International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 11, pp: 42-46 www.ijaem.net ISSN: 2395-5252

# Study and analysis of hazards in pneumatic cylinder motion

Basher ahamed M[1], Muthukumar K[2]
[1]PG Student, Industrial Safety Engineering, Bannari Amman Institute of technology, Tamil Nadu, India
[2]Professor, Industrial safety Engineering, Bannari Amman Institute of Technology, Tamil Nadu, India

Date of Submission: 05-12-2020 Date of Acceptance: 20-12-2020

**ABSTRACT**:Numerous industrial applications require linear motion during their operating sequence. One of the least difficult and cost effective ways to achieve this is with a pneumatic actuator, often referred to as an air cylinder. Actuators are generally mechanical devices that take energy and convert it into some sort of movement. That movement can be in any structure, for example, blocking, clamping, or ejecting. This activity includes risks that may make minor significant injuries to operators, most usually crush injuries. Often we use to look into the forward motion of the cylinder has hazardous one than the reverse motion but actually the pneumatic cylinder has equivalent degree of dangers in invert movement as well, so it is important to reduce the risk in the reverse motion. In this work the study of pneumatic cylinder and hazards in motion of the cylinder is to be analysed and deciding the correct method to decrease the danger in the pneumatic chamber movement.

**KEYWORDS:**Actuator, Pneumatic cylinder, Light curtain Sensor, Reed switch, Hollow block, Reverse motion.

## I. INTRODUCTION

Pneumatic cylinders are usually utilized in many manufacturing industries especially in assembly units. The most well-known danger that are seen or experienced during working in the pneumatic presses are crush injuries, exposure to high noise etc. There are other concealed dangers that are able to make harm to the workers. Particularly the opposite movement of the cylinder which is usually not considered has hazardous than the forward movement. But many crush injuries also taken place by the reverse motion of the cylinder. In this work we are discussing about the hidden hazard and the control strategies which are as of now existing and other design modifications to overcome the hazard in reverse movement of the cylinder.

[1]. a technique for exact position control utilizing a pneumatic chamber driving device is introduced. To conquer the impact of friction force and transmission line, minimum friction type cylinder applied externally pressurized air bearing structure is utilized and two control valves appended both side of the cylinder directly.

[2]. control algorithm is proposed for the position and trajectory control of pneumatic actuators based on the sliding mode control approach. The stability of motion is proved for the case of a linear, time-invariant switching surface. A disadvantage of using sliding mode control for third- and higher-order mechanical systems is the need for acceleration feedback.

## II. SAFETY FUNCTIONS IN A PNEUMATIC SYSTEM

While designing a pneumatic system, there are five safety functions that must be considered.

- Protection against unplanned start-up
- Exhausting
- Holding, blocking and stopping
- Reversing the movement
- Reducing speed

**Protection against unplanned start-up**

The important safety consideration in pneumatic system is to protect against the machine which starting up accidentally. The most well-known approach to do this is with a pneumatic safety valve which has been worked for the reason, and ensured to the proper performance level(PL). For a basic solenoid valve is adequate, with a single valve component which will cut in. More complex valve developments are needed for applications, which will regularly require repetitive valve components to guarantee full security usefulness. A few items may have inbuilt gadgets for this capacity, while others may require a wellbeing PLC or relays to comply with safety requirements.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 11, pp: 42-46 www.ijaem.net ISSN: 2395-5252

**Exhaust or air pressure dump protection**

Exhausting of air tension in the system will presumably happen simultaneously as a sudden start up, . A pressure supply valve will close the air supply in case of any failure, forestalling overabundance pneumatic force developing in the framework. Simultaneously, pneumatic force inside the framework will be unloaded securely, although a manual exhaust can be used as a back-up. In the two-channel, three-valve framework that is ordinarily utilized with higher PL applications, the downstream stream will be more prominent than the input supply, so that downstream pressure can in any case be decreased to a protected level, regardless of whether the input valve neglects to stop. Later innovation is probably going to consolidate delicate beginning valves and position sensors to control accidental start up and pressure dumps.

**Holding, blocking and stopping**

Holding, hindering or halting operational gear is one of the key safety functions in a pneumatic system, and applies to a wide range of utilizations over a wide PL range. It could be as basic as introducing a pressure check valve in the cylinder port. The caught pneumatic air in the cylinder will hold the heap and ensure it can't move, and a pressure switch added to the circuit could give DC.

**Reversing cylinder movement**

In simple, low PL applications, this safety function can be accomplished in a pneumatic system by a spring-return solenoid valve. Higher PL applications will require a more robust solution, such as a servo-pneumatic unit. The other technique is the position of each valve element being sensed and transmitted to a safety PLC. This will ensure that the cylinder may possibly extend if both valve el components have moved.

