

**Design and Development of De-Dusting System**Vivek P. Mitra<sup>1</sup>, Shebaz A. Memon<sup>1</sup>, Narayan Sen<sup>2</sup><sup>1</sup>Mechanical Engineering Department, Institute of Technology, Nirma University<sup>2</sup>Electrotherm Steel and Engineering India Ltd.

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**Abstract** —Dust control reduces wear and increases service life. Increasing stringent emission control requirements have a major influence on dust control system design and help protect the health of the workforce. Therefore, it is of prime concern to reduce the emission of the chemicals and the harmful dust fines by developing the de-dusting system, which will help to increase the charging time of raw material and thus increase the production capacity of liquid metal and will also maintain the environment clean and safe. The system will increase the efficiency of the plant if the successful operation of the de-dusting system is carried out. With the design of de-dusting system 100% dust control is not possible but it will be reduced to 75% dust and chemical emission and thus the workforce will be able to carry out the work and the plant can increase their overall output

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**Keywords-** De-dusting system, TMT bars, R.M.H.S, emission.

**I. INTRODUCTION**

The major problem as observed and identified was the dust and pollution in the plant mainly in the Blast furnace area of the Electrotherm steel and thus to reduce that chemical emission and dust fines from the plant it was of main concern therefore the design and development of Dedusting system.

The De-dusting system is based on the principle of the induced draft fan is attached with the column and hopper section and the outlet of the induced draft fan is connected to the chimney outlet, the chimney height is same as the height of the column and hopper section.

The main aim of this project is to minimize the emission of the dust and the chemicals and this will eventually increase the production capacity of the blast furnace plant. The De-Dusting systems also known as the bag filter dust collection. The dust is generated mainly from the raw material handling system where in the dust particles chemical fines from the coke and iron is generated thus creating impossible for the worker working over there to stay at the time of charging the material this causes the worker to reduce the charging time for the material and therefore the production reduces.

And at the time of summer season it is more difficult to charge the material in the hopper/bunker of the iron and coke material because in summer due to the hot and high temperature the raw material becomes dry and the moisture content in the raw material is 0% and therefore is the material is discharged from a little height to the hopper/bunker this creates a lot of dust as the material is dry and the moisture or the humidity gets removed due to the increased temperature.

The main area of this report is the focus on the De-dusting system and the methods to reduce the emission of the dust. The investigation from the research paper also helped in the result and the outcome for this project of the design of the system

**II. LITERATURE REVIEW**

The growth of Indian manufacturing sector depends largely on its productivity and quality. Productivity depends upon many factors, one of the major factor being manufacturing efficiency with which the operation is carried out in the organization, productivity can be improved by reducing the total machining time, combining the operations etc. in case of the continuous production where variety of products are less and the quantity or the production is huge. Therefore, it is very much important for the organization to continuously run the production despite of carrying out the breakdown repairs but per day production should be as per the requirements. And thus, this will be done when there is continuous charging of the material and this material is received to the Blast Furnace continuously and thus maintaining the production required per day.

During hot metal production as well as in steel works and foundries emissions arise at very different locations. These emissions must be reliably captured and filtered. And this is done with the help of De-Dusting system or the other name air bag filter dust collection. Besides intensive filtering, efficiency plays a key role. The emissions must be extracted with as little false air as possible. Moreover, the pressure loss in the duct system must be minimized.

The de-dusting system works on the basis of bag filter dust collection, where the induced draft fan is used for the suction of the dust from various dust generating points. The different points are provided for the suction of the dust and the header is provided which is the pipe kept in horizontal position with diameter approximately 250-300 mm and

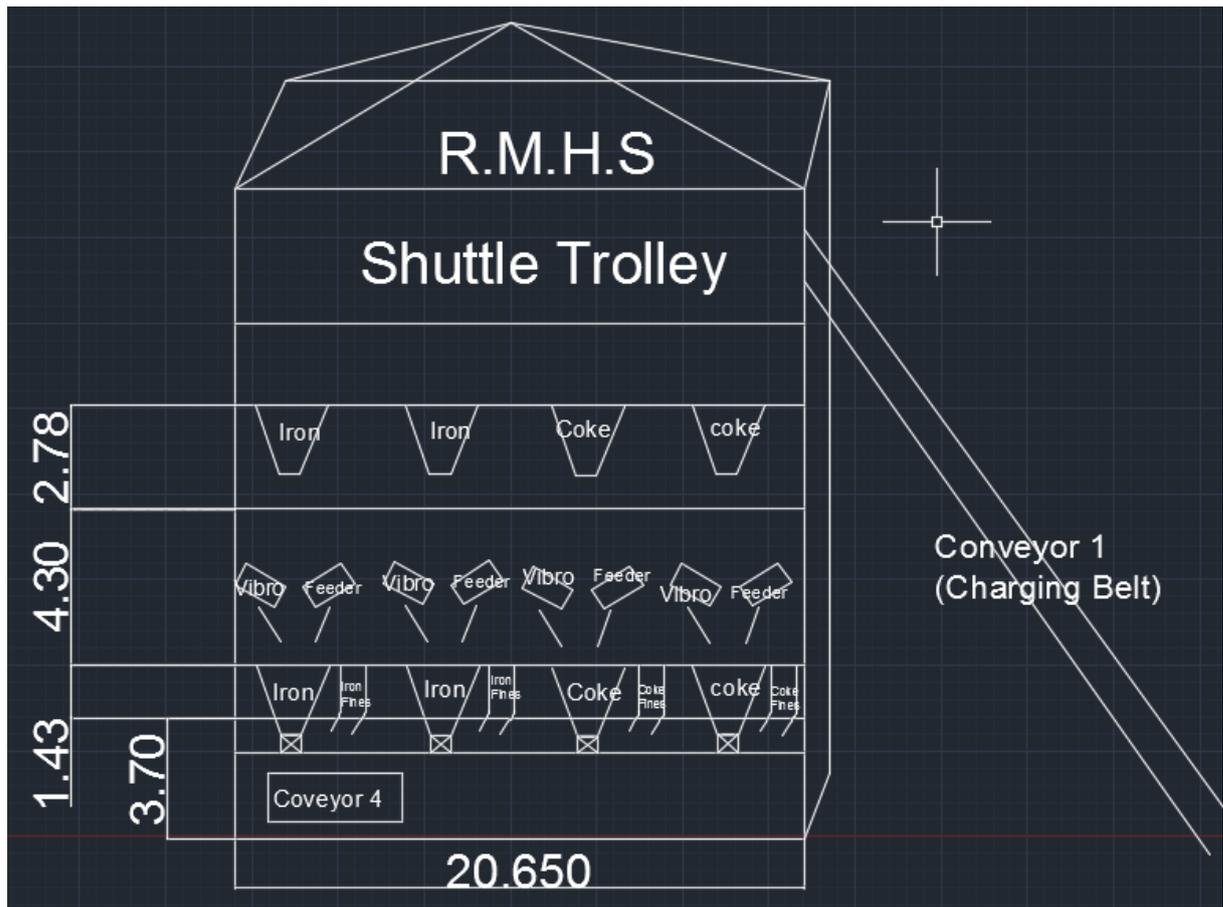
the suction pipe from the main point is connected to the header and thus that dust than goes to the bag filter dust collection chamber.

