



IJRTSM

INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

“A REVIEW PAPER ON DESIGN, DEVELOPMENT CYCLONE SEPARATOR”

Prateek Chouhan¹, Yogesh Kumar Tembhurne²

¹ P.G.Scholar, Dept. of Mechanical Engineering, B.E.R.I., Bhopal, MP, India

² Assistant Professor, Dept. of Mechanical Engineering, B.E.R.I., Bhopal, MP, India

ABSTRACT

Dust collection is an online process for collecting any process-generated dust from the source point on a continuous basis. They are often used as an air pollution control device to maintain or improve air quality. Conventional mist collectors or wet scrubber available and used in the industry are extremely costly, high running cost and high maintenance cost hence there is a need of a modified cyclone separator that primarily can separate the particulate matter by mere action of cyclone in the dry condition there by reducing the initial investment, running cost and maintenance cost. Many cleaning process available but this mechanical device very costly therefore to replace the less cost effect and performance of remove dust particle is very efficient. This paper summarizes the research literature referred relative to the cyclone separator design aspects, flow in cyclone separator and efficiency of cyclone separator.

Keyword: Cyclone Separator, CFD, Collection efficiency.

I. INTRODUCTION

Cyclones are mostly used for removing industrial 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.

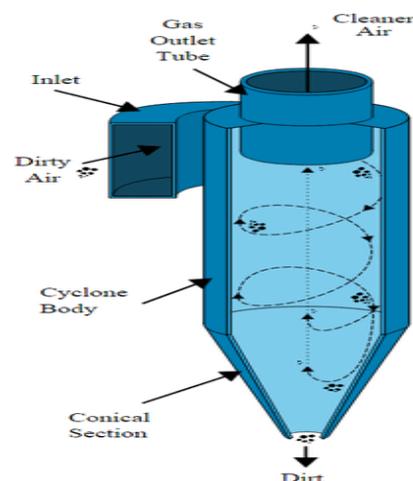


Figure 1.1 cyclone separator

II. LITERATURE REVIEW

A. Sakin, et al.[2019] Performance characteristics of a novel cyclone with tangential inlet were presented in axial and reverse flow operation modes. 3-D and unsteady governing equations were used for the numerical solution of the two-phase turbulent flow in the cyclone separator. The Eulerian approach was used to solve the flow field, and the Reynolds Stress Model (RSM) with the scalable wall function was employed for the numerical study. The Lagrangian approach with the Discrete Phase Model was used to calculate the discrete phase by releasing particles from the inlet surface. CFD calculations were run for different geometric configurations to analyze the performance of the cyclones regarding pressure drop, cut-off diameter, and fractional efficiency. Axial and tangential velocity profiles are presented at the defined sections. The computational results of pressure drop, velocity field, and separation efficiency were also compared for the axial and reverse flow cyclones at the same flow rate. The results show that pressure drop and collection efficiency in reverse flow mode are higher than that of the axial flow operation. However, axial flow cyclones seem to be more efficient for small particles comparing to reverse flow cyclones.[1]

Harsh Patel et. Al. [2018]review of the literature was undertaken to discover recent particulate control technology developments in other industries that may benefit the flour mill. In these researches we can design compact and Economic a cyclone separator for satisfy primary benefits like high efficiency, reduce pressure-drop etc. In the review paper we can change the geometry of cone section for develop high efficiency and low pressure drop. In these review paper are developed of cyclone separator with circular cone section in same capacity of vertical cone cyclone separator. We give comparisons for two cyclone for using experiment method and optimization by computerize analysis (CFD) [2]

Prachi k. Ithape,et. Al [2017] In This paper for the most part perception on varieties of geometric parameters of a violent wind and breaking down its impact on the assortment proficiency and give following end. [3]

Changing parameter	Impact of Collection efficiency
Cylinder height decrease	Increase by 25% keeping overall height constant.
Cylinder height decrease & keeping cone dimensions constant.	and increase by 25%
Cone height increase and & cylinder height constant.	decrease by 25%
Cylinder height increase and & dip tube height increase by 30%.	decrease by 25%
Dip tube height increase	decrease by 30%.
Outlet tube dia.	decrease by 30%.

