"Vacuum Powered Material Handling Machine"

Yogendra Chalke[1], Maruti Shendage[2] , Sagar Yadav[3]
Under Graduate Student, S.M.S.M.P.I.T.R.AKLUJ.
Mr.Ravikiran V. Adat [4]
[4]Assistant Professor, S.M.S.M.P.I.T.R.AKLUJ.

Abstract: Now a days, In industries there are lots of material handling device are present, but they are costly as well as, they affects the environment condition. As we can see that, Out of the total time spent for manufacturing a product 20% of the time is utilized for actual processing on them while the remaining 80% of the time is spent in moving the material from one place to another, waiting for the processing or storage. So to overcome this problem we had made a cheap material handling device. The biggest advantage of this material handling system, is that it is pollution free and it is easy to operate. In this device, we are using Bernoulli's principle for moving the material from one place to another. With the help of venture, Vacuum is created at the end of the venturi and the material handling take place.

Keywords: Bernoulli's Principle, Material Handling, Venturi, Vacuum.

1. INTRODUCTION

In order to convert the raw material into finished products, it is essential that one of the three basic elements of production, i.e. material, men or machine should move. In majority of the industrial processes it is the material that moves from raw material stage to the stage of when it becomes the finished goods. Because the material is more widely moved rather than the men or machines. Hence the term "Material Handling" and its impact in manufacturing processes is significant. Material handling amounts to 15 to 25% of the total cost of the product according to American material handling society. Material handling is the art and science involving the movement, handling and storage of materials during different stages of manufacturing.

2. METHODOLOGY:

From beginning our objective was to do a project in material handling equipment and also in industry 80% of the time is spent in moving from one place to another, waiting for the processing or storage. So our main objective was to manufacture or develop system which contributes to some percentage reduction in non-productive time.

In industry there are various material handling devices which are used for handling different type of materials. The different devices are cranes, AGV (automated guided vehicle), conveyors, pallet, industrial robots etc. In above devices material grasping takes place by mechanical, hydraulic, electrical, pneumatic, vacuum, and magnetic principles. Vacuum techniques are innovative but have been found out to be less applied. We have decided to go with this principle for pick & place arrangement.

There are various systems to generate a vacuum, such as vacuum pump, blower, and ejectors. As the pump and blower are costly and ejector has limitation for load carrying capacity, we decided to search for other alternative. Ultimately we came across the Bernoulli's and venturi principle.

After detailed study of Bernoulli's and venturi principle we have manufactured nozzle which may help to generate the vacuum. According to principle prime need is to maintain uniform negative pressure gradient of water to generate the vacuum. This is done by hydraulic pump and nozzle which is selected on the basis of requirement. As per the specification of the pump tank has been designed.

We have gone through market research during we have come across the suction cup. The suction cup which available in the market was unsuitable for our objective. So in the same we have done some modification as per our requirement to fulfill objective. After completion of gripping mechanism we have switch over to pick and place mechanism.

For pick and place mechanism two types of movement are required such as linear movement and rotary movement. For getting above movement we have gone through different mechanism like mechanical, hydraulic and electrical. We have made combination of electrical and mechanical systems to get required motion.

3. DESIGN:

3.1 Design of Gripper:-

After market search, we have buy and modified gripper for trial basis it is easy and economical to use 50 mm diameter gripper. We are designing gripper to lift load of 2 kg .

Fig 3.1: Gripper

Now ,the lift capacity of the suction cup depends on the effective area of the cup and the negative air pressure between the cup and the object. The relationship can be summarized in the following equation

$$F = P*A$$

Where

F = the force or lift capacity, kg

P = the negative pressure, kg/mm2

$$Ps \text{ (suction pressure)} = \frac{W}{\Pi/4*D2}$$

$$= \frac{2}{\Pi/4*(50*10-3)2}$$

= 1018.60 Kg/m2

= 0.1 bar.

3.2 Design Of Nozzle:-

For this pressure we have designed nozzle by an formula as shown below

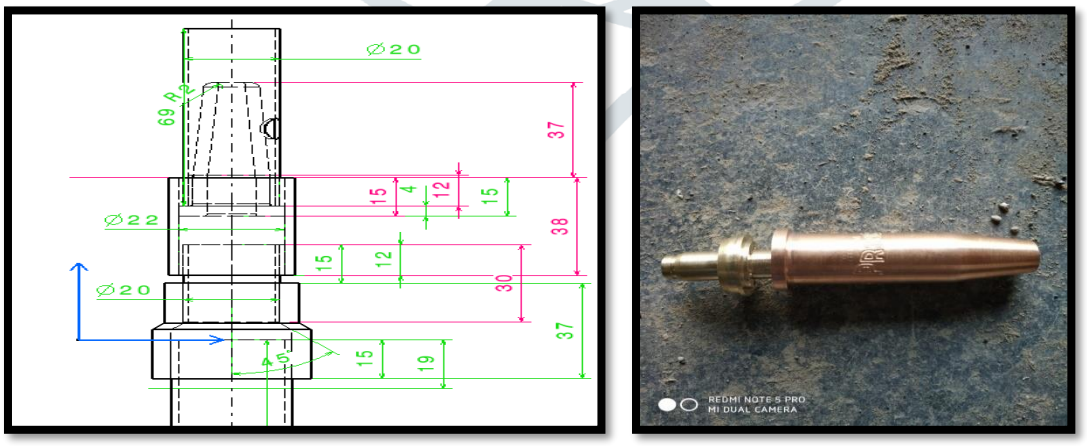

Fig 3.2 : Nozzle

Inlet dia .of the nozzle= di =16mm
Outlet diameter of the nozzle= de =5.4mm
Gripper diameter =D=50 mm
Weight to be lift=2kg.

$$C_{inlet} = \frac{P_s}{\rho_{water}} * \frac{1}{(1-\beta 2)}$$

But,

$$\text{Diameter ratio} = \beta = \frac{\text{Outlet diameter}}{\text{Inlet diameter}} = \frac{5.4}{16} = 0.3375$$

$$= \frac{1018.60}{1000} * \frac{1}{(1-0.33752)}$$

= 1.29*10-3 m/s.

