DESIGN AND FABRICATION OF GRAIN TRANSFER SYSTEM BY VACUUM

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Abstract: *Vacuum units are fit for taking care of the most troublesome of materials and feature a unique delivery system. Powered by suction blower, the pneumatic units easily move food grains such as Bajra, Wheat and other beans are capable of delivering them to any desired location either for live discharge or dead storage. The Pneumatic principle have been used in a number of applications, from mining solutions to environmental and factory spill clean-ups. There are endless possibilities and applications.*

Keywords: Vacuum Transfer, Pneumatic system, Automation, Grain Transfer, Cyclone Separator, Suction Blower, wheat, low cost.

Introduction:

According to the Food Corporation of India (FCI), More than 60,000 Tons of Food grains have been wasted each year in which 84% was rice and 14% was wheat. Mainly due to Storage and Transfer system available in India. Grain wasted heavily during rainfall when it was stored in Open Grounds instead of Warehouse and Other Main factor is the Lack of labor workforce who can transfer these grains to the godown manually. So, the Basic Idea was generated from this Scenario in our country.

Main objectives of using Grain transfer system by Vacuum are [2]:

- Mainly, Zero wastage of food grains during severe circumstance such as rainfalls.
- Less weight compared to conventional machines.
- Easily movable or portable using wheels.
- Used in APMCs, Market yard, FIC Warehouse and Farmers carried out on day-to-day basis.
- Eliminate Manual work or labour.
- Unskilled handler required instead of labour.
- Labour costs cut out significantly.
- More than 1000 Grains storage can be benefited.
- Low power consumption
- High efficiency achieved compared to labours in transferring grains.
- No downtime period or No Breaks.
- High returns on investment.
- No pollution at all
- No damage or breakage of grain particles
- Less maintenance required.

To counter this problem, we require to resolve this problem by finding such a solution that is viable, compact, easily mobile and works on Low Power consumption and More importantly, eliminates the labor workforce requirements in transferring grains to godown by Tractors, Jumbo Bags and other medium.

Mainly, the system must able to Loading and Unloading Task in transferring the Grains across storage facilities.

Vacuum Power is most efficient Pneumatic system which can suck solid grains particle with high suction pressure. Air Pneumatic system is capable of handling the most difficult of various materials ranging from few microns to 3 millimetres.

Powered by Suction Blower air, the pneumatic units easily transfers food grains such as wheat, bajra, Soybean and other seeds are capable of delivering them to any desired location across Government / FCI Warehouses with minimize losses.

Our vacuum machine has been used in a number of applications, from mining solutions to environmental and factory spillage clean-ups. There are endless possibilities and applications of the Vacuum Machine in spice grinding and flour milling industries.

Working Principle:

This System is worked on principle of Pressure difference or acts as density separation. Suction pressure created at nozzle by the blower at 5000 rpm creates pressure difference which, transfers the food grains from the heap to the inlet pipe followed by cyclone separator. As grains enter the cyclone, it falls down to the bottom after revolute few circles inside chamber due to its weight. The food grain is denser than air and tends to resist vortex path as it has low inertia of mass. Air is discharged from upward of cyclone to the environment. In this way, Grains collected at bottom and can be transfer either to the storing vehicle or used to pack grain bags, while it eliminates the chances of breakage of food grain.

Why need for automation?

- To reduce the time.
- To reduce human effort.
- To reduce overall cost.

- To escalate efficiency.
- To reduce the wastage.

Design calculation – Cyclone Separator:

Assuming 30-32 Kg of food grains transfers each minute, based on approximate density of grain as 800 Kg/M^3 we get flow rate of 0.04 Metric cube/minute. In designing of cyclone separator there are mainly 3 types [1D2D, 2D2D, 1D3D] of standard designs are used. However, here we used 2D2D design configuration for Maximum inlet velocity up to 17m/s., using the formula we can find the diameter of cyclone:

$$D_c = \sqrt{\frac{8Q}{V_i}}$$

We get Body diameter 140 mm and for getting standard dimensions for 2D2D cyclone, we get it from below diagram –

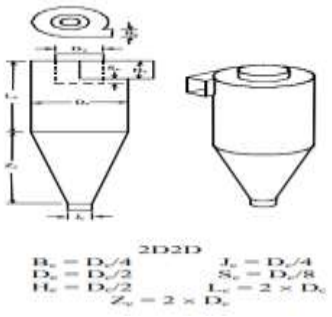


figure -1 [2]

We calculated the parameters of Cyclone separator based on above standard table as

Below:

1. Body Diameter: 140 mm
2. Diameter of Inlet: 45 mm
3. Length of Barrel: 280 mm
4. Length of Cone: 280 mm
5. Bottom discharge diameter: 55mm

Design Calculation – Suction Blower Experimentation:

When the developed prototype of transfer system was applied for small heap of food grain, it successfully created the suction pressure at sufficient level to suck and transfer the grain and the following results were obtained as mentioned in table below.