W.I. Mazyana, An et al [2017] this article rational inquires about the effect of extension inconsequential chambers on the efficiency of solid gas parcel in vicious breeze separators used in gas treatment. To dissect the effect of such a development on the rough wind execution, the size division of the solid particles pulling off the ideal gas is taken a gander at between the conventional storm plan and that with the proposed extension. It is demonstrated that the diverting chamber updates the parcel capability by 21% in the normal storms, particularly for 4- μ m particles. The development of the digressive chamber to update the adequacy of the general solid gas parcel in twister scrubbers was likely inspected. The test outcomes demonstrated that the use of an extra diverting chamber would initially have the option to also extend the atom division capability generally for smaller particles, and second channel traces of

tremendous size particles. Finally, the proposed system gives a helpful resource for improving the solid getting adequacy, contributing out and out to cost saving, backing, and safe keeping of the downstream equipment in the oil.[4]

Abhijeet Gayakwadet. A. [2017] Many ventures are utilizing the cyclone dust separators with no adjustments for over a century. The gas strong cyclone separator is generally utilized in ventures. For foreseeing the cyclone execution as far as speed and weight variety, an enormous number of computational examination was led because of its much application in the modern territory. The recreation is completed utilizing computational liquid elements (CFD) for gas-particle stream with cyclone separator in one of the methodologies. The majority of the consideration is centred around improving the cyclone execution parameters. As off late the majority of the investigations concentrated on the geometric impact on the cyclone execution. In this paper the geometric impact on cyclone separator is contemplated with the production of even extraneous gulf cyclone separator and contrasted it and the old style cyclone separator. The outcomes demonstrated that the new geometric change to the cyclone improves the presentation. [5]

J.J.H. Houbenet. Al [2016] A issue of cyclone separators is the second rate effectiveness of little particles. Along these lines, a high productivity cyclone separator has been created and effectively tried in previous work. In this cyclone separator, a vortex stabilizer is utilized to stifle the vortex centre precession. In this article, the weight and stream field in this cyclone separator are determined by methods for computational liquid elements utilizing the business programming ANSYS Fluent 13. The situation of the vortex centre is followed in these reproductions via looking through the situation of negligible powerful weight and the focal point of snapshot of the level speed segments as capacity of the hub arrange. The outcomes are contrasted and trial information. It is shown that when utilizing a stabilizer, the vortex is kept in position. Besides the limit of the digressive speed is seen as bigger, which is known to positively affect the division of little particles in the internal strong body revolution vortex.[6]

Mahesh r jadhav [2014] A little scale savage breeze considered for flour plant is Evaluate and end are derived. for experiential assessment its assume that the weight drop is additions as the inlet speed increases for same farthest point model By changes under control geometry of tornado. In this article Two adjusted channels the stream gets isolated in to two areas.

The assessment execution parameters consider of adjusted inlet vicious breeze are perfect than single bay twister. It in like manner reasons that as narrows speed increase the savage breeze capability moreover augments for same point of confinement model.[7]

P.A. FunKEvasés [2014] or leave diffusers possibly strategy could diminish outlet pressure drop without changing combination profitability. Three rectangular eases and an extended evasé with a variable opening were taken a stab at two hurricanes. Weight drop was recorded for channel speeds from about range between subordinate upon 10 to 20 m s⁻¹. The extended evasé decreased twister pressure drop by between up to 8.7 and 11.9 percent when its leave area was proportional to the stream zone of the tropical storm vortex pioneer or gas exit. A direct pay reliant on kept up a key good ways from essentialness costs was assessed to be between up to 3600 and 5000 h, excluding foundation cost.[8]