**Reducing speed**

The easy way to implement the safety functions in a pneumatic system is reducing the speed. It requires the installation of simple flow controls that can be approved with the appropriate movement parameters. Tamper-resistant locks may be introduced to ensure these parameters are not adjusted.

## III. HAZARDS IN A PNEUMATIC SYSTEM

The risks exists in the pneumatic system are significantly ordered into two, one is during activity and other one is during development of pneumatic system. The dangers related with the activity of pneumatic system are viewed as high danger. The regular injury that occurs in the pneumatic workstation is crush injuries because of pinch point operation.

Types of pinch point injuries include

- Amputations
- Lacerations
- Crushing of tissues and bones, and broken bones.

During the reverse motion of cylinder there is possibility that hand may got crushed in between.

## IV. CONTROL OF HAZARDS IN PNEUMATIC CYLINDER

There are many existing control procedures and gadgets that are available today to decrease the danger in the cylinder movement. The current measures gives safe working of pneumatic system in the industries Pneumatic technology as of now incorporates a few safety features and parts to secure equipment and operators, to reduce down time, improve dependability and expand operational life. With the appearance of the Industrial Internet of Things (IIoT), pneumatics innovation is getting considerably more practical, with new abilities in following and estimation giving significantly more prominent knowledge into machine activity and the exhibition of parts and subsystems. With this extra usefulness comes a more extravagant occasion to monitor machine safety attributes and protect individuals and hardware from risk.

**Cylinder and actuator control**

Cylinder and actuators that hold tooling moving a vertical way can introduce an administrator squeezing danger and can harm the machine tooling on the off chance that they fall when air is released. To reduce or eliminate this safety risk, a locking gadget, for example, a pilot check valve or a mechanical obstructing should be utilized to hold the tooling in position during a crisis stop or force off condition.

A pilot check valve, when used to hold vertical tooling in position, traps air which is consistently a safety concern. The check valve should in this manner incorporate a manual relief to deplete the stored air for repair or maintenance purposes.

**Safety Light Curtain sensors**

Safety Light Curtain sensor are one of the most well-known protections for pneumatic press

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 11, pp: 42-46 www.ijaem.net ISSN: 2395-5252

machine work location (risk zone). Safety light sensor is utilized for protecting work force around numerous dangerous machines. Light curtain gives freedom, adaptability and decreased workers fatigue when compared with other guarding strategies.

**Restraint device**

The restraint (hold) gadget uses links or cables that are appended to the operators hands at a fixed point. The links or cables must be acclimated to let the operators hand travel inside a foreordained safe territory. There is no expanding or withdrawing activity included. Therefore, hand-feeding apparatuses are regularly fundamental if the activity includes setting and eliminating work piece in the press work zone (danger zone).

**Pullback device**

Pullback gadgets use a progression of links joined to the operator's hands, wrists, or potentially arms. This sort of gadget is essentially utilized on machines with stroking activity. At the point when the slide is up between cycles, the operator is permitted admittance to the press work region (danger zone). Pullback gadget not needed to utilize hand feeding tool placing and removing work piece in any case if use, it is extra safety control.

**Cushioning**

Compressed air can enter the cylinder at a fast phase. In the event that the cylinder hits the cap or head at rapid, it can prompt damage. To overcome that, most chambers are furnished with end-of-stroke safeguards/cushioning's, which diminish the cylinder's speed instantly before it arrives at the cover and thus reduces the impact of shock.

There are two ways to reduce the shock:

- Flexible shock absorbers
- Adjustable cushioning

**Magnetic reed switch**

Magnetic reed switch is an electromagnetic switch used to control the progression of power in a circuit. when the piston with the magnetic band passes under the pneumatic cylinder Reed Switch, the switch's reeds close a circuit to produce a sign that can be utilized to control an electrically operating systems.

**Fixed guards**

Fixed guards are basic, simple to give and cover parts as well as tossing particles if any. Guard opening and its distance from the dangerous part should be completely protected. Such dispersing and distance are endorsed and formulae are additionally accessible however it is a choice of individual requirement. They should be a fit, adjust and to withstand speed, vibration, impact. It should be appropriately fitted by clamps, bolts, and so forth requires special devices for their expulsion for extra safety.

**Cost effective block mechanism**

The idea of making hindering mechanism in the pneumatic cylinder is to decrease the dangers in the backward movement of the cylinder rod and also to be used by all organisations which can't give high end control system to give protection to the workstation. The expense of this obstructing component is less than the existing control methods. The block inside the cylinder limits the reverse motion of piston rod and subsequently makes the gap during home position.