The dust and the fine particles are there in the chamber then there are different filter bags provided in which the long cage around 2500 mm in length.

The cage is provided with the fiber cloth mostly used material is P.T.F.E (polytetrafluoroethylene) whose melting temperature is 326.8 °C. Now when dust enters the chamber then it goes to the filter bag and sticks there in the bag (the material has a property that can hold the dust and chemical fines well).

To prevent equipment from generating the dust and to achieve trouble free operation of dedusting plant certain conditions must be met.

### III. LAYOUT AND DESIGN OF DE-DUSTING SYSTEM



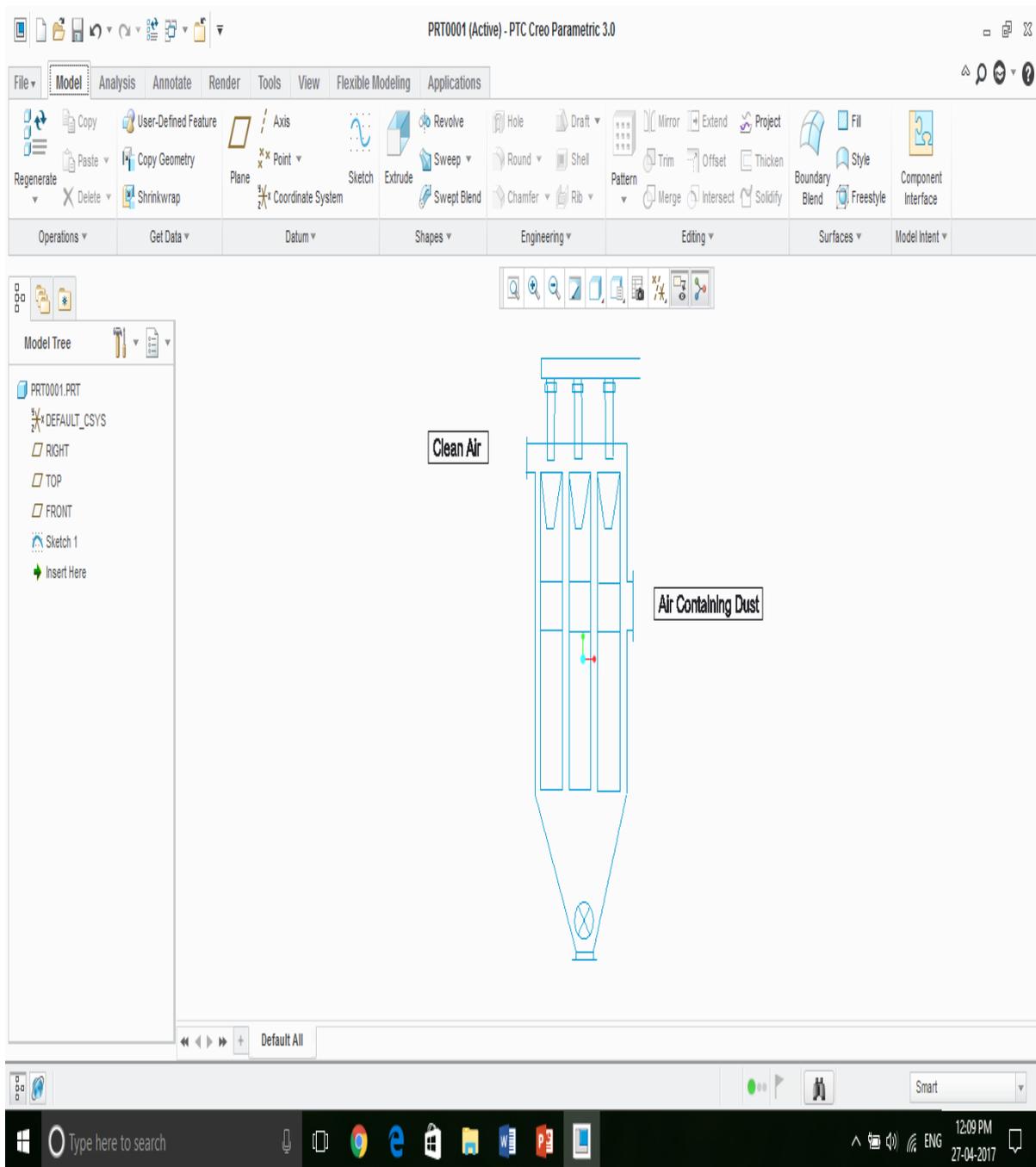
**Figure 1 layout and design of de-dusting system**

As shown above the drawing of raw material handling system, the conveyor belt 1 shown this belt transfers the raw material from the raw material storage ground to the raw material handling system at the top most floor as shown in the figure here the material is dropped to shuttle trolley now at the time of the material discharge to the trolley there is huge amount of dust at this height and the chemicals from the iron and coke is emitted at very high rate. And as this discharge happens at top floor there is dust everywhere in the blast furnace plant. And therefore, as discussed earlier the company limits the charging time as the dust emission is very high.

