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Design & Development of Three Axis Pneumatic Modern Trailer by using CAD FEA Model

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Abstract: *This project has mainly concentrated on the difficulties arises while unloading the material from dumper or trailer and hence a suitable arrangement has been designed. Such that the vehicles can be unloaded Material from the trailer in three axes without application of any impact forces. By pressing the Direction control valve activated. The compressed air is goes to the pneumatic cylinder through valve. The ram of the pneumatic cylinder acts as a lifting the trailer trolley. The pneumatic cylinder is coupled to the Air Compressor. This is definitely reduces the use of extra fuels and solve the problem of turning of truck in limited space.*
Keywords: *Air Compressor, pneumatic Cylinder, Trailer, Material Unloading.*

I. Introduction

In recent days automation plays a vital role in the development of manufacturing sectors. Automation of manufacturing sectors can be implemented through hydraulic systems, pneumatic systems and robotics system integrated with computers depending on the requirements.

Mechanization is broadly defined as the replacement of manual effort by mechanical power. Pneumatic is an attractive medium for low cost mechanization particularly for sequential or repetitive operations. Many factories and plants already have a compressed air system, which is capable of providing the power or energy requirements and the control system. The main advantage of an all pneumatic system are usually economic and simplicity the latter reducing maintenance to a low level. It can also have outstanding advantages in terms of safety.

A Trailer or dumper is a vehicle designed for carrying bulk material in constructional sites. It is usually an open 4-wheeled vehicle with the load skip in front of the driver. Modern trailers have payloads of up to 10 tones. A trailer is an integral part of any construction work and hence its role is important for completion of any constructional site works. One of the problems cited with dumper is the unloading of material in narrow roads and mines. Hence, the need of the project work is raise which is about to unload the material in any direction except the front side.

II. Objectives

1. To Solve the Material unloading Problem of Dumping Trailers in crunch situation and narrow road site area.
2. To achieve Low cost automation Model of unloading of material.
3. To increase efficiency of dumping Trailer while unloading the material.
4. To reduce manpower and save time while unloading the materials.
5. To combine pneumatics and micro controller in our model.
6. To achieve higher safety of worker during the work time.

III. Literature Work

The word ‘pneuma’ comes from Greek word and which means breather wind and pneumatics is the study of air movement. Today pneumatics is mainly understood to means the application of air as a working medium in industry especially for the driving and controlling of machines and equipment. [1]

There was a review on a need of the modern three axis pneumatic trailer in shipping industry to lift the heavy loads. They also studied pneumatic circuit system and its application in shipping industry and various parts of the modern three axis pneumatic trailer was studied and their performance was analyzed in terms of the work. [1]

There are many papers which include use of three hydraulic piston cylinders one on cabin side and one each on lateral sides of the trailer body. Main hydraulic cylinder is placed at middle of front side of chassis for back side tilting and other two cylinders are placed at lateral side of body for left and right side tilting. It also include Six hinge joints - 2 on each side for degree of motion to sides. [5] But, there is no cost wise analysis of components and there was also used of-three-cylinder in the-design for lifting the load. [2]

At the last here mentioned that 'this mechanism will-also be applicable-to-other industries-also rather-than shipping industry. [1] Also they mentioned that there will be scope of modification and development according to the requirements. [3] The paper was also mentioned about there will be a scope of Providing ball and socket joint or universal joint at the tip of pneumatic cylinder piston. Another changes was suggested that to introduce some rollers in between the load cabin and the body of the vehicle. This setup will make the rotation of the load cabin easier and thus the rotating disc will no longer have to experience the complete load. [5]

Also mentioned there could be use of single hydraulic cylinder with the help of external compressor to make the system more efficient. Another changes was suggested that to introduce some rollers in between the load cabin and the body of the vehicle. This setup will make the rotation of the load cabin easier and thus the rotating disc will no longer have to experience the complete load. [4]

IV. Working Principle

1. The compressed air is used to activate the pneumatic cylinder.
2. The valve is activates the direction of air flow which is controlled by it.
3. The setup consist of pneumatic cylinder, direction control valve, flow control valve, 360 degree rotatable wheel, and a tray for lifting purpose.
4. The movable tray consist of dc motor for rotating a trailer.
5. A worm gear arrangement is used with motor for rotating purpose. The pneumatic cylinder is attached with the lifting plates.
6. When the cylinder is actuated the tray is lifted up to certain height. This can be done by the compressed air as said above.
7. The 360 degree rotatable wheel is used to turn the required direction. The motor is used to turn the whole trailer.

