

# Design and Fabrication of Improved Cyclone Separator to Control the Dust in Rice Mills

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**ABSTRACT:** Rice is the important food for most of the people in our country; it is the largest consumed calorie source among the food grains. Rice mill is one of the oldest and largest agro processing industries in our country. The methods used in industries for converting paddy to the form of rice involve cleaning, hulling, whitening, polishing etc.

The raw material which will be received by the miller commonly contains more heavy dust particles, fine dust particles, small sized stones and many other small waste particles. Fine dust may include the small sized soil particles in which the grain is actually grown, Milling is the process where the paddy is transformed into rice which is suitable for human consumption, during this process heavy amount of dust particles is left to the atmosphere which is very much dangerous to the human beings respiratory system and due to the respiratory problem many of them has lost their life, the most dangerous part is that, the people who is working in rice mill will be effected first. Identifying these problems we are planning to use cyclone separator with filter unit and blower to control the dust particles which is liberated in the various places of the rice mill during the process.

The present Project which we all four members doing, as name mentioned above involves with the” Design and Fabrication of Improved Cyclone Separator to control the dust in Rice Mills” and filtration of air before letting it into the atmosphere for an eco friendly atmosphere in the rice mills.

**KEYWORDS:** Rice mill, paddy, milling, dust particles, respiratory system, cyclone separator, filtration.

## I. INTRODUCTION

Rice milling is one of the oldest agro processing industry of our country. The methods used for transforming paddy into rice are unsafe and indigenus. Whole paddy which is grown in the farm land is directly transported to the rice mills to make required final products. These raw Grains used to be conventionally processed at rice mill; mostly located in rural areas near to the farmlands. We have notice six places in the rice mill where the maximum amount of dust is generated.

The raw material received by the mills commonly contains fine dust particles in addition to long fiber shaped dust particles; also Fine dust includes the actual soil in which the grain was grown, the Environmental aspects associated with the rice mills are air Pollution, these units generate maximum amount of air pollution.

Total dust which is created in the rice mill is freely left to the atmosphere which is very harm full to living beings and the most dangerous thing is that, the people who are working in the rice mill will be affected first by causing respiratory system problems.

We are making use of three important components one is blower, the main function of the blower is to increase the speed of air stream with the help of rotating impeller, and send the air which is containing dust to the cyclone separator. second component is cyclone separator, the function of cyclone separator is to separate the dust from air where again heavy dust particles will be concentrated on the bottom part of cyclone separator and the light dust particles will be moving towards upward direction and third important component is filter unit, here light dust particles which is coming

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out from upper part of cyclone separator will be entering to the inlet part of filter unit where mesh and geotext material will be absorbing the fine dust particles, only pure air will be coming out of the filter.

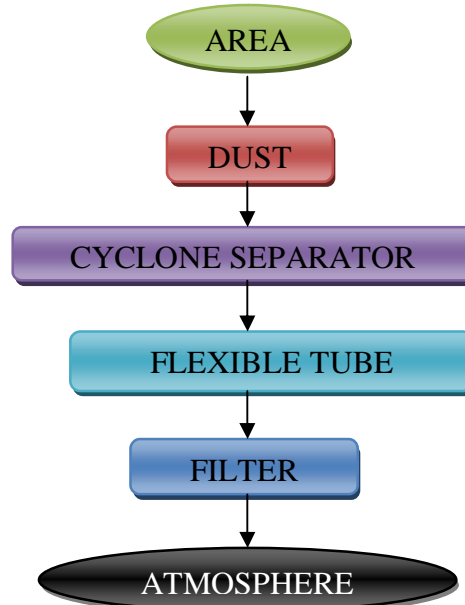


Figure 1: Processing Sequence of Cyclone Separator with Filter Unit

## II. LITERATURE REVIEW

During our literature survey we contacted a person who is working in Manjunatha Rice Mill from more than 12 years, he was seriously suffering from breathing problem due to the dust, as we met other person where he was not able to see properly after started working in rice mill. There are still many cases where the people are finding difficulty and many other problems due to the polluted environment.



Fig.2 Showing Chest radiograph of a rice miller, showing reticular changes and fine nodulation in lower and mid zones of both lungs. There is also a bulla in right mid zone.