There is dust at each point where material goes through the stages as shown in the above figure from shuttle trolley to storage hopper/bunker then to the vibro-feeder then to the screen then to the fines conveyor thus the whole R.M.H.S system is dusty during this process.



**Figure 2** The emission of dust while discharging the material to the shuttle trolley



#### IV. AIR PURIFICATION PRINCIPLE

As shown above in the figure there is high pressure air tube i.e. (Pulsing valve) and pipe for blowing is provided venture tube is provided at the top of the cage, its cross section is decreasing cross section and thus avoid pressure drop, then air inlet is provided at the cage side and thus the air containing dust enters there and is attached to the bag which is stucked to the bag and then when sufficient amount of dust and chemical fines is attached to the bag then the sensor after specified time shoots the pulse of air and thus the dust falls off the bag and collected at the bottom of the hopper and there the screw conveyor from where the dust is discharged and thus useful fine can be re-used.

Bag filters are widely used for cleaning the exhaust gas from several kinds of impurities. They are usually made of fibre woven fabric or combination of glass fiber. Polytetrafluorocarcon is the widely-used material.

## V. Calculations

There are in all 11 suction points from where the air and dust is to be sucked and they are not operating at the same time. Thus, the calculation is based on that, the simultaneous operation of the ducts are 4 suction points at the same time. The suction points are as follows.

Two at the top of the storage building from where the charging is done i.e. above the shuttle conveyor trolley there will be 2 suction points. Below the trolley there are 4 bunkers among them 2 bunkers are of coke and the other 2 bunker are of iron ore.

From the shuttle trolley the material is discharged in the bunker and during this the dust emission is very high and so 4 suction points above the bunkers (these all are at 4<sup>th</sup> floor of the building i.e. at 11m around from the ground).

Then below that there is screen and vibro-feeder is installed in this area the required size is sent to the conveyor no 3 and the rest are sent to the fines conveyor which are under size. The vibro-feeder and the screen section is located at the 4.30m from the ground and here also the dust emission is very high as the vibro-feeder shakes and separates oversize and undersize material therefore the dust emission is very high therefore here also 4 suction points are required to be given.

Below the vibro-feeder and screen there is belt conveyor in which the material is discharged from the hopper as shown in the figure below and that material goes to the belt no 4 (conveyor No.4) this material is sent to the Blast furnace-1 and is discharged at the top of the furnace. And when the material is discharge in the B.C-4 then there is also emission of dust thus there also the suction point is to be give therefore in all total 11 suction points are provided.

Thus, there will be total 11 suction points to be provided.

There will be 4 suction points below the shuttle trolley as discussed earlier and among them 2 of the points will operate continuously, because among 4 bunkers 2 of them are of coke and other 2 are of the iron.

Now to increase the thermal efficiency of the Blast Furnace the coke bunker is preheated with hot air supplied continuously from the side of the bunker with the help of I.D fan.

Now due to this hot air the fines and dust of the coke comes out from the bunker and thus increase the dust and chemical emission therefore these two suction points of the coke bunker needs to be operated continuously, rest the other 2 bunker of iron need not be operate continuously because there is no such mechanism of preheat there and thus emission is not there except during the charging time, it need to be operated.

## VI. Check of ID Fan Capacity.

The top suction point cross section (hood/ cover area) is as shown in figure below:

1.

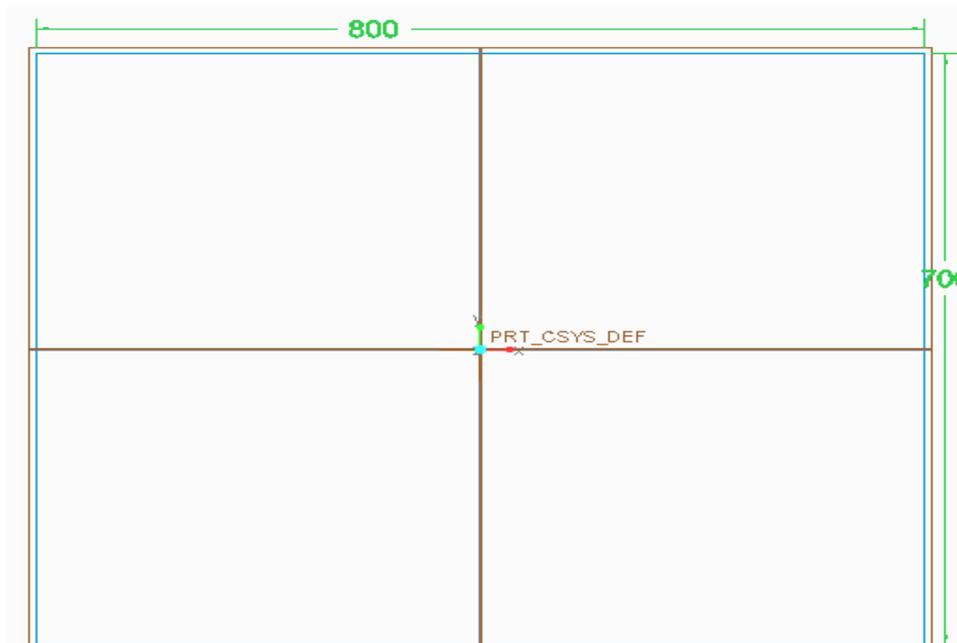


Figure 3 Suction area

(Velocity is assumed to be 25 m/s)  
 Area=  $3.14 \times (0.3)^2/4$  (m)