Selamidemir, et al [2014] A preliminary report with deference with the effects of vortex pioneer width and height, pipe formed stature and barrel stature on brutal breeze pressure drop was performed. Weight drops were assessed at six different narrows speeds in the range between subordinate upon 10 to 24 m/s. The components of vortex pioneer, cone molded height, and barrel stature were in the range up to D to 2D, 2D to 3D, and 0.5D to 0.7D, correspondingly. The exploratory results recommended that the weight drop decreases with an extension in barrel height and decreased stature, while it assembles vortex pioneer increases. Proportions of foreseen to evaluated pressure drops for the novel model up to 0.388 and 1.785. The fair worth was 1.059. The residuals from the novel model were commonly spread around the mean estimation of zero with a minor positive skewness. The epic model can be with insistence used for measure clean weight drop with R²= 0.976 [9]

Zhiyi Xionget. Al [2013] This examination was planned for advancing the arrangement of a vortex discoverer to improve the detachment productivity and diminish the weight drop of cyclone separators. Six sorts of cone-molded vortex discoverers were planned and tried for their presentation on gas-strong partition at various stream rates and

particle concentrations. The trial results exhibited that the reflux cone and holes (straight and winding) in a vortex discoverer could improve detachment execution of the cyclone separator through lessening the weight drop and expanding the general division productivity and grade effectiveness. The new cyclone separator with the vortex discoverer (Type D) that had both reflux cone and winding hole (15° dextrorotation) designs had the best detachment execution, which diminished the weight drop by 73% and expanded in general division proficiency by 9% when contrasted with the cyclone separator with the essential vortex discoverer (Type A). This new cyclone separator expelled 99% particles with a distance across greater than $10\ \mu\text{m}$. Our examination demonstrated that the changed vortex discoverers (particularly with both reflux cone and winding hole designs) have extraordinary potential for their application in gas-strong partition for natural gas cleaning.[10]

Sujeet Kumar Shukla, et. Al. [2013] study expects to show all had speed scattering charts are differentiated and the exploratory results with Hoekstra, and multiplication of arrangement profitability result are support with the exploratory outcomes of Zhou. Result exploratory model imbued material used are child powder. Velocity was taken as 16.1 m/s and atom speed was 20.18 m/s. The assumed that when particle size will augment so grouping adequacy augmentations and they similarly investigated when center point size addition in CFD entertainment results near the preliminary outcomes. They contemplated that aggravation huge swirl multiplication (LES) has incredible appear differently in relation to RSTM model mean stream field and instability stream field. [11]

Safikhani et al. [2011] carried out a multi-objective optimization using the genetic algorithm technique to obtain the best vortex finder dimension (diameter and length) and shape (convergent and divergent). Four design variables have been investigated; the vortex finder diameter, angle, upperpart length and lower-part length of the vortex finder. They applied neural networks to obtain a meta-model for the pressure drop and collection efficiency from CFD dataset.[12]

Khalkhalia and Safikhania [2011] performed a multi-objective optimization of a cyclone vortex finder shape using CFD simulations data set. Two meta-models based on the evolved group method of data handling (GMDH) type neural networks are used as fitness functions for Pareto-based optimization.[13]

Ficici et al. [2010] performed an experimental study using three cylinder shaped vortex finders with diameters of 80, 120 and 160 mm. They investigated the effects of gas inlet velocity, the vortex finder diameter D_x and length S on the cyclone performance. They reported a linear relationship between the length of the vortex finder and the pressure loss. [14]

Pishbin and Moghiman [2010] applied genetic algorithm for optimum cyclone design. They studied the seven geometrical parameters. The data used for optimization was obtained from 2-D axisymmetric simulations. However, the flow in the cyclone separator is 3-D unsteady. Instead of using multi-objective genetic algorithm (e.g., non-dominated sorting genetic algorithm II (NSGA-II) [34]) they used the weighted-sum genetic algorithm.[15]

III. METHODOLOGY

- a) Mathematical model of cyclone system for optimal precipitation of dust capacity. Development of mathematical model of system of mss flow rate of air.
- b) Development of mathematical model of system of mss flow rate of air , derivation and resolution of pressure drop across various sections of the separator , determination of forces and utilizing system of forces to determine the precipitation of dust and particulate material.
- c) Mechanical design of above components using theoretical theories of failure after selection of appropriate materials
 - 3-D modeling of set-up using CATIA
 - Meshing using ANSYS.
 - Validation of strength calculations of critical components using ANSYS fluent.

