Automated Compressed Air Control System

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Abstract- *Gravity die casting method is competitive casting method when production quantity is relatively small or when heat treatment is needed to improve the mechanical properties. This casting method gives better tolerances and surface finish than sand casting. The tooling costs are somewhat higher than by sand casting.*

In this we are going apply an automation system for the opening and closing of compressed air input valve by means of current position of dies. When die will be opened the supply of compressed air will be off and when die will be closed again the supply will be started again.

Keywords- Automation, die casting, heat treatment, tolerances, sand casting.

I. INTRODUCTION

GRAVITY DIE CASTING

Casting process in which the melt is poured from a pressurized pouring furnace via a riser tube into a permanent mold (die). This process is mainly used in the production of light metal castings, particularly those made from aluminum casting alloys (see Low pressure casting plant) but also those made of magnesium alloys (magnesium low pressure casting plant) with a casting weight of around 1 to approx. 70kg. However, there are also plants for heavy metal casting (brass casting). This process is widely used in the production of aluminum wheels. The production of castings with complex designs is possible using the low pressure casting process, examples are: crankcases, cylinder heads, pump casing and chassis parts.

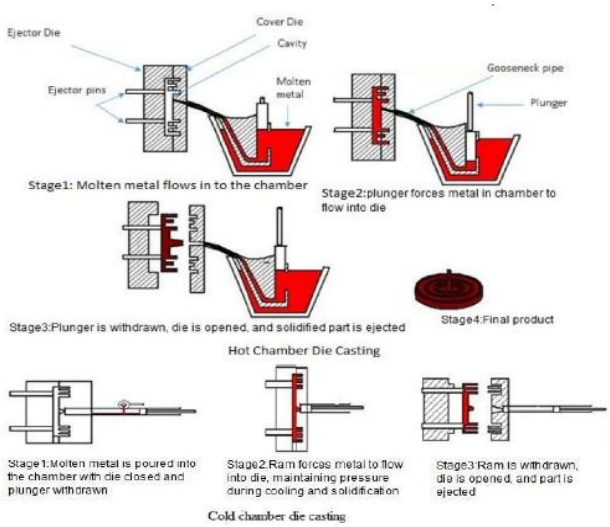


Fig.1 Die casting process

II. LITERARURE SURVEY

Ishrat Meera Mirzana [1]: We focused on the very practical, safe, economical and rewarding strategies i.e. the application of LOW COST AUTOMATION. In Industry which uses of automation, a sequence is followed in the manufacturing of number of products of the same kind and thus chance for Automation. In our research we have achieved low cost automation through a Programmable Logic Controller. It is used to replace the necessary sequential relay circuits for the control on the devices. In automated system, PLC is usually the central part of the control system.

F. Bonollo, J [2]: Among the innovative and conventional foundry processes for Aluminium alloys, low pressure die casting is characterised by several advantages, including high yield, excellent control of operative parameters, good metallurgical and technological quality. This process is often (and incorrectly)associated only to the production of automotive wheels, while it is improving its potential both towards other automotive components and non-automotive parts. The paper is aimed at showing the potential of low pressure die casting for the production of safety boxes, to be employed in chemical, petrol and off-shore plants.

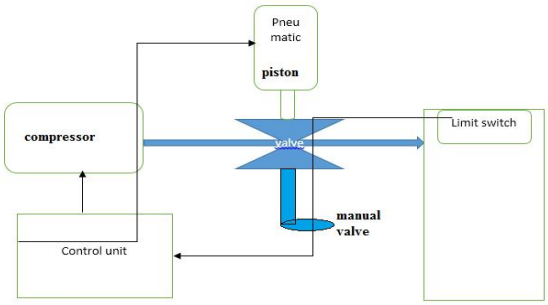
III. SYSTEM DESCRIPTION

The compressed air is received from the compressed air storage i.e. pneumatic compressor. This compressed air is flown through hoses to the check valve i.e. non return valve. Thus it enters to the pneumatic actuator. The working of limit switch is done by microcontroller.

The position of dies at instance of when the dies is closed is sensed by sensor which sends it the analog to digital convertor.

The ADC converts the data from analog to digital and sends it to the microcontroller.

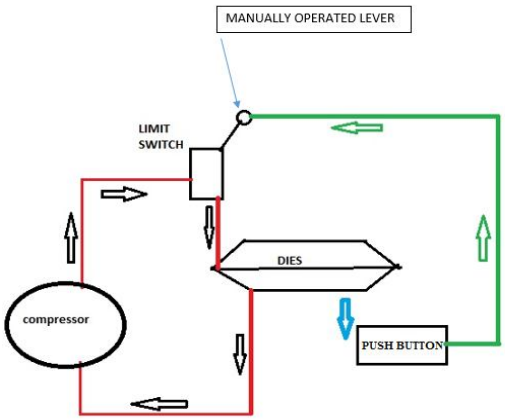
The microcontroller reads the data from ADC and displays the data as per the position of dies i.e. the dies are open or closed.
Thus the path of input to the controlling system is handled to give the output of display that the dies are open or not and according to the position of dies the limit switch will act and open or close the compressed air supply to the dies.



