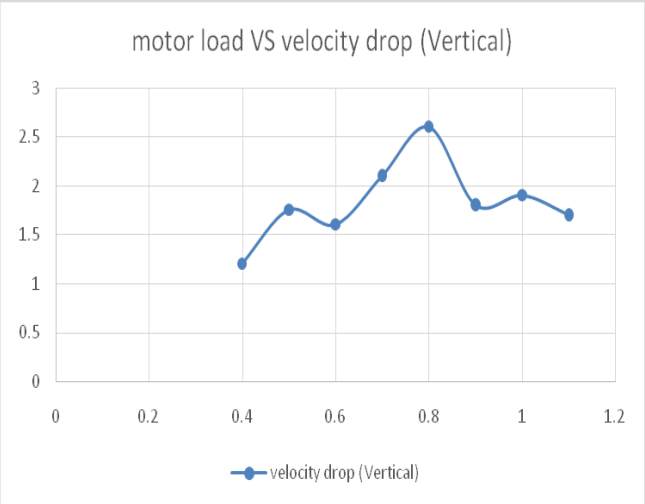
Table 4. Velocity Measurement of vertical cone cyclone separator

No.	**Motor Ampere**	**Inlet velocity**	**Outlet velocity**	**Velocity drop**
1	1.1	19.3	17.6	1.7
2	1.0	17.2	15.3	1.9
3	0.9	16.3	14.5	1.8
4	0.8	15.4	12.8	2.6
5	0.7	13.9	11.8	2.1
6	0.6	12.1	10.1	1.6
7	0.5	10.4	8.9	1.75
8	0.4	7.9	6.8	1.2

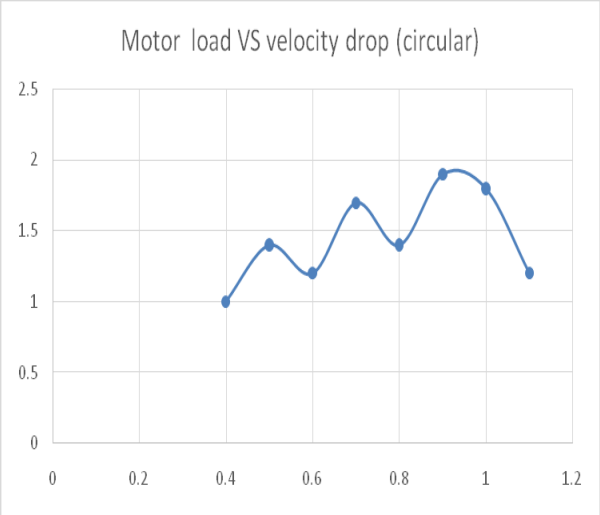
Table 6. Velocity Measurement of circular cone cyclone separator

No	**Motor Ampere**	**Inlet velocity**	**Outlet velocity**	**Velocity drop**
1	1.1	19.3	17.7	1.6
2	1.0	17.2	15.4	1.8
3	0.9	16.3	14.5	1.8
4	0.8	15.4	13.2	2.2
5	0.7	13.9	11.9	2.0
6	0.6	12.1	10.6	1.5
7	0.5	10.4	9.0	1.45
8	0.4	7.9	6.9	1.0

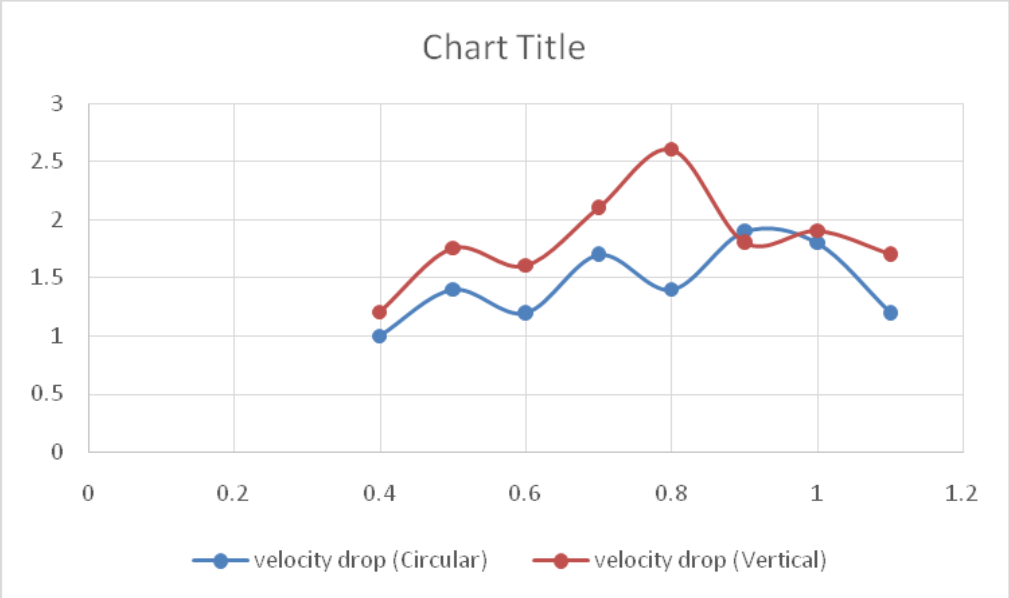
For the above mentsion experiment the follwing plot are to be genrated. Plot 1 are to genrated velocity drop vs motor load for vertical cyclone separtor. We can seen to the graph its not liniarly incraese of velocity drop with respetced to the moto load. Same case are in to the circular cyclone seprators in seen in to plot no.2. plot no. 3 are to be genrated for both cyclone velocity drop vs motor load



Plot .1. Velocity Drop vs Motor Load plot for virtcical



Plot.2. Velocity Drop vs Motor Load Ploat for Circular



Plot 3. Velpcity Drop of Vitcial and Cicrcular Seprators vs Motor Load

II. CONCLUSIONS

From experiments of both cyclone separator following results are concluded:

- To the both vertical cone and circular cone cyclone separator when the flow rate increase the velocity are to be increase. But it's no relation with pressure drop.
- For the vertical cone cyclone separator maximum velocity drop in 0.8 motor load .and circular cone section its 0.9 motor load. optimum value are to be find in 0.5 ampere load
- The optimum value to both cyclones is in 0.8 motor load. of the optimum load the vertical cyclone pressure drop is 2.6 and for circular cyclone separator its 2.2. That means these value pressure drop is to be minimum for comparison.
- The velocity drop of the vertical cyclone separator is higher than circular cone cyclone. Then circular cone cyclone separator is better than vertical cone cyclone separator.

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