Area= 0.07065 m<sup>2</sup>

Now,

$$Q = \text{Area} \times \text{velocity}$$

Q= 0.07065 x 25

Q= 1.766 m<sup>3</sup>/s

And the calculated Flow rate is,

$$Q = 6358.5$$

2. Second suction point

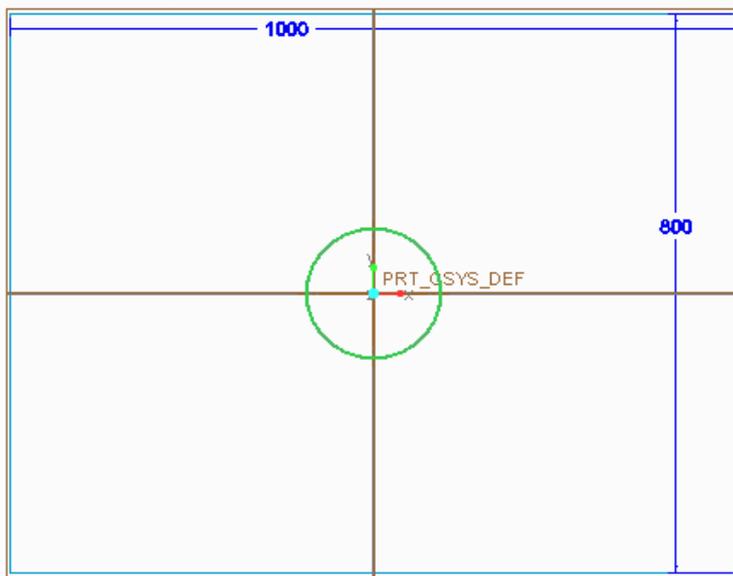


Figure 4 Suction area

Area= 0.8 x 1

$$\text{Area} = 0.8 \text{ m}^2$$

And calculated Flow rate is,

$$Q = 2880 \text{ m}^3/\text{hr}$$

Now,

There are 4 screens and vibro-feeder therefore and the all will not operate at same time so accordingly the total air flow and velocity required are 6000 m<sup>3</sup>/hr and 30m/s respectively.

$$Q = A \times V$$

$$A = 0.055 \text{ m}^2$$

Now,

$$A = \pi/4 \times d^2$$

Therefore.

D= 0.264 m equivalent to 265 mm, thus the diameter of the duct or the header is 250-265 mm and the header pipe diameter is 300 mm.



Checking the I.D Fan Capacity

Total air flow

Therefore, <u>the total simultaneous suction points are</u> Q= 6358.5
+ 2880
+ 6358.5
+ 2880

Thus, the assumption of selecting the **20,000 Nm<sup>3</sup>/hr** capacity fan is correct. The diameter of the pipe which is the header section of the de-dusting system is to be 300mm and the pipe which is to be connected to the suction point is to be 250-265 mm diameter.

**Losses Considered**

The darcy-weisbach equation is used for calculating the pressure loss in a cylindrical pipe of uniform diameter D.

$$\Delta P = f l V^2 / 2gd.$$

Where,

- **ΔP= Pressure Drop.**
- **F= Pipe friction Co-efficient.**
- **L= Length of pipe.**
- **V= Mean Velocity.**
- **D= Pipe Diameter.**

- ❖ **f= 2.738.**
- ❖ **L= 20.650 m.**
- ❖ **V= 30 m/s.**
- ❖ **D= 0.3 m.**

Therefore,

$$\Delta P = 2.738 \times 20.650 \times (30)^2 / 2 \times 9.81 \times 0.3$$

$$\Delta P = 8645.214 \text{ Pa}$$

$$\Delta P = 0.0864 \text{ bar}$$

Now, the capacity of the I.D fan which is there with the Electrotherm Company in store is of the capacity 20,000 Nm<sup>3</sup>/hr (Normal Meter cube per hour).

**The fan power requirements are to be calculated.**

$$P = dp \times q$$

Where,

- P= power consumption (W)
- Dp= total pressure loss (Pa)
- Q= air volume flow (m<sup>3</sup>/s)

Now,

- ❖  $P = 0.86 \times 10^5 \times 5.55$
- ❖  $P = 277,777.77 \text{ (w)}$

$$P = 277.77 \text{ (Kw)}$$

The motor HP required is obtained from the manual of the supplier [Rajdeep Engineering] is 40 HP motor

Table Motor HP Required

SR. NO	GAS VOLUME M <sup>3</sup> /HR.	STATIC PRESSURE MM WG.	BLOWER MOTOR HP.
1.	15000	350	30
2.	20000	350	40

### Fan Efficiency

$$\mu_f = dp \times q / P$$

$$\mu_f = 0.5 \times 10^5 \times 5.55 / 277.77 \times 10^3$$

$$\mu_f = 0.958 \text{ or } 95.8 \% \text{ efficiency.}$$

Where,

- ❖  $\mu_f$  = fan efficiency (0-1)
- ❖  $Dp$  = pressure (Pa)
- ❖  $Q$  = air volume delivered by fan (m<sup>3</sup>/s)
- ❖  $P$  = power used by the fan (W)