From this velocity we have to find discharge of pump by using the formula as shown below,

Discharge = area of pipe * velocity of fluid

Q = A*V

The diameter of exit pipe of pump = 2 cm = 0.02 m

Q = Π/4 * (0.02)2 * 1.29 * 10-3
= 0.4 m3/s
= 0.4 * 103 litre /s
= 6.08 (aprox.7) litre/min.

But, pump gives discharge of 15 lpm, so we can lift the load of 2 kg, but for the purpose of demonstration we have considered 400gm weight. According to principle of vacuum generation prime factors to be considered are as inlet, outlet diameter, cup diameter.

4. Manufacturing:

Firstly we took raw material of mild steel and then we made the frame of the model by using cutting and arc welding process. After that hole is drilled on the frame with the help of radial drilling machine. Then we placed motor and pump on that frame with the help of nut and bolt. Pvc pipe, flexible pipe, elbow, venturi, ball valve, gripper, non-return valve are the parts connected to the pump.

Fig 4.1 : Actual Project Model

5. Working:

When the motor starts, water gets sucked through the pipe from the tank. The pressure increases flow through the venturi at that time negative pressure (vacuum) is created. And this vacuum goes to the gripper through ball valve. With the help of ball valve vacuum pressure is controlled .When the ball valve is ON the material will pick up and when the ball valve is closed material will release.

6. Advantages And Disadvantages:

6.1 Advantages:-

1) To make proper use of waste water.
2) It is Pollution free process.
3) To improve safety in material handling.
4) To lower the cost of process inventory.
5) To minimize delays, interruption by making available the materials at the point of use at right quantity and right time.
6) Minimize cost of material handling.
7) Prevention of damages to the materials.

6.2 Disadvantages:-

1) Vacuum gripper only able to lift smooth surface weight.

7. Conclusion:

During our project work on the topic "Vacuum Powered Material Handling Machine" we have get the knowledge about the modern trends in material handling systems .By implementing the vacuum gripper in material handling we came across one of the cheapest way. This project work gives practical experience about design and manufacturing especially discussion with the project guide and professors regarding our project prove to be successful. We interacted with lot of people and their attitude while completing the project work.

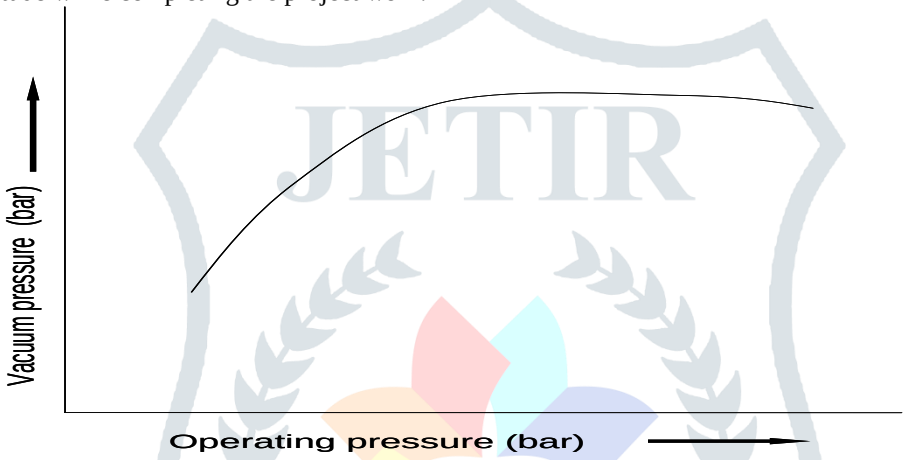

Fig 6.1: Vacuum Pressure Vs. Operating Pressure

The operating pressure is generated by the pump and the vacuum pressure is generated by the nozzle.as the operating pressure increase it will affect on the velocity of the fluid. This velocity is responsible for to generate vacuum. Above graph show the relation between operating & vacuum pressure. As the operating pressure increase vacuum pressure is also increase, but there are limitations on vacuum pressure because it depends upon other parameters like density of fluid, gripper diameter.

$$C_{inlet} = \frac{P_s}{\rho_{water}} * \frac{1}{(1-\beta 2)}$$

By using this formula we can calculate load lifting capacity on the basis of pump, nozzle and grippers specifications.

8. References:

[1] IJST - Vacuum Gripper- An Important Material Handling Tool (2017) - A. K. Jaiswal, B. Kumar.
[2] IJARS - Justification of design and parameters of Bernoulli–vacuum gripping device (2017) - Volodymyr Savkiv, Roman Mykhailyshyn, Frantisek Duchon, Olena Fendo.
[3]ELSEVIER - Effectiveness of a vacuum lifting system in reducing spinal load during airline baggage handling(2018) - Ming-Lun Lua, Jonathan S. Dufourb,c, Eric B. Westonb,c, William S. Marrasb.
[4] Industrial Engineering& production management-By Martand Telsang, S.Chand. page no127
[5] Industrial robotics-M.P.Groover-McGraw-Hill INTERNATIONAL EDITION Page no.127