Design, Manufacturing and Analysis of Rubber Compression Mould

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Abstract— Rubber is one of the materials which can be used dueto its conforming properties according to the requirements. But, major problem arising with rubber parts is that it is very difficult to form or manufacture rubber parts with accurate dimensional properties. Molding is the most common manufacturing process used for working with rubber. Compression molding is a well-known technique to develop the required product from rubber. It is a closed molding process with high pressure application. In this method, two or more matched metal moulds are used to fabricate product. Design of these moulds is largely depend upon the controlling parameters of compression molding method which are applied pressure, temperatures developed and molding time. This design, manufacturing and analysis of the mould can be done with the help of modeling and simulation software.

Key words: Compression Mould, Gasket, Rubber

I. Introduction

Compression molding is a well-known technique to develop any product from variety of materials. It is a closed molding process with high pressure application. In this method, as shown in two or more matched metal molds are used to fabricate composite product. In compression molder, base plate is stationary while upper plate is movable. Raw material is placed in the metallic mold and the whole assembly is kept in between the compression molder. Heat and pressure is applied as per the requirement of material for a definite period of time. The material placed in between the molding plates flows due to application of pressure and heat and acquires the shape of the mold cavity with high dimensional accuracy which depends upon mold design. Curing of the material may carried out either at room temperature or at some elevated temperature. After curing, mold is opened and product is removed for further processing. In principle, a compression molding machine is a kind of press which is oriented vertically with two molding halves (top and bottom halves). Generally, hydraulic mechanism is used for pressure application in compression molding.

II. Literature review

Orhorhoro et al [1] explained the basic concept of the compression molding method. In this paper, along with the information of basic compression molding machine, he discussed about operation of compression molding, primary factors of compression molding, and critical process parameters of compression molding method, conceptual design, functional requirement and design parameter. He studied the flow characteristics of the material to be used. According, the study and mathematical modeling of the thermal parameters as well as pressure requirements is done. With the results of the tests performed, a basic design of compression molding machine is given here. Test performance was carried out on the fabricated compression molding machine. Polythene materials in pellet and small size particles were completely melted between 2000C to 2200C. The time to melt and mold forming were taken note of respectively. The machine was designed, fabricated and assembled from locally available raw materials. The machine fabricated in this paper consists mainly of threaded screw, hopper, heater, heating chamber, forming chamber, steel frame, and control switch.

Skrobak et al [2] demonstrated what influence has a change in production technology on mechanical properties of rubber testing samples. He compared two basic production technologies compression molding and injection molding. The aim of this research was to show and evaluate to what extent the properties (tensile strength, extension, tear strength and micro hardness) are influenced by the used production technology and to quantify this potential difference on the basis of standard tests. The mechanical tension test according the standard ISO 37, the test determining tear strength according to the standard ISO 34-1 and the instrumented micro hardness test (DSI) according to the standard ISO 14577. It compares two basic production technologies compression molding and injection molding. The aim of this research is to show and evaluate to what extent the properties (tensile strength, extension, tear strength and microhardness) are influenced by the used production technology and to quantify this potential difference on the basis of standard tests. The mechanical tension test according. The performed tests and measured values show that the different technology of production of rubber samples has an impact on their mechanical properties. The injection molded test samples show smaller force to tear, hardness and elastic modulus. The given results show that mechanical properties of rubber test samples will have a significant effect behavior in micro-volume. The rupture of structure in micro-regions will gradually expand an avalanche of other small cracks that lead to total breakage of the sample.

Bickerton and Abudullah [3] studied injection and compression molding which are closed mould polymer composite manufacturing processes. Analytical solutions to simple flow geometries have been utilized to explore the potential benefits of molding methods. A series of parametric studies were presented, considering the effects of process parameters on mould filling times, and internal tooling forces. Two modes of compression flow are considered, constant speed, and constant force. While significant reductions in fill time can be achieved, these gains are balanced by increased clamping force, or increased internal stress applied to the mould. Constant force compression is shown to minimize fill times, using the full capacity of the clamping device. An experimental study was completed to verify the applied models. Comparisons to predicted fluid pressure histories are very good, verifying the applied pressure governing equations. Total clamping force predictions have shown important qualitative differences, which have been related to the use of elastic preform deformation models. Significant viscoelastic stress response was exhibited by the reinforcement studied, in the absence of any resin. Due to the similar time scales of mould filling and preform stress relaxation behavior, viscoelastic deformation models are required to improve filling simulations. The paper presented the analytical solution to simple flow geometries have been utilized to explore the potential benefits of compression molding, also presented the prediction of mould clamping force during the compression stage.