## VI. DESIGN OF DE-DUSTING SYSTEM

### Layout of the De-Dusting System for R.M.H.S

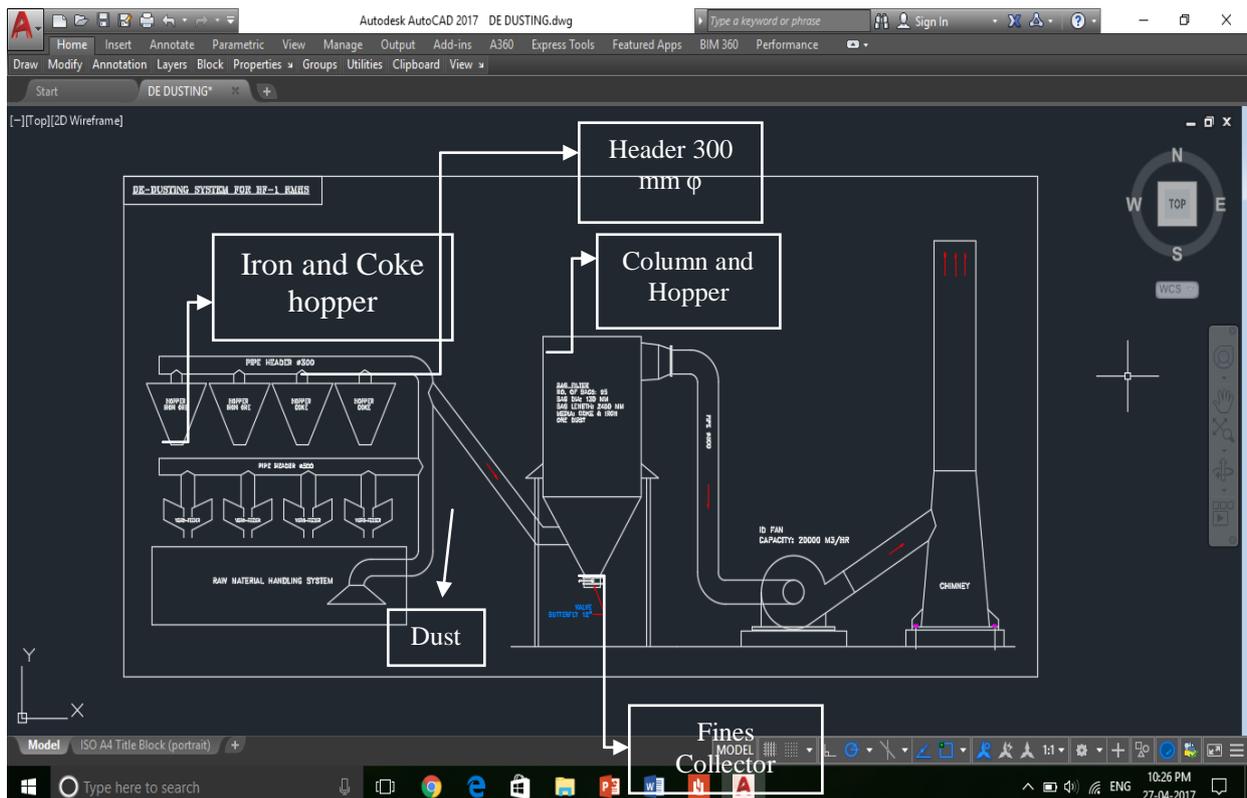


Figure 5 Layout of De-Dusting System

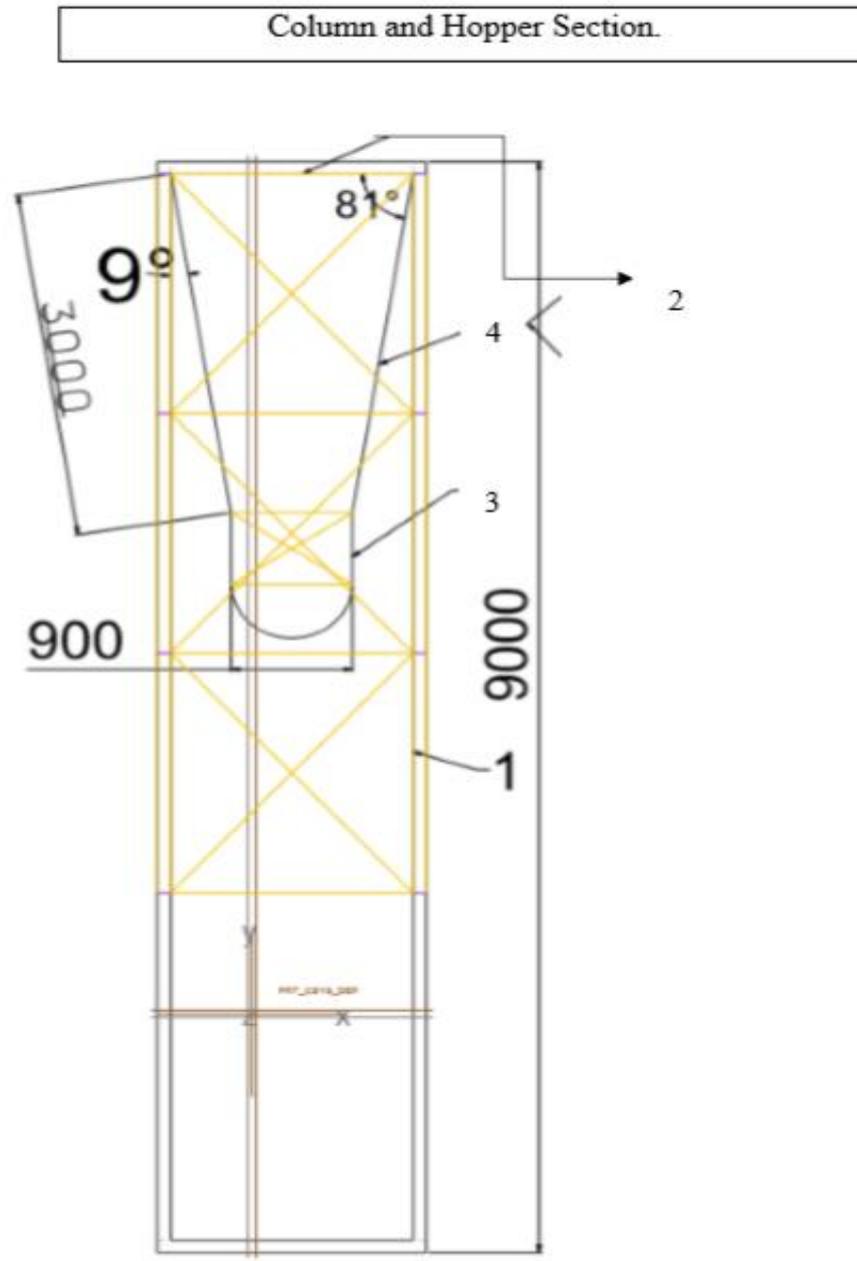


Figure 6 Column and Hopper Section

Sr. No.	Description
1	ISA 150 (INDIAN STANDARD ANGLE).
2	Mild Steel Plate 3mm Thick
3	Valve 300 NB (for removal of dust)
4	ISM 100 (Indian Standard Medium Channel)

