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Design & Fabricate a Liquid Silicone Rubber (LSR) Moulding Tool for Tea Cups, Bolt & Nuts and Ganapati Statue

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ABSTRACT

Making the case for tiny and mid-sized volumes with liquid silicone moulding (LSR). Liquid silicone rubber moulding is frequently employed in large-scale medical technology. According to Grand View Research, the global LSR market will be valued $3.29 billion by 2025, with medical applications experiencing the highest growth, with a CAGR of roughly 9% from 2016 to 2025. There are several reasons why LSR is in such high demand. However, low-to-mid-sized products may be left out in the cold due to tooling issues and expresses associated with LSR. The attractiveness of LSR, the tooling issue, and how moulders are providing choices to get LSR into small and mid-volume runs will all be discussed.

Keywords: Liquid silicone moulding (LSR); fabrication and statue

1. Introduction

Dow Corning invented addition cross-linking liquid silicone rubber (LSR) near the end of the 1970s. Over the last few years, liquid silicone rubber has gained in popularity as a good material with good processing qualities. High productivity can be obtained with high speed automatic, environmentally friendly processing processes using liquid injection moulding equipment due to their fluid nature and low cross linking periods (LIMS). The transition from compression moulding to automation processing is a cost concern that should be carefully considered. As a result, the piece price would be reduced significantly. As a result, LSR products can be found in practically every branch of industry. Keypads, insulators in high-voltage technologies, and baby bottle nipples are examples of crucial items. The material is also employed in a variety of medical applications since it can be sterilised and has strong biocompatibility qualities. Building components currently range from small and precision pieces weighing less than 0.05 g per piece and made in huge volumes to big volume components weighing up to 80 kg and fabricated in small or medium series. A new revolution is underway in the variety of suitable applications. It is now possible to link plastics with silicone rubber in one working step thanks to the two-component or dual colour injection moulding technology now available for use with liquid silicon rubber. LSR is a two-component system with components A and B that must be mixed at a ratio of 100 to 60. Poly silicon polymers or copolymers with active or inactive fillers and additives make up these materials. LSR is a blend of silicone polymers with vinyl groups and cross-linking components with Si-H groups before vulcanization. They have great process capabilities due to their uniformity and cross-linking behaviour. When compared to solid silicone rubber, their viscosity is extremely low (HCR). They have paste-like qualities when they are resting. Vulcanization is based on the hydrosilation mechanism. This chemical process produces a three-dimensional network that is very elastic and has good mechanical, electrical, and optical properties. Unlike peroxide curing, there are no by-products emitted during the Vulcanization of LSR compounds, and good storage stability is accomplished with the use of inhibitors and the proper silica selection.

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Silicones' unique qualities make them perfect for high-demand applications. Liquid silicone rubber (LSR) injection moulding provides the user with simplicity of processing, high-volume moulding, increased productivity, and consistent part quality. Silibione LSRs can be stored for a minimum of 12 months from the date of manufacturing when stored in its original un-packaging at a temperature of 24°C (77°F). Blue Star Silicones no longer guarantees that the product will match the sales specification beyond this date. The MSDS is not included in the product box, but it may be obtained by calling blue star silicones at 866-474-6342 or speaking with a blue star silicones representative. Silicon material providers have made significant development in LSR formulations over the previous decade, resulting in improved performance, processing stability, and competitive cost. These advancements in LSR technology have levelled the playing field and provided a better alternative to plastic in many applications.

Contributions

- The aim of our project is to design & fabricate a liquid silicon rubber (LSR) moulding tool for Tea cups, bolt & nuts and Ganapati statue.

- Liquid silicon rubber (LSR) is silicon rubber mould from a liquid component. This liquid component consists mainly of silicon polymer which is well known for being non-toxic and temperature resistant. The mould provides and smooth flow of the material and very easy to demould.
- The mould provides good tensile strength with low shrinkage. Curing can be done at room temperature within 6-8 hours.

