

LOW COST INJECTION MOULDING –SHAPING OF CERAMICS

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applications. It is actually a combination of powder metallurgy and plastic injection moulding.

Abstract-In the last few decades Injection moulding has emerged as a promising route for shaping of ceramics. However it is full of challenges with respect to the technology and also with the machine being used. In India very little research has been done in this field –one of the major concern is the machine itself. This paper is based on a project in which we tried to make a low cost semi automatic injection moulding machine. The machine was successfully made and ceramic parts have been processed using the machine.

Ceramic injection moulding has over the past decade established itself as a competitive manufacturing process for small precision components which would be costly to produce by alternative methods. It is capable of producing parts in both large and small volumes, of complex shapes from almost all types of materials including metals, ceramics, inter-metallic compounds, and composites. The aim of this project was to design and fabricate vertical plunger type hydraulically operated

I. INTRODUCTION

Ceramic injection moulding (CIM) is a process which is used to create small, complex metal parts in high volumes for use in a variety of industries and machine so as to have following advantages:

- Installation floor space is about one half space as compared with horizontal machine with same capacity.
- Plastic-ceramic combined part moulding is facilitated by the machine.
- Durability of alignment of a mould clamp-unit and the mould in the vertical machine are much superior to that in the horizontal machine, because the heavy mould is supported on the horizontal mould platen in the vertical clamp-unit

A. Design

The pressure requirements for injection of ceramics being high it was decided to chose a hydraulic system. The injection process was to be hydraulically driven. The design considerations are presented below:

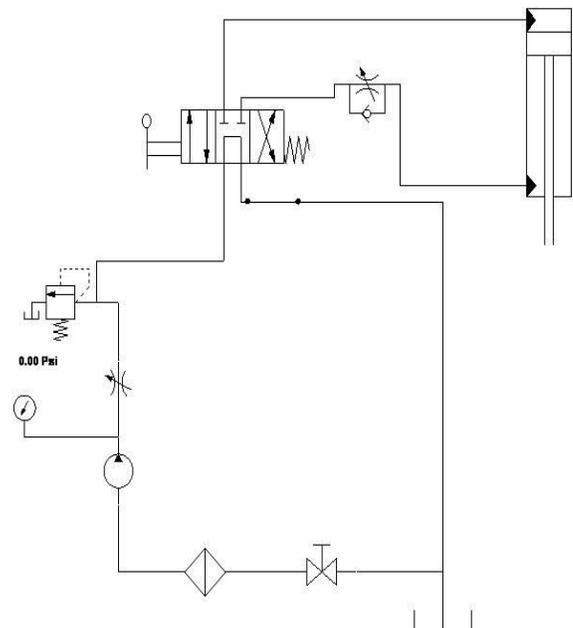


Fig.1. Circuit Diagram Of Hydraulic System

B. Hydraulic cylinder

Injection Pressure [p] * c/s area of injection chamber [a] = hydraulic pressure [P] * c/s area of hydraulic cylinder [1]

$$P A = p a$$

$$\text{Required injection pressure [p]} = 3000 \text{ psi} = 211 \text{ kgf/cm}^2$$

From Calculations,

Diameter of hydraulic cylinder = 4.096cm
Therefore Diameter chosen = 5 cm.

C. Selection of Pump rating

We know that Flow rate [Q] = cross-sectional area of hydraulic cylinder * Velocity
Velocity = distance travelled / injection time

Therefore Velocity = 6.6667 cm/second

$$\begin{aligned} \text{cross-sectional area of hydraulic cylinder} &= (\pi / 4) * (\text{dia. of hydraulic cylinder})^2 \\ &= 19.625 \text{ cm}^2 \end{aligned}$$

$$\begin{aligned} \text{Flow rate [Q]} &= 130.833 \text{ cc /second} \\ &= 7.8 \text{ lpm} \end{aligned}$$

Thus, we selected a gear pump of maximum discharge capacity of 10 lpm.

