

# Design and Manufacturing of Manually Operated Cup Sealing Machine

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**Abstract :** Finishing and Packaging has been a major activity for every production Industry in recent times, as proper finishing and packaging helps to keep a business green. In India today, there has been an increasing demand for packed products such as fruit juice, ice creams and packed water etc. which require foil seal before capping or without capping as the case maybe. In some of our small scale and growing industries, sealing of cup products is being carried out by the use of locally fabricated manual type sealing machines whose draw backs includes man labour intensive, machine multiplicity and costs. This work centred on the design and construction of a portable automated adjustable-cup foil sealing machine which is a final unit operation for finishing and packaging department of some product industries.

## I. INTRODUCTION

In the current Indian scenario better quality, low cost with higher productivity are major factors for any enterprise to rise their business . The measure companies like Amul, Dabur, Gagangiri have packed their product by sealing machine which are high in cost but they are affordable due to mass production but in case of small sellers like tea stall or fruit juice seller can't afford such machine but our low cost machine is easily affordable and its operation is also easy. Hence in these paper problem of high cost machine, design of low cost machine, working and cost comparison have been described.

In this scenario better quality, low cost with higher productivity are major factors for any enterprise to flourish. To cope up with the ever increasing market competition, low cost automation is the safest strategy. Low Cost Automation comprises the use of standard components to mechanize or automate machines, processes and systems. These low cost automated machines can be operated by semi-skilled or unskilled labours as it requires limited human intervention. In this paper need of automation, types of automation, design, process flow and cost comparison have been described.

## II. PRINCIPLE USED

Heat seals are strong enough for small liquid force, and are the most commonly used form for sealing. Heat sealing requires no special materials such as pressure sensitive adhesives sealing therefore heat sealing is very economical. The aluminium foil and plastic cup are bonded with just heat and pressure both delivered at once by a press that is heated by conduction. The amount of heat required should be enough for the plastic to reach its transition temperature, but too much could char the plastic cup. This method will be the main focus of our project. The old method or a machine shown in below figure, which cost about more than 30K which is unaffordable for small fruit or juice sellers.

## III. HEAT SEALING PROCESS

Heat sealing is the process of sealing one thermoplastic to another similar thermoplastic using heat and pressure. The direct contact method of heat sealing utilizes a constantly heated disc or sealing disc to apply heat to a specific contact area or path to seal or weld the thermoplastics together. Heat sealing is used for many applications, including heat seal connectors, thermally activated adhesives, film media, plastic ports or foil sealing.

## IV. PROCESS OVERVIEW

The function of the process is to seal the plastic cup with an aluminium foil using heating coil. The process is fairly universal, it can be performed in separate segments or all at once, but it generally follows the same order regardless. The process begins with the input of the raw materials, which include rolls of the aluminium foil and polymer materials, plastic cups (used for water, juices, lassi etc). If the foil is brought in as one large foil sheet, it is then cut into the properly sized sections or else standard sized cut papers are also available in market. Next, the paper foil material is unrolled and formed into the proper circular shape through thermoforming. Next the food material is placed in the plastic cup further placed it on cup holding stand on which aluminium foil of same diameter of the cup opening is kept on it. This foil is hen seal by forcing and holding the heated disc for 4-5 sec which has temperature about 150-170 degree Celsius .



Fig.4.1 Machine available in market

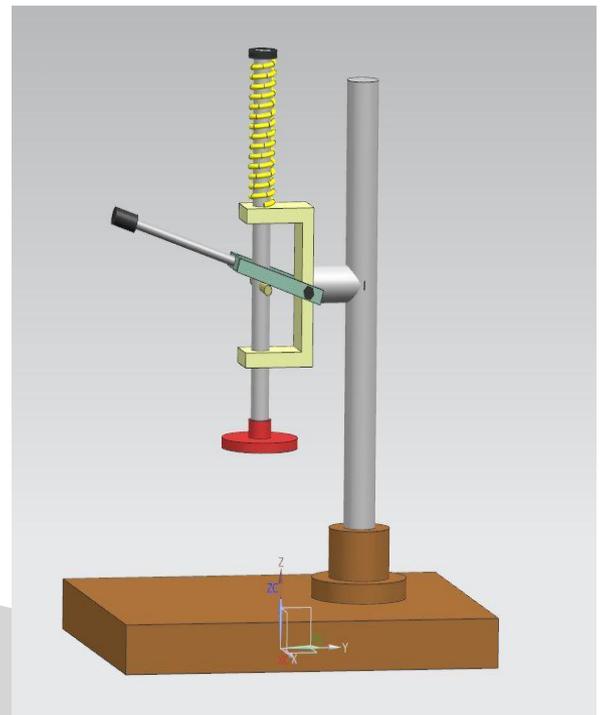


Fig 4.2 Rough cad model

## V. METHODOLOGY

Methodology followed to achieve the proper and better performance of the machine is shown below in chart. As explained above this machine is made up on considering or recognising the need small juice, fruit salad sellers which should be small in size, should have low cost and easy to use. So the design was done on the basis of the mentioned requirement.