Odenberger et al [4] presented an experimental visualization of flow during mould closure in compression molding. Special attention is given to the advancing flow front, for which the full complexity is captured by means of continuous high resolution close-up monitoring. From the experimental visualization of the flow front, three phases are defined, namely squish, flow, and boiling. During the initial phase, squish, outer layers do not remain outer layers, the actual flow is very complex and air is likely to be entrapped. The governing process parameters during this phase are mould temperature, mould closing speed and amount of preheating in the mould. During the second phase, flow, the flow is stable and seemingly viscous. During the last phase, boiling, bubbles are observed in the low pressure region at the flow front, favoring the void content both internally and on the surface. To summarize, two mechanisms for void formation during compression moulding of SMC have been identified; entrapment during the initial phase of pressing and boiling in low pressure regimes. Adjusting the pressing speed and/or the temperature on the mould halves did only change the pattern of the squish and the intensity of boiling. Based on earlier studies on processes such as RTM, the best solution to minimize the void content would be to evacuate the mould before and during the initial phase of pressing and then secure a high level of pressure all over the part when the mould has been filled.

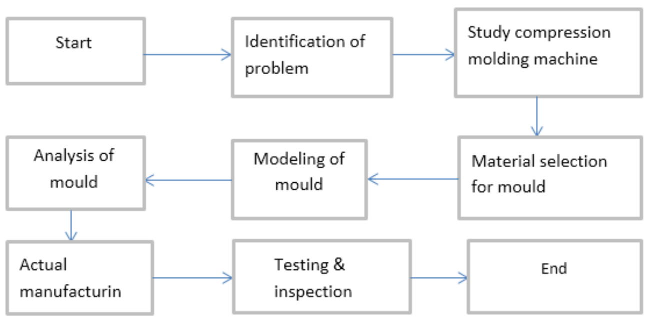
Hocine et al [5] analysed fracture of rubber-like materials by the cavitation phenomenon has been experimentally and numerically. Specific disc-shaped samples, called pancake specimens, were experimentally tested under uniaxial tension. Because of the particular geometry of such specimens, high stress triaxiality seems to be generated in the bulk of the material, increasing the hydrostatic stress and, therefore, leading to the cavity nucleation. In fact, fracture surfaces exhibit void footprint suggesting that the total rupture of the specimen happened by the nucleation and growth of cavities. The volume fraction and size of the observed voids depend on the specimen shape factor. In fact, increasing the shape factor of the specimen allows the occurrence of small cavities uniformly distributed through the fracture section. However, when this factor decreases, the density of voids decreases while their size increases. Moreover, it has been proved, by measuring the specimen volume variation, that the apparition of a critical fraction of cavities is accompanied by a slope break of load–displacement curves. This slope break is very marked for high shape factor values. In the future, improvements in the detection of the void nucleation will be very helpful. It will be also interesting to develop methodologies allowing analysis of cavitation in elastomers by taking interaction effects between fillers into account.

Davide and Focatiis [6] presented several designs for flash moulds intended to aid the damage-free production of polymeric specimens for mechanical and structural characterisation. The designs was consisting of interlocking metal parts that produce appropriately shaped cavities in which polymer specimens are moulded, and that are easily dismantled after moulding to allow removal of the specimens from the moulds. Very limited sample preparation is required after removal of the specimens. Several of the proposed designs have been manufactured and successfully employed in the production of rectangular specimens for characterisation of a range of polymers. In this paper, they proposed a series of designs for the manufacture of tooling suitable for near net-shape compression moulding that specifically addresses all issues by virtually eliminating the need for postmoulding specimen preparation prior to testing. The introduction describes the process of compression-moulding, including mould design and the important thermal transitions of the polymers involved. The design of a range of novel moulds for near net-shape specimen production is then presented. They then reported on their own experience in manufacturing and utilising the novel mould designs for the production of specimens from a range of polymeric materials, and discussed the implications of those observations. This study has presented a range of designs for the