D. Calculation of motor power:

$$\begin{aligned} \text{POWER} &= (\text{PRESSURE} * \text{DISCHARGE}) / \text{EFFICIENCY} \\ &= 3.68 \text{ hp} \end{aligned}$$

Assuming efficiency = 85 %

Power = 3.1 hp Since the motor will not be operated continuously, selecting a standard motor of rating 3 hp, squirrel cage 3-phase induction motor operating at 1430 rpm.

E. Analysis of injection chamber

The injection chamber assembly which comprises of injection chamber, sprue and the gullet are subjected to following stress.

Thermal stresses on the walls because of the presence of band heater around it.
Stress on the exterior walls because of the presence of the torsional spring mounted in between the hopper and the chamber clamp.
Inside walls of injection chamber and the gullet nose is subjected to maximum injection pressure of 3000 psi.

With the above available data and 3-D model of assembly, the drawing in .igs format was imported to SOLIDWORKS /COSMOS for its brief analysis.

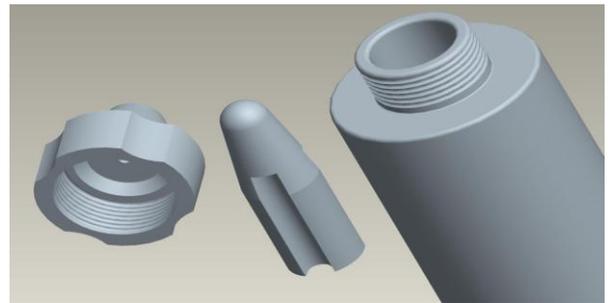


Fig.2. 3-D Drawing Of Injection Chamber Assembly

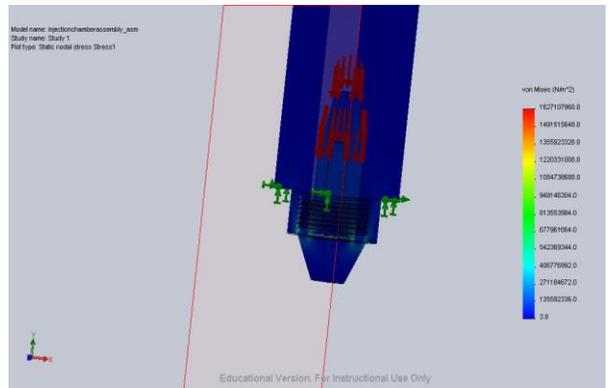


Fig.3. Stress Analysis of Injection Chamber

Above figure shows the injection chamber assembly meshed and subjected to various above mentioned stresses. The figure given below gives us a possible indication of failures at various points in the assembly after looking at the colour coding which now indicates the different stress values. Since no point in the analysis turn red, the design is safe in operation for the various forces subjected to it.



Fig.4. Fabricated injection molding machine

- [1] Peter Rohner- Industrial hydraulic control –
- [2] Industrial hydraulic technology and hydraulic maintenance technology –
- [3] [Parker Hannifin Corporation, fluid power training dept].
- [4] Vicker's manual - (hydraulics).
- [5] William D. Callister Fundamentals of Material Science and Engineering

III. FUTURE SCOPE

The present hydraulic power pack can be modified such that both clamping and injection process will be linked which will achieve semi-automation.

Provision for a control panel will enable us to vary the injection pressure and the clamp pressure.

The basic frame design can be modified. New innovative designs for the frame are possible accounting the aesthetic and the ergonomic consideration.

IV. CONCLUSION

Various trial runs were performed on hydraulically operated machine to check its feasibility and confirm its working. We were successful in our trial runs for our machine. Trial runs were performed with high impact powder, low density polyethene(LDPE).

After accomplishing the task of design and fabrication of our machine, testing of various materials has been successfully done. Plastics and Ceramic parts have been produced with the machine.

REFERENCES