Initially starting with air compresses, its function is to compress air from a low inlet pressure (atmospheric pressure) to a higher pressure level. This is an accomplished by reducing the volume of the air. Air compressors are generally positive displacement units and are either of the reciprocating piston type or the rotary screw or rotary vane types. The air compressor used here is a typically small sized, two-stage compressor unit. It also consists of a compressed air tank, electric rotor and pulley drive, pressure controls and instruments for quick hook up and use. The compressor is driver by a 1 HP motor and designed to operate in 10 – 100 PSI range. If the pressure exceeds the designed pressure of the receiver a release value provided releases the excesses air and thus stays a head of any hazards to take place. Then having a pressure regulator where the desired pressure to the operated is set. Here a variable pressure regulator is adopted. Through a variety of direction control value the motion of trailer is going to controlled.

V. Components And Description

1. DC Geared Motor (12V, 60rpm, 80 kg/cm Torque)
2. Pneumatic Actuator (Stroke Length – 10" , 2 port)
3. Air Compressor (4 CFM , ½ Letter)
4. 4. ¾ " Pneumatic Hoses
5. 2×2 Direction Control Valve
6. DPDT Switch
7. Pressure Regulator Valve
8. Flow Control Valve

1. DC Geared Motor –

The electrical motor is an instrument, which converts electrical energy into mechanical energy. According to faraday's law of Electromagnetic induction, when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's left hand rule. Constructional a dc generator and a dc motor are identical. The same dc machine can be used as a generator or as a motor. While motor action a torque is developed. The torque can produce mechanical rotation. Motors are classified as series wound, shunt wound motors.

2. Pneumatic Actuator –

Actuator are the one, which offers the rectilinear motion to mechanical elements. Cylinders are classified as light, medium, and heavy duty with respect to their application.

3. Air Compressor –

The main function of the air compressor is to compress the air up to the required pressure. The maximum capacity of the compressor is 10×10^5 to 12×10^5 N/m^2. This is a two stages or two-cylinder reciprocating air compressor. The two cylinders are for low and high compression. The air pressure is measured at various places by the use of pressure gauges.

4. Pneumatic valves –

The pneumatic cylinder is regulated and controlled by pneumatic valves. These valves are actuated manually, mechanically, electrically, pneumatically, and by various combined mode of actuation need of Valves.

5. Direction Control Valve –

Directional Control Valves (DCVs) are one of the most fundamental parts of hydraulic and pneumatic systems. DCVs allow-fluid-flow-(hydraulic oil,-water-or-air) into-different-paths-from-one-or more-sources.-DCVs will-usually-consist-of a spool inside a cylinder which is mechanically or-electrically-actuated.-The position-of the spool restricts or permits flow, thus it controls the fluid flow.

6. Flow Control valve –

Flow-control valves include simple orifices to sophisticated closed-loop electrohydraulic valves that automatically adjust to variations in pressure and temperature. The purpose of flow control in a hydraulic system is to regulate speed.