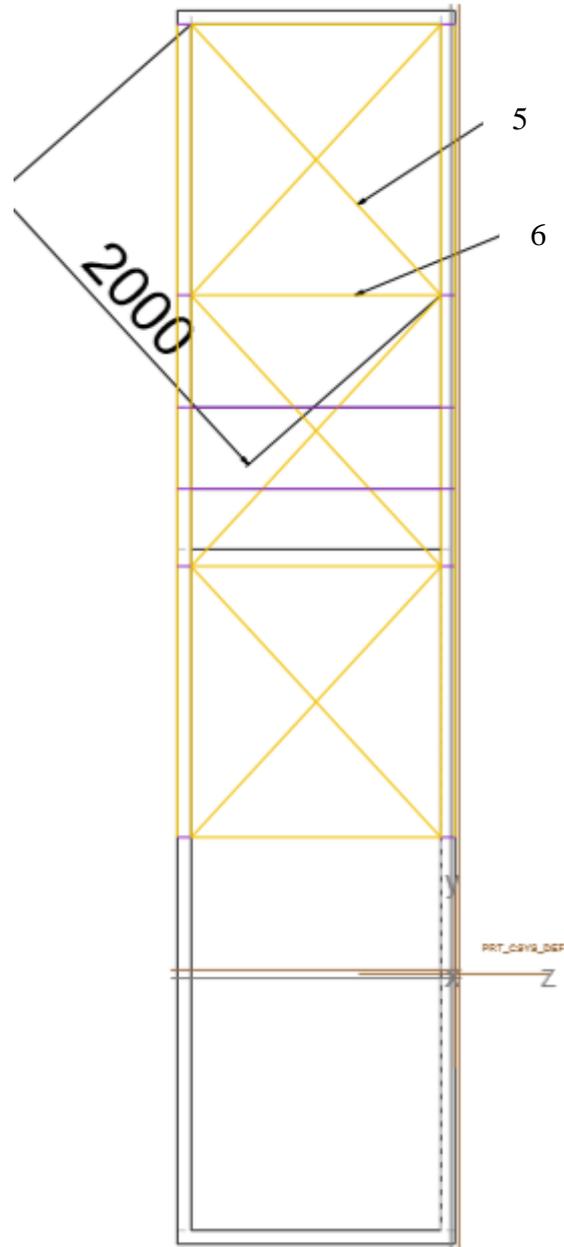


Figure 7 Side View of Column and Hopper

<i>Sr No.</i>	<i>Part No.</i>	<i>Description</i>
1	5	ISA 65 (Indian Standard Angle) 65 mm length.
2	6	Mild Steel Plate 8mm Thick.