IV. CONCLUSION

From the review of various papers on cyclone separators, following conclusions can be highlighted – The cyclone separator is probably the most widely used dust collector in industry because of its simplicity and low operating cost. Tangential inlet velocity plays an important role in the gas movement of the cyclone separator. With increasing particle mean diameter and density, increasing gas tangential velocity, decreasing cyclone diameter, increasing cyclone length collection efficiency increased. Pressure drop and separation efficiency are affected by factors like solid loading ratio, gas inlet velocity flow field parameter.

REFERENCES

1. Ali Sakina, Irfan Karagozb, Atakan Avcib” Performance analysis of axial and reverse flow cyclone separators” Chemical Engineering & Processing: Process Intensification 144 (2019)
2. Harsh Patel and Ankitdarji “A review paper on a design and analysis of cyclone separator for high efficiency by using CFD analysis” Indian Journal of Research” Volume-7 | Issue-4 | April-2018
3. Prachi K. Ithape, S. B. Barve, S. S. Pande & A. R. Nadgire “effect of geometric parameters on the exhibition of violent wind separator utilizing CFD”. IJCRET. E-ISSN 2277 – 4106 pp, 288-292., 2017
4. W.I. Mazyana, A. Ahmadib, H. Ahmedc, M. Hoorfara” increasing efficiency of natural gas cyclones through addition of tangential chambers” ”ELSEVIER. 36-42., 2017
5. Abhijeet Gayakwad¹, Dr. Shivarudraiah² “CFD Analysis of Symmetrical Tangential Inlet Cyclone Separator” International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 08 | Aug -2017
6. J.J.H. Houben¹†, Ch. Weiss², E. Brunnmair “CFD Simulations of Pressure Drop and Velocity Field in a Cyclone Separator with Central Vortex Stabilization Rod” Journal of Applied Fluid Mechanics, Vol. 9, No. 1, pp. 487-499, 2016.
7. Mahesh R. Jadhav. “design of violent wind and investigation of its exhibition parameters.” IJMERR. ISSN 2278 – 0149. Vol. 3(4). 247-252, 2014
8. P.A. Funk. “reducing typhoon pressure drop with evasé”. ELSEVIER. 276-281., 2014
9. Selamidemir. “a practical model for evaluating pressure drop in tornado separators: an test study”. ELSEVIER. 329-338, 2014
10. Zhiyixiong, Zhongliji, Xiaolinwu.”Development of a violent wind separator with high productivity and low weight drop in pivotal delta cyclones”. ELSEVIER. 644-649, 2013
11. Sujeet Kumar Shukla, Prashant Shukla, Pradyumna Ghosh, “The effect of modeling of velocity fluctuation on prediction of collection efficiency of cyclone separators” (Applied Mathematical Modelling 37(2013)
12. H. Safikhani, A. Hajiloo, M.A. Ranjbar, and N. Nariman-Zadeh. Modeling and multi-objective optimization of cyclone separators using CFD and genetic algorithms. Computers & Chemical Engineering, 35(6):1064–1071, 2011.

13. Abolfazl Khalkhalia and Hamed Safikhania. Pareto based multiobjective optimization of a cyclone vortex finder using CFD, GMDH type neural networks and genetic algorithms. *Engineering Optimization*, Available online: 05 Jul 2011, 2011
14. Ferit Ficici, Vedat Ari, and Murat Kapsiz. The effects of vortex finder on the pressure drop in cyclone separators. *International Journal of the Physical Sciences*, 5(6):804–813, 2010
15. S. I. Pishbin and M. Moghiman. Optimization of cyclone separators using genetic algorithm. *International Review of Chemical Engineering (I.RE.CH.E.)*, 2(6):683–690, 2010.