2. Literature Survey

The optics can meet both the criteria for the encapsulation of LED chips and the implementation of an optical function due to the material-specific benefits of very transparent LSR, particularly in terms of exceptional high temperature resistance and tremendous design freedom **[1].** When rubber and silicone are used, having knowledge of material production, vis-coelastic properties, and the processing process is especially crucial for the function and quality of the products as well as the efficiency of the processing **[2].** Poly lactic acid dies are used to make liquid silicone rubber mobile phone pouches. It is made up of inner and outer dies. Using poly lactic acid (PLA) material, a 3D printing machine prints a liquid silicone rubber mobile phone pouch. It is made up of an extruder and a platform that allows you to print the appropriate material at different temperatures. Temperatures on the platform range from 20°C to 60°C, while extruder temperatures range from 180°C to 230°C **[3].** The goal of this project is to take advantage of the material's unique properties, particularly its superior high temperature resistance and design flexibility **[4].** A low-cost blend of aluminium (Al) powder and epoxy resin was devised for producing LSR injection mould inserts in this work. The test specimens generated by the mixture created in this work had tensile strength, hardness, compressive strength, impact strength, and heating rate that were roughly 85%, 97 percent, 89 percent, 99 percent, and 82 percent of the specimens manufactured by commercially available materials **[5].** LSR (liquid silicone rubber) parts are durable and can be used in a variety of applications. It is vital to build a mould quickly and effectively in order to reduce time to market for new injection moulded items. In this work, RT technology was employed to create a mould for LSR injection moulding that included a heating element **[6].** For LSR injection moulding, an injection mould with a heating element was built

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using RT technology in this work. The average microgroove depth and width of the Al-filled epoxy resin mould were found to have a reproduction rate of 90.5 percent and 98.9 percent, respectively **[7].** Liquid Silicone Rubbers (LSRs) are straightforward to integrate into current business structures and facilities since they may be processed using significantly modified thermoplastic moulding equipment **[8].** In this research, liquid silicone injection moulding is proposed as a fabrication process for sensorized robotic skin made of sensor fibre composites. Sensor fibres made of thermoplastic elastomers with two distinct shore hardness ratings (50A and 70A) are coupled with various silicone materials **[9].** Transient interactions between curing, shear rate, temperature, pressure, and tooling characterise LSR processing behaviour. As a result, we'll talk about current LSR models for curing, viscosity, pressure, and temperature **[10].**

3. Methodology

The goal of the project is to create a LIQUID SILICONE RUBBER MOULDING TOOL for tea cups, nuts and bolts, and a Ganapati statue. Liquid Silicone rubber moulding is a straightforward and precise process that will forgive a variety of errors. Starting with a master portion is the plan. This portion can be encased in moulding material, and the negative can then be used to make a variety of pieces. By supporting it on spacers and surrounding it in a retaining frame, this master can be encased. Gather all of the necessary tools, supplies, and safety equipment before beginning the process of producing a silicone rubber mould.

Liquid Silicone Rubber (100%)

Release agent

Fig 1 shows Liquid Silicone Rubber (100%)

The silicone rubber substance is divided into two parts with a volume ratio of 1.1. Before the polymers cure, they are cleaned with propanol alcohol. The part-casting material is likewise mixed at a volume ratio of I: 1. Finally, the releasing agent is required.proto labs' techniques and capacities are constantly evolving. It is a list of current requirements and design concerns. The maximum part size is 127x127x80mm. This is the size envelope that the part must fit into, even if it cannot occupy the entire space. With increased capabilities, part size may rise. The maximum anticipated mould area for

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the part must not exceed 11,335 square millimetres. This is smaller than the 16,129sq.mm footprint of an item that would completely fill the 127mm by 127mm measurements indicated above. The reason for this restriction is that the pressure required to fill a mould with a surface area higher than 11,355sq.mm would surpass the moulding press's clamp pressure. The maximum part volume is 65,660 cubic millimetres. The maximal short volume of proto lab's existing LSR moulding equipment determines this. Wall thicknesses as thin as 0.5mm are possible. The problem isn't with filling, but with milling thinner-walled components from the mould without causing damage. Variation in wall thickness is often not a concern due to LSR's shear thinning. Rip thickness should range from 0.5 to 1.0 times that of the neighbouring wall. Inside fillets should have a radius that is roughly equivalent to the wall thickness.