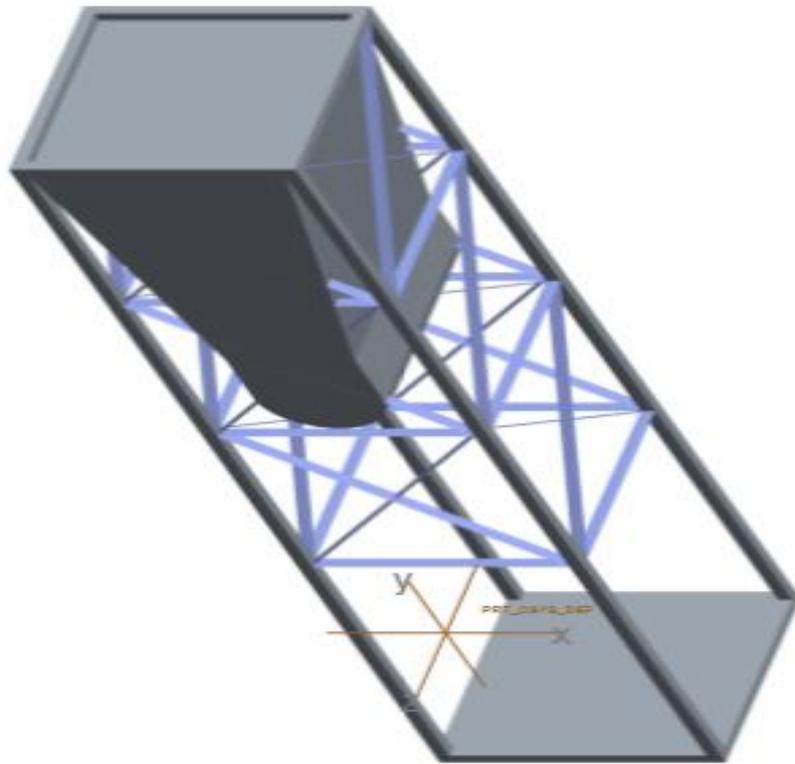


Figure 8 Orthographic View

Design of Chamber

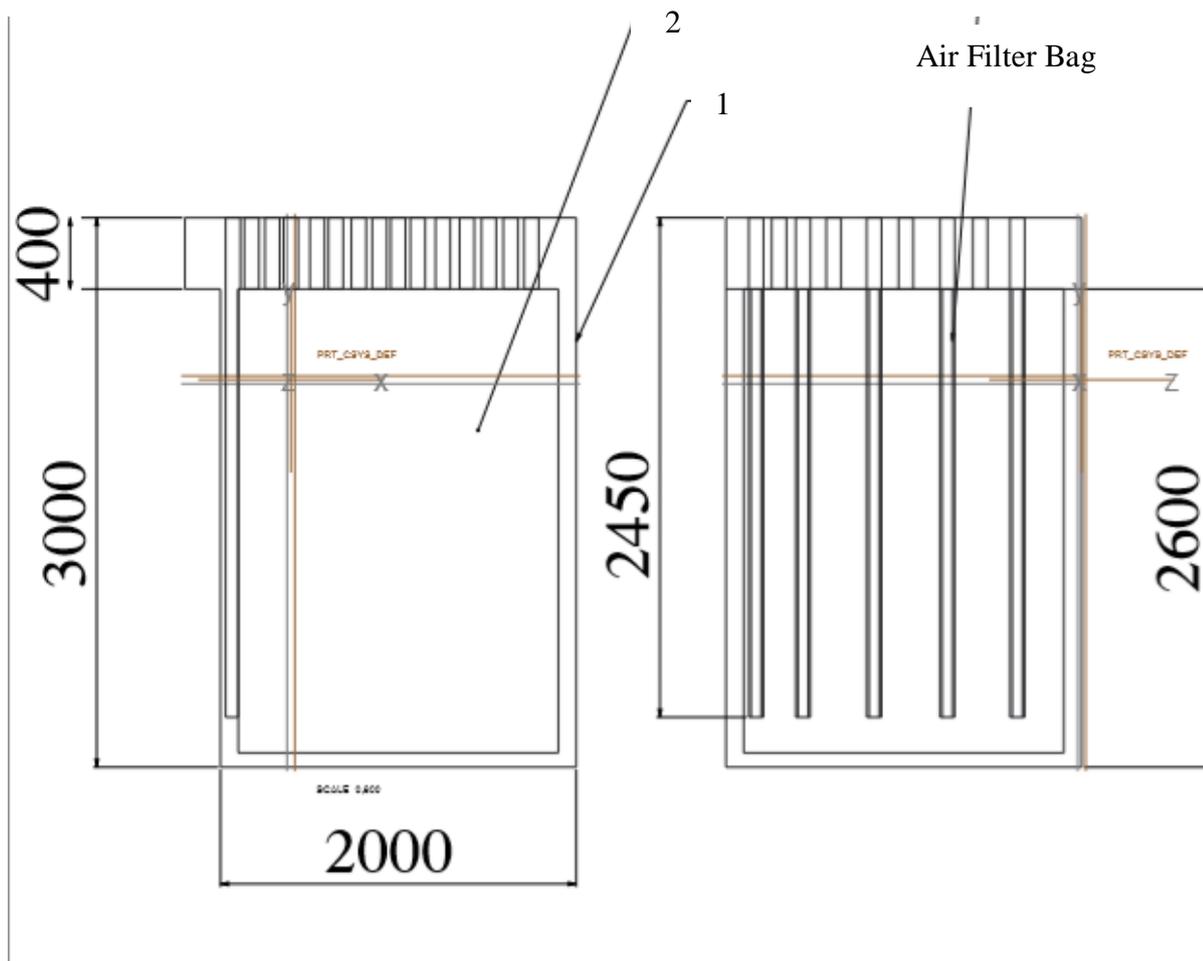


Figure 9 Chamber with Filter Bag

SR NO.	PART NO.	DESCRIPTION
1	1	ISMC 75 (INDIAN STANDARD MEDIUM CHANNEL)
2	2	MILD STEEL PLATE 3MM

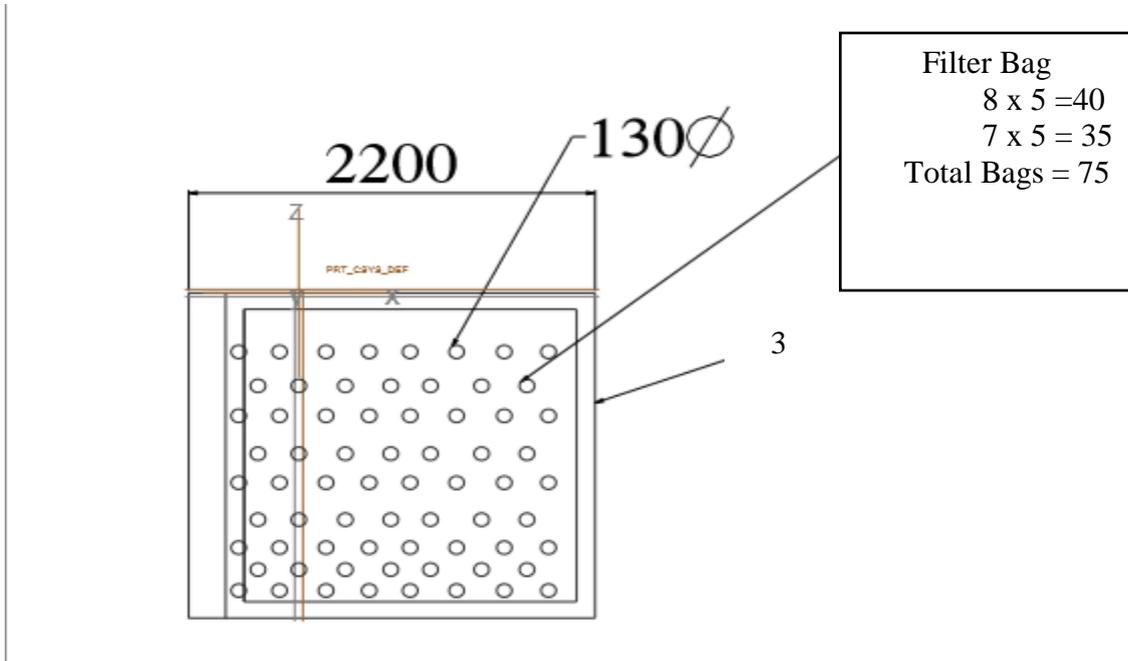


Figure 10 Top View of Chamber

SR NO.	PART NO.	DESCRIPTION
1	3	ISMC 75 (INDIAN STANDARD MEDIUM CHANNEL)