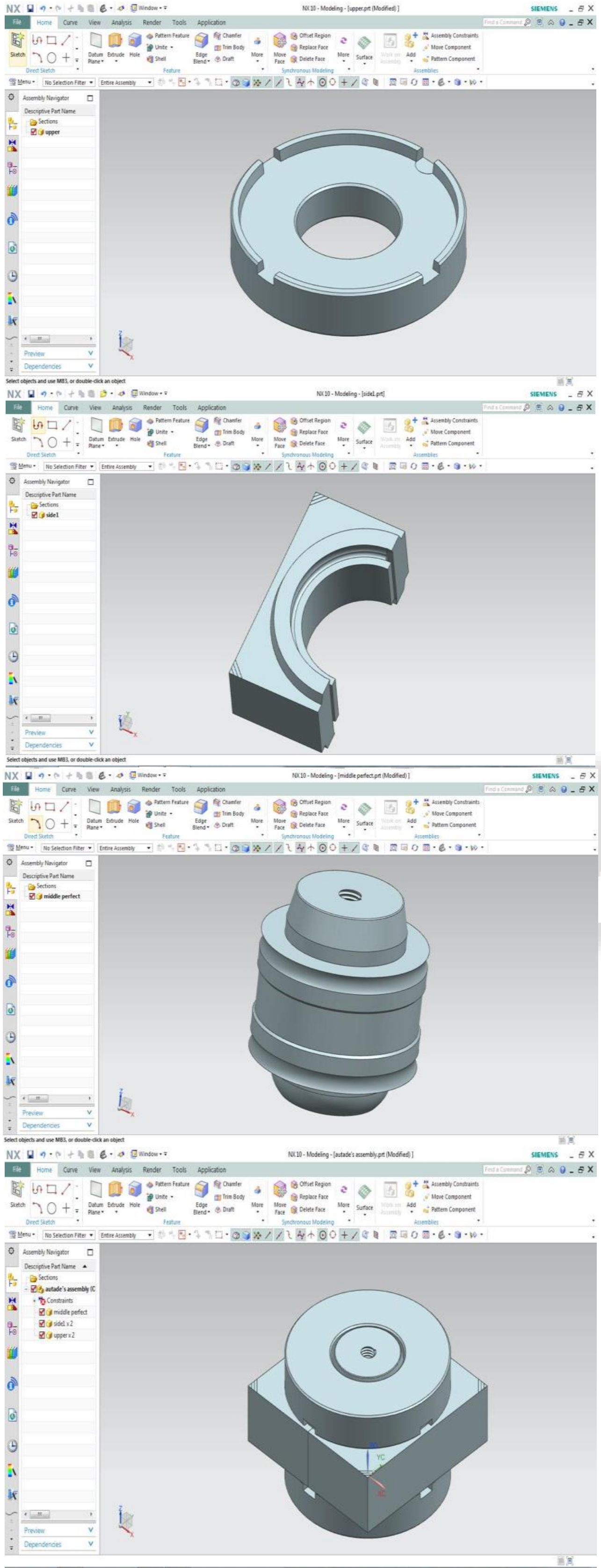
III. PROBLEM STATEMENT

Dimensional accuracy of molded silicone rubber parts is very important and in such cases, the design of the mould must allow for shrinkage of the parts. Linear shrinkage values can be obtained from test molded samples of flat rubber sheets and can be used as a rough guideline to mould design values for very simple parts only. Analyzing the above properties of given silicone rubber sample and mould parameters, we have to design and manufacture the rubber compression mould for seal packing gasket used in aircraft.

IV. METHODOLOGY



V. DESIGN



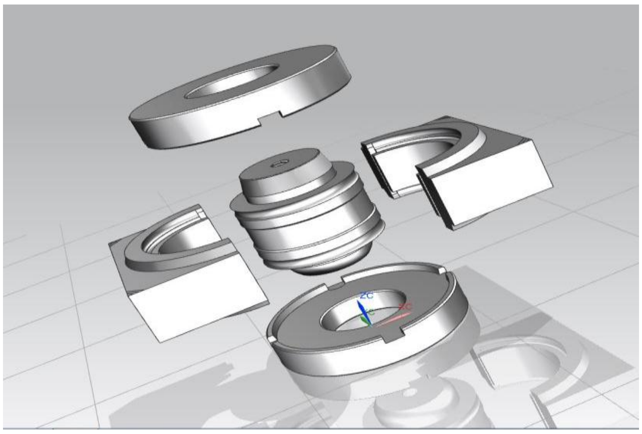


Fig. No1:-Drawing on actucal model

VI. CONCLUSION

From the chapter of validation, using various software we can conclude that a mould for the desired rubber product is withstanding in all the working conditions. The objective of the project was to manufacture a mould for a rubber product as per given dimensions. In this project, we studied various moulding techniques used for manufacturing of polymer products. According to the desired properties of product, compression moulding process was appropriate. Using various research papers and mould guides we studied the methods of mould design. Pre design work such as modelling of desired product in geometric modelling software was helpful in visualization as well as for mould shape finalization. Considering the shrinkage of rubber sample at working conditions, dimensions of the mould were fixed. This mould was analysed using software to find out maximum stress induced in all parts during the moulding process. Drafting of the mould after analysis was important in manufacturing point of view. Manufacturing processes used and parameters of that process were specified and planned in process planning sheets. The rubber product moulded using this manufactured mould was found to be having uniform properties along all the cross sections which can be concluded from the test for uniformity of the product.

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