# Experimental and Investigation of CFBC Cyclone Separator with Reduced Pressure Drop

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Abstract—This project deals with the performance investigation of the CFBC Cyclone Separator, theoretical methods for computing travel distance, cyclone efficiency, numbers of turns and cyclone pressure drop have been employed for validating the simulated readings. Cyclone models have been used without relevant modifications for more than a century. Most of the attention has been focused on finding new methods to improve performance parameters. Recently, some studies were conducted to improve equipment performance by evaluating geometric effects on projects. In this work, cyclone pressure drop and denudation rate has been studied using geometric effects of vortex finder with REPDS (REDUCED PRESSURE DROP STICK). The study was performed for gas-solid flow, based on an experimental study available in the literature, where a conventional cyclone model was used. Various computational numerical experiments were performed on the cyclones. Five types of vortex finders (with 100%, 75%, 50%, 25% REPDS and without REPDS) were designed and tested for their performance on gas-solid separation at different flow rates and particle concentration result shows conventional models has high pressure drop and denudation rate and the new designs reduces the cyclone pressure drop and denudation rate significantly. The new cyclone separator with the 50% REPDS configuration had the best separation performance, with reduced the pressure drop and denudation rate.

**Keywords**: Cyclone Separator, CFBC, denudation rate, pressure drop, REPDS etc...

#### **1. INTRODUCTION**

The work aims at optimizing the vortex finder configuration to reduce the pressure drop and denudation rate, for a given collection efficiency of the cyclone separator. Four different models, with 25%, 50%, 75% and 100% RPDS length were developed for each design and CFD analysis of the existing designs with and without the RPDS were done. The method are given with four empirical models for prediction of cyclone pressure drop which studies and compares the pressure drop prediction models of cyclone of different velocity and temperatures.



#### **Cyclone Separator:**

Cyclone separator provides a method of removing particulate matter from air streams at low cost and low maintenance. In general, a cyclone consists of an upper cylindrical part referred to as the barrel and a lower conical part referred to as cone. The air stream enters tangentially at the top of the barrel and travels downward into the cone forming an outer vortex. Increasing air velocity in the outer vortex results in a centrifugal force on the particles separating them from the air stream. When the air reaches the bottom of the cone, an inner vortex is created reversing direction and exiting out the top as clean air while the particulates fall into the dust collection chamber attached to the bottom of the cyclone.

# **Denudation Rate**

Denudation Rate is the average rate of lowering of the CFBC cyclone separator surface. It is derived from the erosion rate of the CFBC cyclone separator. Where erosion rate is defined as rate of material removed from the CFBC cyclone separator measured as mass removed per unit time.

## **Proposed Work:**

A model suggested for reducing pressure drop and denudation rate is to attach the number of REPDS in the vortex finder and adjust the length of vortex finder. Four different models have been introduced 25% REPDS, 50% REPDS, 75% REPDS and 100% REPDS.

# **Fabrication Of Cyclone Seperator**

The cyclone separator is designed by using sheet metal as per the dimensions.



Lapple Cyclone Stick

Fabrication Of Stairmand Cyclone









Fabrication Of Lapple Cyclone Stick

**Stairmand Cyclone Stick** 





Swift Cyclone Stick









Fabrication Of Swift Cyclone

# **Experimental Investigation**

The flow rate varies from 10m/s to 50m/s. The pressure can be varied from flow rate.



The various design of REPDS as follows



Pressure Drop and Denudation Rate comparison of LAPPLE GP



Pressure Drop and Denudation Rate comparison of SWIFT HE







Pressure Drop and Denudation Rate comparison of STAIRMAND HE



## Result

Different types of configurations for vortex finder of cyclone separator were studied and finally the suggested design modification has been selected. Suggested modification has been divided into five types of vortex finders have been introduced they are 25% REPDS, 50% REPDS, 75% REPDS, 100% REPDS. At flow rate of 500 m<sup>3</sup>/hr. All design novelties have been analyzed using SOLIDWORKS.

#### Conclusion

In a new CFBC loop pressure drop is very less, but after a period of time pressure drop and denudation rate increase. In any of the part has to be modified to reduce these parameters other than cyclone is very difficult. In cyclone separator if any of the dimensions is adjusted then we can easily reduce the parameter.

For this we are adjusting the vortex finder height and inserting the REPDS for compensating the lost in height of vortex finder. In this project I am introducing the REPDS for 25% height of vortex finder, 50% height of vortex finder, 75% height of vortex finder, and 100% height of vortex finder. From the analysis of existing design and the modified design, came to a conclusion that modified design is having a better performance than existing design. Using the DYNAMIC PROGRAMMING optimization technique the 50% REPDS design is the optimized design for all types of cyclone separator. Fabrication has been done using sheet metal of thickness 1mm.

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