Later on receiving data from the microcontroller the microcontroller sends the data to the relay and gives the input to the relay to actually give the signals to the limit switch.
The relay gives the signal to close the supply of compressed air if the dies position is open as sensed by the sensor. And vice versa if the position of dies is closed.

Thus when limit switch receives the data to cut off the compressed air supply from relay, it actuates a pneumatic actuator which pushes the limit switch to off position i.e. the supply of compressed air to the dies is closed.

The working of limit switching to on or off the compressed air supply may be automatic by use of pneumatic actuator or may be done by manual help who will on or off the lever switch by seeing the display on the microcontroller that the position of dies is open or closed.



V.CALCULATION

Specification:

Outer diameter=d_o=10mm
Pitch=p=3mm
Here using acme threads;
β=14.5
μ=0.15
pressure load=5 kg
motor RPM=30
μ_2=0.12 for collar

1) Calculation of lead screw:

We know that mean diameter of the screw:

$$d=d_o-\frac{p}{2}$$ **……..(khurmigupta)…… ……(1)**

$$d=10-\frac{3}{2}$$

d=8.5mm

2) $$\tan\alpha=\frac{p}{\pi*d}$$ **…….(2)**

$$\tan\alpha=\frac{3}{\pi*8.5}$$

tanα=0.11

3)Virtual coefficient of friction :…… ref-R S khurmi page no 643

$\mu_1=\tan\varphi_1$ …….....(3)

$$\mu_1=\frac{\mu}{\cos\beta}$$

$$\mu_1=\frac{0.15}{\cos 14.5}$$

μ_1=0.15

4)We know that the force required overcoming friction of the screw:

$P=w*\tan(\alpha+\varphi_1)$

$$P=w*\frac{(\tan\alpha+\tan\varphi 1)}{(1-\tan\alpha*\tan\varphi 1)} \text{.....(4)}$$

Where w=axial pressure load

w=5*9.81

w=49.05 N

Therefore; above value add in equation no.(4)

$$P=(49.05)*\frac{(0.11+0.15)}{(1-0.11*0.15)}$$

power=0.27318 kw

P=13N

5) Torque required overcoming friction at the screw(T_1):

$$T_1=p*\frac{d}{2} \text{.....(5)}$$

$$T_1=13*\frac{8.5}{2}$$

T_1=55.25N-mm

6)Power required to drive the screw:

power=T*ω

$$\text{power}= T*\frac{2*\pi*N}{60} \text{.....(6)}$$

$$\text{power}= T*\frac{2*\pi*30}{60}$$

.....(N=30rpm…..given in specification)

Where $T=T_1+T_2$

Uniform wear,

Torque required to overcome friction at bottom(T_2)

$T_2=\mu_2*w*R$

.....(7)

Hole on plate radius=6

Radius of threads =5

$$R=\frac{6+5}{2}$$

R=5.5 mm

The above 'R' value add in equation no(7)

T_2=(0.12)*(9.81*5)*(5.5)

T_2=32.37 N-mm

Now value of T_1 &T_2 add in equation $T=T_1+T_2$

Therefore;

T=55.25+32.37

T=87.62 N-mm

T=0.087 N-m

Therefore value of 'T' add in (6) equation and fine the power value.

$$\text{Power}=0.087*\frac{2*\pi*30}{60}$$

7) Efficiency of the lead screw:

We know the torque required to drive the screw with no friction.

$$T_0=\frac{W*\tan\alpha*d}{2}$$

.....(8)

$$T_0=\frac{49.05*0.11*8.5}{2}$$

T_0=29.23 N-mm

Therefore efficiency

$$\eta=\frac{T0}{T}$$

$$=\frac{22.93}{87.62}$$

η=26.16%

VI. CONCLUSION

We Designed and developed an automated system for opening and closing a compressed air supply valve with respect to the position of dies used in die casting method of foundries and forging industries. We also built a prototype model of the same which will show the working of automatic compressed air supply to the die casting set up with respect to the position of dies.

Use pneumatic actuator system to on-off the limit switch and compressed air supply valve provide extra accuracy and higher precision. The whole system is monitored by electronic control unit. The electronic control unit is 8051 microcontroller based circuit which triggers the whole system to operate the actuator and compressed air supply. We propose a low cost automation system to industries that will shut-off and start the compressed air supply with respect to dies position i.e. open or close which will implement into cost and energy conservation. This system will reduce the wastage of compressed air energy. It also avoids accidents and problems caused when compressed air supply is on at time of die are open. Which will provide a safe working environment.

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