**Design of block**

Hollow Block diameter = D + 20% of D

D- Diameter of the piston rod

Example: diameter of piston rod is 100mm then the hollow block selection would be

Hollow Block diameter = 100 + 20% of 100

= 120 mm

= 100 + 20

**Other control methods include:**

- Maintaining two hand control method by provide double hand reset and set button
- Hazard recognition training for workers
- Creating procurement policy that cover all safe systems in the machine

Example: extended piston rod with reverse control valves (5/2)

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 11, pp: 42-46 www.ijaem.net ISSN: 2395-5252

## V. RESULT

Comparative study and analysis of control method for pneumatic cylinder press machine

| Controls | Type | FORWARD motion | REVERSE motion | Possible deviations | Installation requirements | Cost |
|---|---|---|---|---|---|---|
| **Light curtain sensor** | Requires additional source of energy to control the process (electric) | Provides protection from pinch point injuries in forward stroke operation | Provides protection from pinch point injuries by interlocking mechanism | possibility of a power source related malfunction | Highly skilled technician required | 10000 – 25000 INR Approx. |
| **Reed or Magnetic switch** | Requires additional source of energy to control the process (electric) | No protection in forward stroke operation | Can control the flow of piston rod in reverse stroke operation thus provide protection from injuries | If a magnetic object is placed close to it, the actuator could operate suddenly, which could pose a hazard to humans.<br><br>Can be easily adjusted | Moderate skilled person with knowledge on circuit is adequate. | 500 – 2000 INR Approx. |
| **Fixed guard** | No source of energy is required to protect from hazards | No protection in forward stroke operation | provides protection in reverse stroke operation | Deliberated act or sharp edges in the guard creates hazard | It is not required always expertise or skilled person | 200 – 1000 INR Approx. |
| **Blocking mechanism** | No source of energy is required to protect from hazards | provides no protection in forward stroke operation | provides protection in reverse stroke operation | Wear and tear inside the cylinder can damage the seal and cause air leakage which could result in accidental drop of the load | It is not required always expertise or skilled person | 20 – 100 INR Approx. |

**COMPARATIVE STUDY AND ANALYSIS OF CONTROL METHOD**

The advantages of block mechanism are

- ✓ Easy to install
- ✓ No external disturbance or factor that affects the performance
- ✓ Suitable for existing operation wherein major cannot be done
- ✓ Can give effective protection during reverse stroke of cylinder operation
- ✓ Quick and effective control method when other means of control need time to install

## VI. CONCLUSION

There are numerous ways to enhance safety in the pneumatic system with its own cost and requirements. The means of cost effective and easy to install and repair are most demanding way of safe system in pneumatics actuators. To have a safety control in the pneumatic cylinder first we should understand the operation that the cylinder is going to perform and the ultimate output that is produced from the operation and overall cost involved in the operation. By having all this in consideration the right choose of control has to implement.

We are continually attempting to accomplish the right balance between giving a safe machines that satisfies industry guidelines and one that is not all that prohibitive that the end user finds the machines difficult to use if it is excessively prohibitive, at that point the end user will override safety devices for everyday tasks, prompting a dangerous working condition. To accomplish the right balance requires a multi-discipline way to deal with machine safety and usability. Mechanical, electrical and programming must be used together to make the machine safe and easy to operate.

## REFERENCES

[1]. Jang, J., Byun, J. A method of accurate position control with a pneumatic cylinder driving apparatus. J MechSciTechnol 20, 993–1001 (2006).

[2]. Pandian, S. R., Hayakawa, Y., Kanazawa, Y., Kamoyama, Y., and Kawamura, S., 1997, "Practical Design of a Sliding Mode Controller for Pneumatic Actuators," ASME J. Dyn. Syst., Meas., Control, 119, pp. 666–674.

[3]. Situm, Z., Pavkovic, D. and Novakkovic, B., 2004, "Servo Pneumatic Position Control Using Fuzzy PID Gain Scheduling, "Journal of Dynamic Systems, Measurement and Control, Vol. 126, pp. 376–387.

[4]. LaiJ. Y., MengC. H., and SinghR., 1990, "Accurate Position Control of a Pneumatic Actuator," ASME JOURNAL OF DYNAMIC SYSTEMS, MEASUREMENT, AND CONTROL, Vol. 112, pp. 734–739

[5]. Najafi, F., Fathi, M. &Saadat, M. Dynamic modelling of servo pneumatic actuators with cushioning. Int J AdvManufTechnol 42, 757–765 (2009).

[6]. Messina A, Giannocaro NI, Gentile A (2005) Experimenting and modeling the dynamics of pneumatic actuators controlled by the pulse width modulation (PWM) technique. J Mechatron 15:421–444

[7]. Ahn K, Yokota S (2005) Intelligent switching control of pneumatic actuator using on/off solenoid valves. J Mechatron 15:683–702.

[8]. T. Muto, H. Yamada and Y. Suematsu, "PWM-digital control of a hydraulic actuator utilizing two-way solenoid valves", J. Fluid Control, vol. 20, no. 3, pp. 24-41, 1990.

[9]. B. W. Surgenor and H. N. Iordanou, "Experience with advanced position control of pneumatic systems", IFAC Workshop: Trends in Hydraulics and Pneumatics, 1994-Nov.