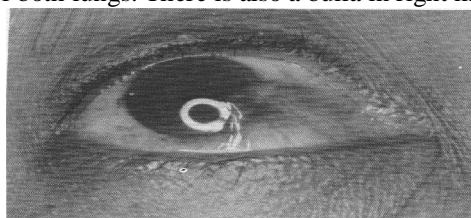


Fig. 3 Eye of rice miller, showing conjunctival injection and a pterygium extending from medial angle of eye on to cornea. (Bright ring in centre is a reflection of camera lens)

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At each rice mill field there are six places where maximum amount of dust is generated, Paddy pouring station, sifting sieve station, whitening polish station, swaying sieve station, bran filling station and rice sack station. The raw material received by the mills commonly contains much fine dust. Fine dust may include the actual soil in which the grain was grown, the size and amount of dust particles will be more in raw material. During literature review we recorded that the paddy pouring station is the place where the highest amount of dust particles (Smaller than 10  $\mu\text{m}$ ) were present.

### III. COMPONENTS USED IN THE PROJECT TO CONTROL THE DUST

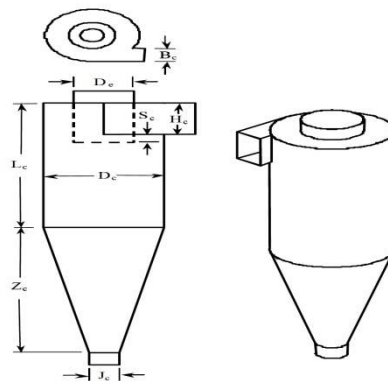
1. **Centrifugal Blower:** Centrifugal blowers of 5HP rating which looks more similar like centrifugal pumps. The impeller is belt driven and rotates as faster as 15,000 rpm to 16000 rpm, It is single stage blower, as in this type of blower air does not take many turns and hence it is more efficient. These Centrifugal blowers can operate against pressures between 0.35 to 0.70 kg/cm<sup>2</sup>, but has capable of achieving higher pressures.



Figure 4: Centrifugal Blower

2. **Cyclone Separator:** cyclone separator is the devise where the entered air will make the effective turn inside the device and due to the cyclonic action the heavy dust particles will be settled at the bottom of the cyclone separator. The centrifugal force created by the cyclonic action throws the dust particles toward the wall of the cyclone device, after striking the wall; these particles will fall down where some arrangements will be made to collect the dust.

We are using 2D2D cyclone separator where it has more number of effective turns (6 turns where the air stream can make inside the device).



2D2D

Fig.5 Detail design of 2D2D Cyclone Separator

The D's in the 2D2D designations refer to the barrel diameter of the cyclone. A 2D2D cyclone has barrel and cone length of two times the barrel diameter.

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$B_c = D_c/4$        $J_c = D_c/4$        $D_e = D_c/2$   
 $S_c = D_c/8$        $H_c = D_c/2$        $L_c = 2 * D_c$        $Z_c = 2 * D_c$ .  
 Assumption  $Q = 1500 \times m^3/hr$   
 $Q = 0.42 \times m^3/s$   
 Inlet velocity = 10 m/s ( assumption value)  
 $D_c = \text{diameter of cyclone} = \sqrt{8Q / \sqrt{V_i}} = 0.58m$ .  
 Most Suitable Model in 2D2D Design:  
 $B_c = D_c/4 = 0.58/4 = 0.145m$   
 $D_e = D_c/2 = 0.58/2 = 0.29m$   
 $H_c = D_c/2 = 0.58/2 = 0.29m$   
 $J_c = D_c/4 = 0.58/4 = 0.145m$   
 $S_c = D_c/8 = 0.58/8 = 0.0725m$   
 $Z_c = L_c = 2 \times D_c = 2 \times 0.58 = 1.16$   
 $L_e = 0.93 \times D_c = 0.93 \times 0.58 = 0.54m$

Based on the calculation the cyclone separator has been designed on the 3D CAD modelling and fabrication has been done.