We have selected Suction blower for low pressure capacity of volumetric flow rate of 30 CFM Cubic feet/minute. Each one of cubic meter per minute is equal to 35.31 CFM.

So, volumetric flow rate of Blower is 0.0141 cubic meter/second.

Second step is to find Inlet air velocity which is,

Velocity = Flow Rate (Q) / Area of Inlet Pipe.

= 0.0141 (Cub Mt per sec) /0.00158 (Sq. Mt)

So, Velocity = 8.87 m/s.

Third step is to find Dynamic pressure from below equation,

Dy. Pr. = ½ x Density x (Velocity) ^{2}

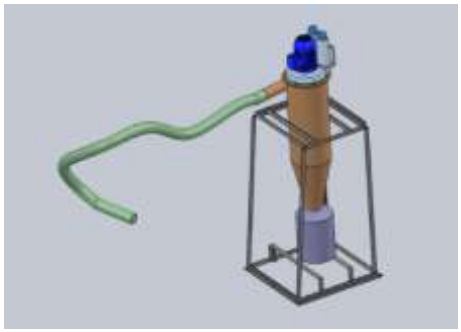
So, Pressure = 48,000 Pascal.

Lastly, Power requirement = Q (Flow Rate) x Dynamic Pressure.

=0.0141 x 48000

= 700 J/Sec.

Final 3d Conceptual Design



[3-D Assembly Diagram of System]

Bajra (Pearl Millet) Grain taken as Sample Material	
Weight of Sample in *(Kilograms)*	**Time taken to transfer in *(Second).***
1	5
5	25
12	60
**Above result is tested for Pipe length of 2 Meter, Result may vary for longer pipe due to pressure difference.*	

Future Prospects of System:

There are additional changes one can occur in system to suitable its application in agricultural and seed processing facilities as mentioned below:

- Installing few components such as Roots Blower, Gate Valve and Delivery pipe to the existing system, it can be used to transfer grain from one place to another place for further processing in seed cleaning facilities.

- By adjusting discharge height of cyclone and placing high pressure centrifugal blower, it can be used to load the food grains to vehicle in Market yards.

- By Adding the Screw conveyor at the bottom of cyclone discharge which is inclined, can be used in transferring the grains to the tractor trolleys in large farms or used to store grains in large silos for storage purpose.

Construction:

The main components of the system are –

- Cyclone Separator
- Suction Blower
- High Speed Motor with MCB
- Suction Pipe with Nozzle
- Supporting Frame & Wheel

Cyclone is the key component as it separates food grains from air [1]. It is constructed according to the 2D-2D Configuration in which bottom conical and upper cylindrical portion having same length. Both Portion are made from Mild Steel of 2 mm thickness and bend it in form of cylindrical and welded together to make a single cyclone separator.

Suction Blower should be capable enough to create suction pressure by high speed rotating impeller and made it from Aluminium body to keep low weight. Selection of suitable blower and its power rating is prime importance to keep necessary flow rate of air with minimum power consumption.

A/C Motor is directly coupled to the impeller of blower and MCB in installed for safety precaution. Suction pipe should be flexible and easily clamp to the inlet of Cyclone, either use PVC or Rubber. Nozzle is fabricated from Mild steel convergent type. Supporting Frame is fabricated from Mild Steel angle by cutting it in required size and welded together to withstand load of cyclone and blower on it. Wheel is attached to the frame which is made from moulded Poly Urethane polymer.

Assemble suction blower to the cyclone by Nut Bolt Arrangement, while clamp flexible hose pipe to the inlet using bronze clamp fittings.

This makes the end to the construction of the grain transfer system.

[Final Component Assembly of Grain Transfer System]

Conclusions:

From the calculation and analysis we can conclude that, our system can contribute to solve the need to find the sustainable solution to the labour workforce to increase productivity and to facilitate heavy work in agricultural activities such as handling heavy crops and fertilizer load bags, and delivering and transporting in shared environment.

In terms of health and safety in agriculture, most accidents are caused by collisions and human errors. In this context, our system can be used to mitigate the accident causes.

In agricultural environment, several approaches already been implemented. However; In particular, the flexibility and adaptability of this technique give potential to increase productivity and generate a positive economic impact in the near future.

Acknowledgment:

The developed Grain Transfer system is effectively applicable in Market yards, large farms and Seed Processing Facilities to achieve its primary grain transferring function. This system has wheels and can be mobile for flexibility of its operation and with regard of references taken into consideration the developed Grain Transfer system works satisfactorily according to our research and analysis. We like to appreciate the support provided by our guide

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