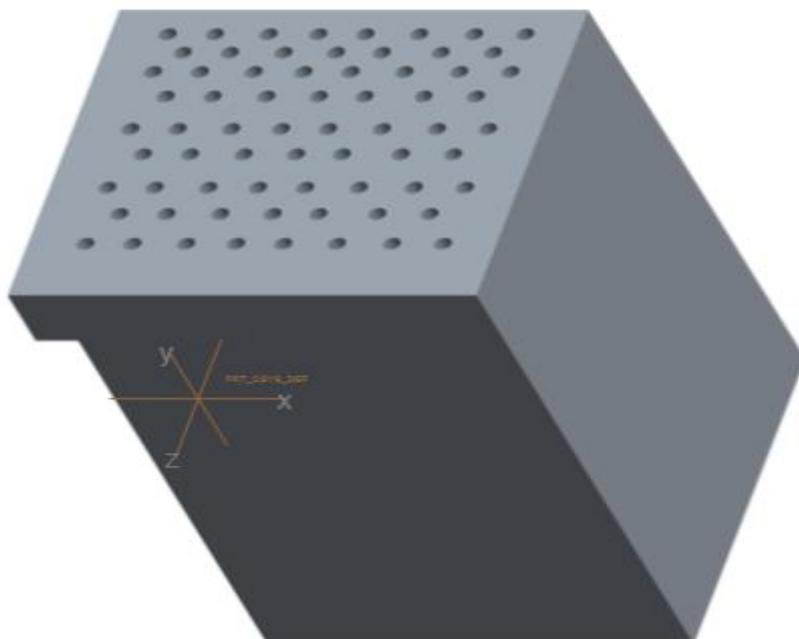


Figure 11 Orthographic View of Chamber with Filter Bag

## VII. DE-DUSTING SYSTEM LAYOUT

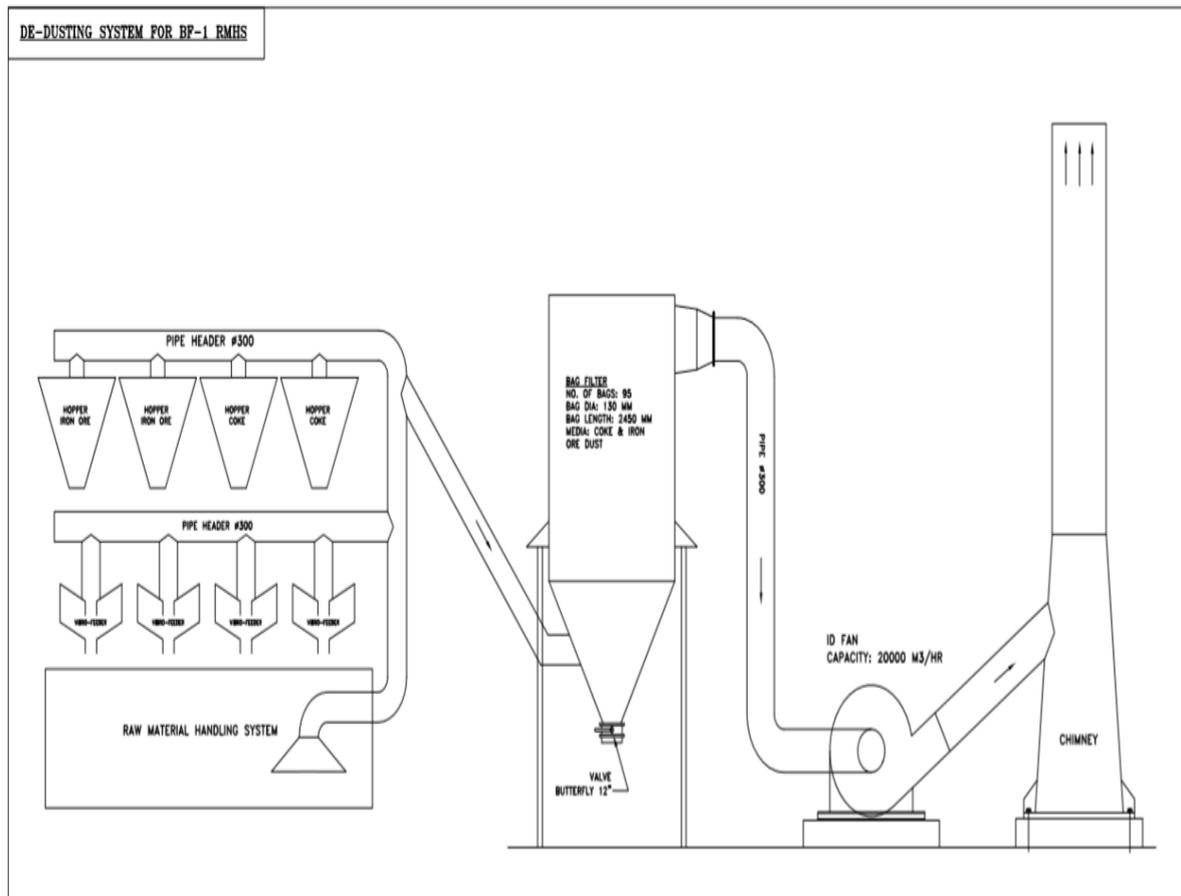


Figure 12 De-dusting system layout

## VIII. CONCLUSION

The main purpose was to reduce the emission of dust from the blast furnace plant and this will eventually increase the production of the plant. The outcome of detailed analysis was that the major dust is from the raw material handling system of the blast furnace thus the design of De-dusting system was done based on the R.M.H.S section of B.F plant. Then the calculations and the considerations required for the design is discussed. After that the calculations are done for the de-dusting system and thus based on that the design was carried out in the software PTC Creo and Auto Cad. After that the bill of material was prepared under the guidance of the company mentor. The company has accepted the design and they are planning to fabricate the same after discussing with the supplier.

## VIII. REFERENCES

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