Design of Self Discharge Railway Wagon

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Abstract: The present work emphasized on modelling of self-discharge wagon prototype. This prototype can be used for unloading coal from the wagon. The various methods are discussed and have been patented for the last 30 years. But from the literature, it was found that the existing process of unloading coal from wagon takes much time. Therefore there is a need to design the wagon for unloading the coal in Indian railways. A prototype model is prepared by using Pro-E modelling software and analytical design is carried out. In this method material can be unloaded without disengaging the wagons and may reduce the imposed penalties on the power plant due to time delay.

1. Introduction

In the current scenario, innovation creates the decisive competitive edge with the use of innovative transport technologies; there is a demand to implement future-oriented, customized provision solutions. Power plants, stainless steel plants, cement plants; other metal processing plants need bulk raw materials. For this purpose there is a need to minimize the time of unloading the wagon. Different methods for unloading the wagon are available, such as track hoppers & wagon tippers for mechanized unloading, of which wagon tippers have proven economical & high demands due to their less initial investment & ability to unload a wide range of open BOX wagons from Indian railway infrastructure.

CIMMCO, Texmaco, HDC, Besco, Binny Engineering Works, Titagarh, and Modern make the majority of the wagons. Organizations in the public sector, such as Burn Standard Co., Braithwaite, Jessops, Bharat Wagon and Engg. Co. [1] .Today industries are growing with drastic speed due to various facilities now available in India. Indian industry has witnessed rapid growth in past 2-3 decades. This rapid growth has faced the industry with several challenges. Every industry needs higher productivity, and for this the equipment should work in good condition. So for this, it could be presumed that the quick stacking framework could be embraced for the majority of the materials. Henceforth both the kinds of emptying frameworks viz. wagon tippling framework and track container framework are being utilized recently. Industry must pick wagon stacking and emptying framework which expands their generation rate and furthermore accommodating for the executives individuals for smooth task [2].

2. Prototype model of self-discharge wagon

Fig.1.Prototype model of self-discharge railway wagon

A prototype model was prepared by means of different parts:

1) *Pneumatic actuator*: An actuator is a power output tool for energy conversion into useful work. The system controls the output signal, and the actuator responds to the control signals via the final control element. Other type of output device is used to indicate the status of control system or actuator.

2) *DC Valve:* Pneumatic control systems are composed of signals, control elements and a working part. The signal and control components influence the operating sequence of the working element and are termed valves. Valves are devices for controlling or regulating "start", "stop" and "direction".

3) *Hose pipes:* Beyond the compressed air distribution system, which is composed of rigid main pipelines, feeder lines and associated fittings and accessories, a means must be provided for conducting clean, dry and lubricated compressed air to tooling and equipment. Air hose tubing are used for this purpose.

   Many types of rubber hoses are available for a wide variety of applications:

   . They are of 3 general types. 1) Wrapped 2) Horizontal braided 3) Vertical braided

   The walls of the hose must be sufficiently strong to resist heavy impact and shock blows. Hose length should be at minimum, consistent with maneuverability of the tool and the tool travel distance.

   Plastic tubing is also used for portable power tools and other compressed air applications in instances where the degree of flexibility and other operating conditions may permit utilization of certain advantages such as smaller diameter and less internal wall section. Coiled or self-storing plastic tubing may be used to advantages in various instances.

4) *Wheels:* Ball bearing hub of bicycle is used as a wagon wheel which has flanges like railway wheel set.

5) *T- joint:* T-joint is used to join the hose pipe connections.

6) *Pressure gauge:* The pressure gauge is used to measure and maintain the pressure in the tank.

7) *Connectors:* Connectors are used to join the fittings like hose pipes, DC valve & tank.

8) *Flow Control Valve:* The flow control valves (Throttle valves) impact compressed air volumetric in both directions. A flow control valve with constant restriction. Here, the length of the throttling section is greater than its diameter.

3. Design of self-discharge wagon

1) Pneumatic Calculations

Consider a load of 30 kg to be lifted by pneumatic cylinder Pressure- 6 bar

i. Force necessary to lift the wagon: $F_g = m \times g$

$= 300$ N

ii. Piston area necessary(at 6 bar) to lift the wagon:

$A = F/p$

$F = p \times A$

$=300$ N/ 60 N/cm^2

$= 5$ cm^2

iii. Selecting cylinder diameter: $A = d^2 \times p/4$

$d = 2.52$ cm $= 25.2$ mm

Since there is no cylinder with diameter of 25.2 mm the next available size is to be selected.

Selected cylinder size: 32 mm

Instead of using one cylinder take 2 cylinders of 16 mm dia.

Here, Fg- Necessary force, m – mass, g –gravity, p – pressure and A – Area

2) Hinge Pin Calculations:

Take material for hinge pin AISI 1030

From design data book: s_{ys} (τ)=183 MPa (AISI 1030) P = 30 kg = 294.199 N

$P = 2 \times \pi/4 \times d^2 \times \tau$

$d = 1.01$ say $\cong 5$ mm

Put the value of d in above equation

$\tau = 7.4917$ MPa

Designed shear stress < allowable shear stress

∴ Hence, design is safe.