3D CAD modelling of Cyclone Separator

- Filter Unit:** The filter unit involves three different stages, where in first and second stage filters are used to collect the big and normal sized dust particles and third filter used to collect the dust particles which cannot be observed from our eyes which can be achieved through porous material. In first and second stages we are using wire mesh material of large and medium mesh size (2mm, 1mm respectively) as the filter and in the third stage we are using geo text material as final filter.



Fig. 7 filter unit with three stages of filters

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## IV. METHODOLOGY

We have selected six places where the maximum amount of dust is liberated; we made some chimney kind of arrangement in those places which is attached to the blower with the help of PVC pipes. The main function of blower is to suck the air with the help of impeller blades and the same air is sent to the inlet of cyclone separator.

Here when blower is started, it sucks the dust air through the chimney which is placed near the location where maximum amount of dust is generated. The outlet of the centrifugal blower is connected to the inlet of the cyclone separator where the dust air enters the separator and due to the centrifugal action the air streams make certain amount of effective turns inside the separator. During effective turns made by air streams, the dust particles hit the walls of the cyclone separator and fall down from the cyclone separator. Bag material has been arranged at the bottom to collect the dust which is falling down from the bottom part of the cyclone separator. Remaining dust particles of medium and smaller size will be moving away from the upper part of the cyclone separator and enter the inlet part of the filter unit. Dust particles will be arrested in mesh filter material and geo text filter based on their sizes. Hence only pure air will be coming from the outlet part of the filter unit.



Fig.8 Photo taken during testing of Cyclone Separator

Fabricated cyclone separator with filter unit was successfully installed in Manjunatha Rice mill, Gubbi road Tumkur, and testing was made frequently to check the performance of the cyclone separator and filter unit.

## V. EXPERIMENTAL RESULTS

The gas outlet tube in the newly improvised cyclone separator can be moved up and down depending upon the requirement, whereas the gas outlet tube in other cyclone separators are fixed. For the experimental purpose the initial position of the gas outlet tube is placed 11 inches from the top dead centre of the cyclone body for the first trial and it is raised by 4 inches for each trial.

| TRIAL NO | TIME TAKEN FOR EACH TRAIL IN MINUTES | RAISE OF GAS OUTLET TUBE FROM CYCLONE BODY IN INCHES | DUST COLLECTED AT THE BOTTOM OF CYCLONE SEPARATOR IN GRAMS | DUST COLLECTED IN FILTER UNIT (GRAMS) |
|----------|--------------------------------------|--|--|---------------------------------------|
| 1        | 60                                   | 11   | 7.21   | 2.9                                   |
| 2        | 60                                   | 15   | 10.42  | 3.5                                   |
| 3        | 60                                   | 19   | 7.08   | 3.4                                   |
| 4        | 60                                   | 23   | 6.52   | 3.1                                   |
| 5        | 60                                   | 27   | 4.77   | 2.8                                   |

Table.1 Tabular column showing dust collected using cyclone separator at every interval of time.

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The detail description of testing and analysis for the cyclone separator is shown in above table. The table represents the dust collected at the bottom of cyclone separator. The amount of dust particles which is collected varies due to raising of gas outlet tube for each trail by 4 inches, we have taken 60 minutes for each trail to see the actual working performances of cyclone separator. In trial 2 when the gas outlet tube was raised by 15 inches, the maximum amount of dust particles was collected from cyclone separator and filter unit. Hence this arrangement was considered to be more efficient.

### Cost Analysis of over all Units.

| UNIT                         | AMOUNT IN RUPEES |
|------------------------------|------------------|
| CYCLONE SEPERATOR            | 25000            |
| BLOWER FOR CYCLONE SEPERATOR | 34500            |
| FILTER UNIT                  | 7500             |
| TOTAL AMOUNT                 | 67000            |

Table.2 cost analysis of the project

The above table represents the Cost Analysis of over all units that are cyclone separator, blower to run the cyclone separator and filter unit which is the last unit placed at the exit of the cyclone separator. It includes the exact cost of each material during the manufacturing of a component.

### VI. CONCLUSION

An improvised cyclone separator has been developed for collection and separating dust particles before letting it to the atmosphere. The fabricated cyclone separator has been successfully used with the newly designed filter unit for controlling dust in Rice Mills. This newly designed cyclone separator can be assembled / disassembled easily for cleaning and it is easy for handling.

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