Electro mechanical control systems essay example

Health & Medicine, Stress

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Analysis of system diagram

Linear actuators favor movement of an object in an exact straight line. Now let us discuss about the system diagram of a simple molding machine. The simple machine has three linear actuators one being used for opening and closing of mould, the second being used for the barrel movement, the third for injecting polymers.

Fig1. 1 represents the block diagram of a simple molding machine. As mentioned before, it has three linear actuators. The linear actuator1 as shown in fig1. 1 controls the opening and closing of the mould. Once the mould is closed, the barrel can be moved forward or backward. This barrel movement is controlled by linear actuator 2 as shown above. For injecting polymers, linear actuator 3 is used. When the barrel is moved forward, the

linear actuator 3 can be moved forward or backward for injecting polymers. When the molding is done, the part can be expelled. Different types of linear actuators are available such as pneumatic linear actuators, hydraulic actuators, and electromechanical actuators. A closed loop control system is proposed for the molding machine to make it operate effectively.

Control system

Any electromechanical device has a considerable loss while operating. The basic formula for any electrical device is Input power = Output power + losses. Thus, power supply is important input for a device that should match the load requirements and the losses. Filters are generally used to minimize the losses. A filter reduces the fluctuations and it tries to produce a steady direct current output. Current limiting units are used in vast to protect the device. It also helps in reducing the motor torque correspondingly speed control is achieved. The basic fact behind this technique is that, current is directly proportional to torque and torque is inversely proportional to speed. Hence, speed control is achieved through current limiting units.

Speed Control

Figure 1. 2 shows a closed loop control system for a simple molding machine where the movement control can be achieved by giving negative feedback signals to the respective blocks.

Electronic control circuit for molding machine

The best part of control unit is that, it controls the injection flow of polymer into the mould. It compromises pressure flow, quantity and direction of polymer to obtain the desired mould. The tank that stores the polymer

should be flexible enough to adjust the initial pressure and the speed at which direction the barrel moves. If the barrel is moved at very high speed, there will be a tremendous loss due to friction. This friction loss leads to decomposition and color change of the molded parts. On the contrary, the gas in the mould cannot be discharged out free resulting in the formation of air bubbles. This air bubble makes the molded part weak and it cannot be used. During the injection of polymer through the barrel, the pressure should be maintained, so that, controlled molding is ensured throughout the process. In this control circuit, as shown in fig1. 3 the control switches are placed to ensure proper ejection and injection of polymer. Most of the time, ejector unit is placed for easy ejection of polymer at a controlled rate. The applied force while ejecting should be uniform to get a smoother product. Adding to this, the ejector pin should be adjustable. A timer control is also made available in the control circuit (that is not shown in fig1. 3) to have proper opening and closing of the mould. During opening of the mould, the molded part can be expelled with proper application of ejection force. Timers are used to maintain accurate timing as human control is not accurate which might lead to the material waste. Statistics shows that earlier in the case of manual molding the productivity was about 200 jobs, whereas with the use of programmable logic controller (PLC) the productivity heightens to 300. PLCs used are robust in nature and also it is a cost effective use. On the either side, timers used in manual molding are less accurate and also it has vibration hazards. Use of PLC helps in reducing the wiring cost and troubleshooting is made easier. Hence, PLCs are preferred to hardware timers used in the control circuit. Calibration is another important criterion in

case of manual molding machine. Each time when the molding is about to start, timers has to be calibrated in order to achieve accuracy and precision. In the case of PLC, since it is a programmable device, the user can load the program in to the memory when the product is changed. Thus, control circuit is most essential for the effective operation of a simple molding machine as it results in high efficiency, high productivity and high response time.

Pneumatic circuit

The pneumatic action is described as the conversion of the pressurized or compressed air into linear force. From the fundamental study of physics, we have learnt that

Force = Applied pressure * area Nm

Also, the general gas law states that

P1V1/T1 = P2V2/T2

Buoyant force of about 5500 N is produced by electromechanical linear actuator. With the help of proximity sensors and LPSOs along with a controlled feedback, pneumatics favors locomotion from a source point to the desired point. Pneumatic circuits protects from contamination and other hazardous adherents. The main drawback of using pneumatic circuit is that the pressure loss and air compressibility makes it less efficient compared to other technologies. A pneumatic circuit generally operates at low pressure aiding low forces that reduces the efficiency of the product. The pneumatic circuit for the molding machine is shown in fig1. 4. Compressed air from the air compressor is taken to the filter regulator and stainer circuit. We are using three double acting cylinders for our problem and in order to control

the air flow three number of 5/2 direction control valves are used. One for would opening and closing, one for barrel movement and the other one for injecting the polymer.

Speed control of Linear Actuators

Software holds the key in the speed control of linear Actuators. Most of the electric motor drives are controlled either through SCADA (Supervisory Control and Data Acquisition) or through PLC. M-228 series linear actuators are the most popular actuators used across the industries. Linear actuators also find applications in micropositioning, nanopositioning of semiconductors in electronic industries and used in fabrication process. The M-228 linear actuator along with the help of C-663 controller helps in achieving the smooth speed control with an appealing resolution of about 46nm. It can carry the loads about 20N. This feature supports non-rotating tip, reference switching and mechanical position display. This non-rotating tip feature supports the elimination of torque-induced positioning errors, sinusoidal movement errors, tip-angle dependent coggle. Hall Effect plays a major part in electric drives that can easily be controlled using reference switches.

Conclusion

Thus, a design of simple molding machine using three linear actuators along with control circuit is seen. The control unit plays a significant role in achieving energy saving also to obtain a high quality molded part. The timer control is enhanced using programmable logic controller which promotes higher efficiency.

Reference

- Performance and work capacity of a polypyrrole conducting polymer linear actuator

A Della Santa, D De Rossi, A Mazzoldi – Synthetic metals, 1997 – Elsevier

- Characterization and Modeling of a conducting polymer muscle-like linear actuator

A Della Santa, D De Rossi, A Mazzoldi – Smart Materials, 1997

- Hydraulic booster device for linear actuator

JJ Wright – US Patent 5, 205, 200, 1993 – Google patents

- A dynamic Model of a linear actuator based on polymer hydrogel

D Brock, W Lee, D Segalman- Journal of Intelligent1994

- Shape memory alloy internal linear actuator for use in orthopedic correction

A Carl, MM Chen, KC Craig, JA Fairweather – US Patents – 1996 Google Patent

- The fabrication of electrostatic linear actuator by silicon micromachining

H Fujita, A Omodaka – Electron Devices, IEEE Transactions – 1998

- Manifold-mapping optimization applied to linear actuator with permanent magnet armature

JJ McGonigal – US patent 4, 259, 653 – 1981 – Google patents