Here, P- Pressure, d- diameter of pin and τ – shear stress

3. Working of prototype model

Fig.2 shows the block diagram of working model. In this model two pneumatic cylinders are used for

unloading & lift the wagon which is fitted between the chassis and wagon at top end. When the pressurized air is given to the pneumatic cylinder the piston starts moving up and down direction. For reciprocating motion of the piston, direction control valve is provided. The type of valve used in a system is 3x2 DC control valve. For adjusting the air pressure as per requirement the pressure control valve are fitted to the cylinder.

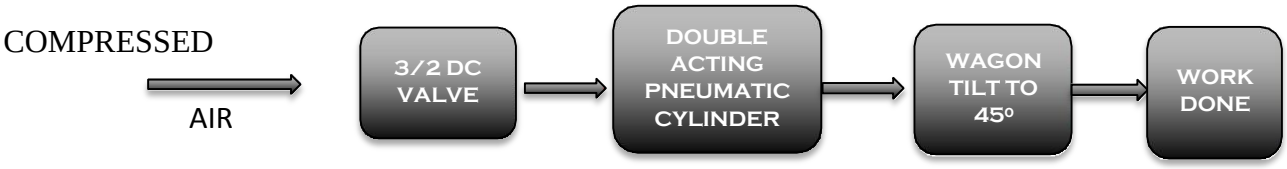

Fig 2. Working block diagram of prototype model

While unloading the wagon, firstly open all the doors of wagon and then give pressure to the cylinder. The wagon starts lifting up and making an angle with the base. Due to inclination of the wagon, content of the wagon are unloaded and the wagon gets empty easily.

The wagon has side rapid discharge system which is easy to unload the content like (coal, track ballast, iron ore). The system requires very less time for unloading and useful for Indian railway & Power plant for rapid discharge. In this model, we are using pneumatic cylinders just for working and demonstration of our concepts.

3. Computer Aided Design Model

The computer aided design (CAD) model was prepared by means of Pro-E modelling software.

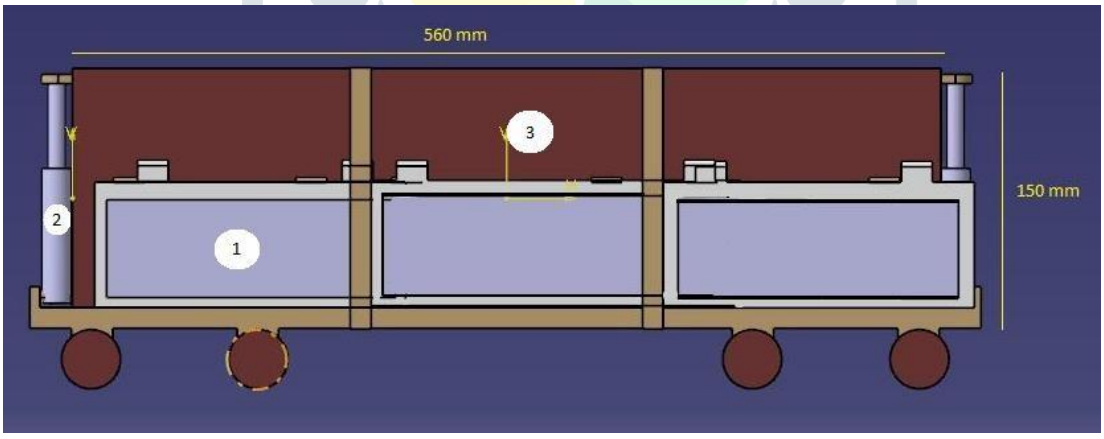

Fig.3. Front view

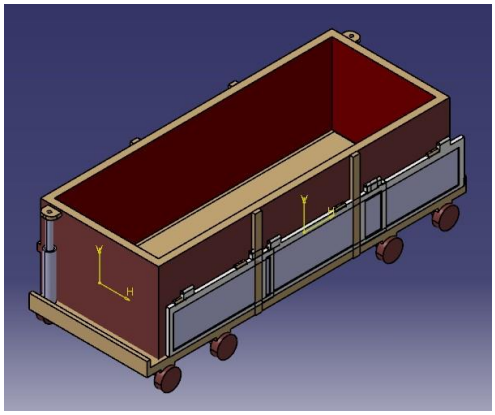

Fig.4 3-Dimensional view

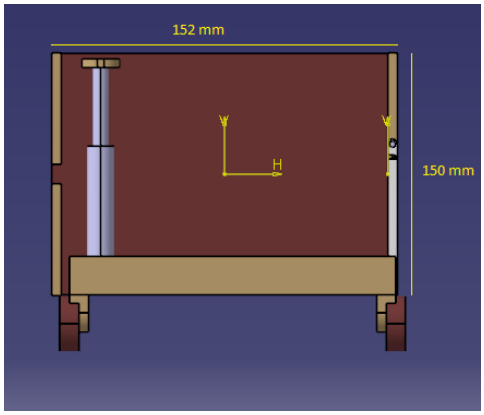

Fig.5 Side view

4. Conclusion

1) The unloading and maintenance cost is high and the dust particles are harmful for workers.
2) By using "self-discharge wagon" we are reducing the cost and time for material unloading.
3) In this method, the material can be unloaded without disengaging the wagons.
4) It also makes the operation easy to unload the Coal.
5) It may reduce the imposed penalties on the power plant due to time delay.

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