4. Results and Discussion

. It's a two-part epoxy technique for casting that uses a high-glossy, transparent, low-viscosity, UV-stable liquid epoxy resin. Application of coatings and adhesives. It's a line of high-performance, easy-to-use epoxy resins.

Table 1 properties of resin

S.NO	DESCRIPTION	PARAMETER	
		RESIN	HARDENER
1.	Physical state	Low Viscous liquid	Low viscous Liquid
2.	Colour	Clear	Clear
3.	Viscosity (mPas 25C)	1160	479
4.	Mixing Ratio	100	60
5.	Gel Time @ 25C (min)	5-10 min	
6.	Set Time (min)	15-20 Min	
	Drying Time min	30-40 Min	

Silicon rubber is used in PU/poly resin, unsaturated resin, plaster, candle and gypsum crafts, toys, soap, statues, and the creation of casting moulds, among other things. Silicone rubber manufactured from a liquid composition is known as Liquid Silicone Rubber (LSR). This liquid chemical is made primarily of silicone polymer and is non-toxic and temperature resistant.

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(a) Sealed for mould outside box using silicone gun

(b) Placed the Ganapathi Statue in moulded box

(c) Spray on the materials using release agent

(d) Poured liquid silicone inside the moulded box

(e) Figure of filled the moulded box

(f) moulded figure

Fig 2 shows moulding process

Blue star silicone encourages the sale of these items to clients that are involved in the development and assembly of certified medical devices that will be implanted in less than 30 days. The purchaser is solely responsible for choosing a specific blue star silicone product and determining its applicability. Additionally, the purchaser is solely responsible for adhering to all applicable legislative, regulatory, and industry rules and standards for compatibility, extractability, testing, safety, efficacy, and labelling. The Vulcanization process is substantially faster than peroxide curing, which is a decision factor in the procedure. Piece prices are lower when the cycle is short. In general, LSR injection moulding is totally automated. Components A and B are metered at room temperature into a static mixer, along with a pigment paste or other actives if needed for a dosing system, and then injected

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into a heated mould. The mixture cures into a solid, elastic component during the dwell period in the hot mould, which can be retrieved automatically or manually after the mould is opened. The cycle times achieved with liquid silicone rubber range from a few seconds to many minutes. To release volatiles and achieve a more complete Vulcanization, the moulded pieces can then be positioned at around 200 degrees Celsius. In many circumstances, a four-hour curing time is sufficient. Many LSR materials are biocompatible, and some have even been approved for implant use. LSR devices are temperature stable (in both hot and cold environments) and can survive aggressive cleaning and disinfection chemicals. LSR also resists UV degradation, is scratch resistant, and maintains its aesthetic appeal throughout the product's existence. The speed with which the LSR material cures makes it appealing when compared to a transfer or compression process employing high consistency rubber (HCR) silicone. Unlike gum substance, parts can be fully cured in seconds rather than minutes. Cycle times can be lowered by up to 90% when using HCR silicone in the transfer process. At first look, choosing LSR as your preferred material may appear tough due to its higher cost than other options. In comparison to plastic and HCR, LSR offers various advantages to manufacturers, particularly fabricators of high-volume parts. The advantages of LSR as a raw material readily justify its usage, despite its higher initial cost, because producers will have near-complete automatic operation of the process – a single person can attend to and maintain several liquid injection moulding machines. This component of cost savings is particularly essential to producers in terms of greater process efficiency, especially when labur costs grow, making LSR the best material choice for your production demands. Despite any perceived flaws, LSR provides consistency and cost-effectiveness to producers in a variety of industries, including automotive, medical, infant care, electronics, and consumer goods. In order to achieve stringent and demanding performance demands and budget requirements, companies and people must carefully evaluate a wide range of material qualities and processing methods for crucial applications, particularly medical devices.