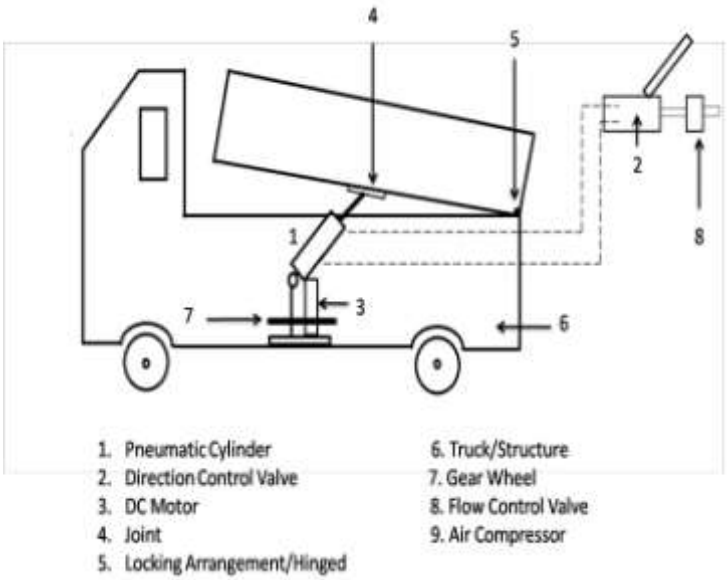
7. Pressure control valve –

Pressure-control valves are found in virtually every hydraulic system, and they assist in a variety of functions, from keeping system pressures safely below a desired upper limit to maintaining a set pressure in part of a circuit. Types include relief, reducing, sequence, counterbalance, and unloading.

8. DPDT Switch –

A Double Pole Single Throw (DPST) switch is a switch that has 2 inputs and 2 outputs; each input has 1 corresponding output. Each of the terminals of a double pole single switch can either be in the on position (closed) or in the off position (open).

VI. Design And Drawing



A. Design of Piston rod:

Diameter of the Piston :

Diameter of the Piston (d) = 40 mm = 0 .040m Pressure acting (p) = 6 kgf/cm² = 5.88×10^5 N/m^2 Material used for rod = Cast Iron

Yield stress (σy) = 36 kgf/mm² = 3.53×10^8 N/m^2

Assuming factor of safety = 2

Force acting on the rod (F) = Pressure x Area
= p x (Πd² / 4)
= 5.88 × 10^5x {(Π x 0.04²) / 4 }
F = 738.36 N
Design Stress (σy) = σy / F0S
= 3.53 × 10^8 / 2
= 1.76 3.53 × 10^8 N/m^2
=18 Kgf/mm²
= P / (Π d² / 4)
∴ d = 0.0023 m = 2.3 mm
∴ Min. dia. of rod required for the load = 2.3 mm We assume diameter of the rod = 15 mm

Length of piston rod :
Approach stroke = 160 mm
Length of threads = 2 x 20 = 40mm
Extra length due to front cover = 12 mm
Extra length of accommodate head = 20 mm
Total length of the piston rod = 160 + 40 + 12 + 20
= 232 mm
By standardizing, length of the piston rod = 230 mm
= 0.23m

Technical Data
Stroke length = 160 mm = 0.16 m
Quantity : 1 Seals
Media : Air
Temperature : 0-80 º C
Pressure Range : 8 N/m²

B. Design of Cylinder Thickness :
Material used = Cast iron
Assuming internal diameter of the cylinder = 40 mm
Ultimate tensile stress = 250 N/mm²
= 2500 gf/mm²
= 2.5 × 10^8 N/m^2
Assuming factor of safety = 4
Working stress (ft) = 2.5 × 10^8 / 4
= 6.25 × 10^7 N/m^2
According to 'LAMES EQUATION'
∴ 1.76 3.53 × 10^8 N/m^2 Min.thick. of cylinder (t) = ri {√ (ft + p) / (ft – p) -1 } Where, ri = inner radius of cylinder in cm.
ft = Working stress (Kgf/cm²)
p = Working pressure in Kgf/cm²
∴ Substituting values we get,
t = 2.0 { √ (625 + 6) / (625 – 6) -1}
t = 0.038 cm = 0.38 mm
We assume thickness of cylinder = 2.5 mm
Inner diameter of barrel = 40 mm
Outer diameter of barrel = 40 + 2t
= 40 + (2 x 2.5)
= 45 mm

C. Flow control Valve :
Technical Data
Port size : 0.635 x 10 $^{-2}$ m
Pressure : 0-8 x 10^5 N/m²
Media : Air
Quantity : 1

VII. Future Scope

This model can be made designed in such a way that, it can lift more payload than this existing model. This model can made on the solar power supply but there is may be many complication arise regarding structure and design. There is also scope of time study of performance of trailer regarding the time taken by it.

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