In order to choose the right material, it's critical to have clearly defined performance standards for qualities like elongation, durometer, and thermal resistance. The wrong material or method might be disastrous for your company. It can cause significant setbacks as well as losses in market share, revenue, and time.

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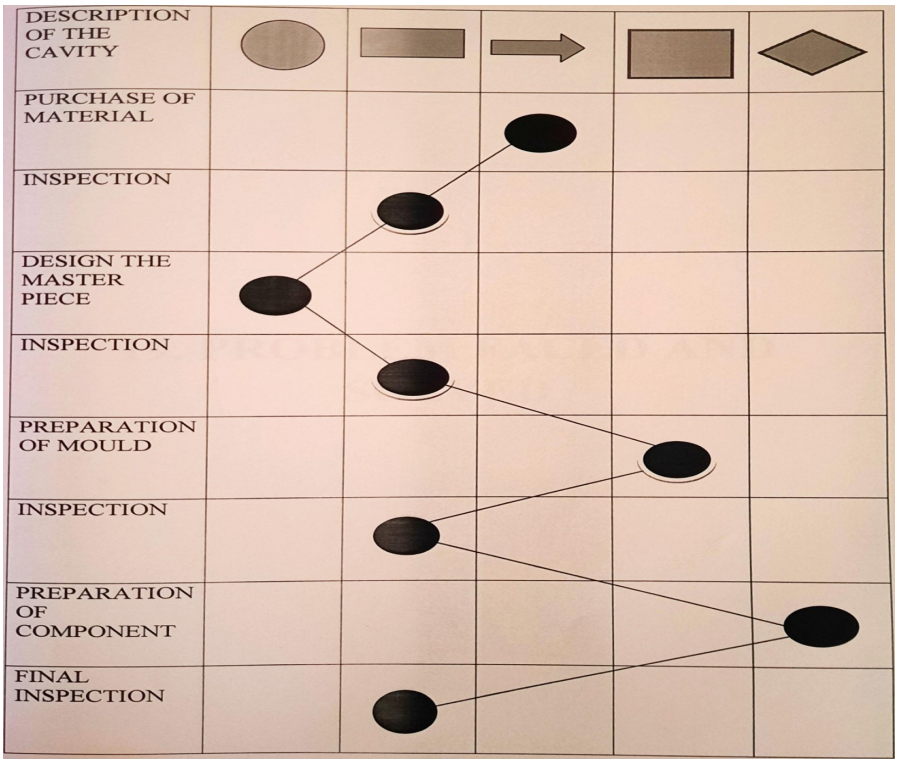

Fig 3 shows the process of mould

It is the art of finding the cost before the bolt & nut is actually manufactured or produced.

Table 2 material costing

S.NO	DESCRIPTION	AMOUNT IN RS
1	LIQUID SILICON RUBBER	3500
2	EPOXY RESIN	3000

Liquid silicon and curing agent in a two-part silicon rubber. It takes 6-8 hours to cure at room temperature. Fluidity and operability are expected, as well as ease of remouldability. Low shrinkage, good tensile and tear strength. Duplication time is long. Evenki's finely divided metallic oxide, AEROXIDE Ti02, is also made utilising the well-known AEROSIL technique. To improve the thermal stability of silicone rubber, AEROXIDE Ti02 P 25 and AEROXIDE Ti02 PF 2 can be utilised. This process also produces the more effective AEROXIDE Ti02 PF 2 product. The inclusion of FeCl results in an AEROXIDE Ti02 PF 2 containing 2% Fe2 03.

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5. Conclusion

We completed the design and fabrication of liquid silicon rubber moulding for bolts and nuts, as well as the Ganapati statue. In our mould, we learned a lot, and it was a positive experience for our team members. This project gave us the opportunity to learn about designing liquid silicon rubber mouldings, manufacturing liquid silicon rubber mouldings, selecting materials, improving our problem-solving skills, completing tasks efficiently, and improving our communication and teamwork skills. We receive practical experience in the disciplines listed above, which gives us the courage to handle industrial circumstances.

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