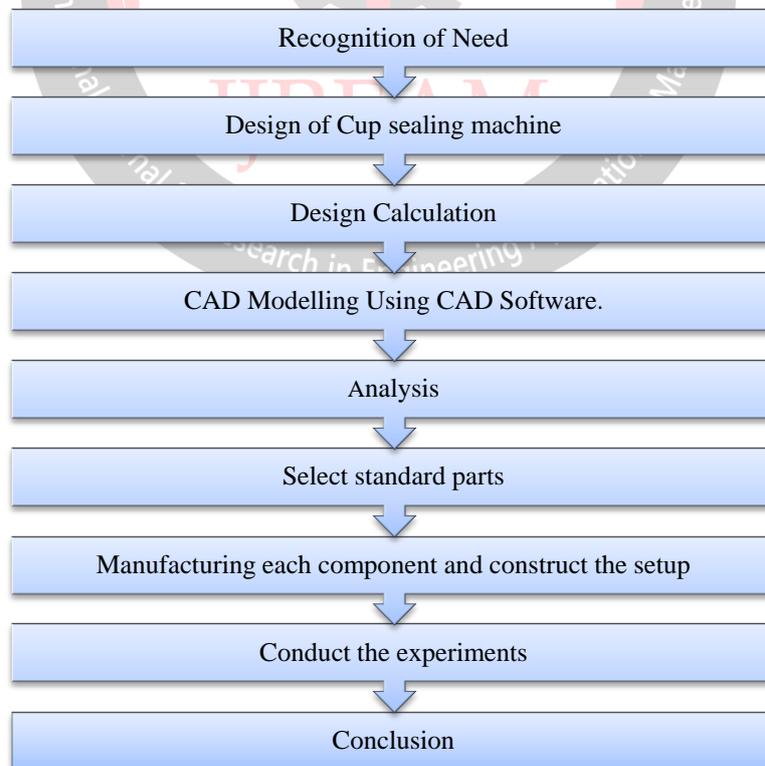


Fig.5.1 Methodology Flowchart

**Conductive Heat Transfer**

The transfer of thermal energy which occurs between the heat sealing plate and the multiple layers of packaging material is essential towards understanding how the seal process happens and the strength of the seal itself. The study of heat transfer and the application of various fundamental equations will allow for a model to be built which can relate the process parameters of material thickness, temperature and time to the material properties of the packaging materials.

The primary equation which can properly represent the rate of heat transfer through a multi-layered body is Fourier’s Law of heat conduction. The following image and equations show an example of Fourier’s law as it is applied to a multi-layer situation.

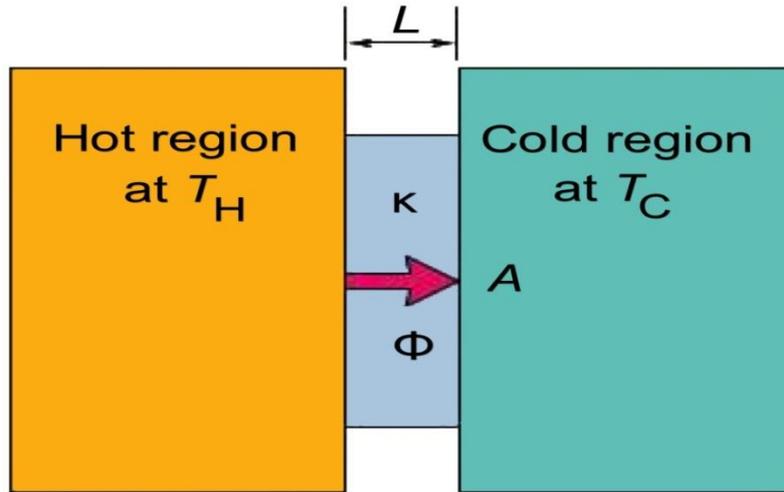


Fig.5.2 An explanation of Fourier’s law.

Fourier’s law provides a mathematical correlation between the thermal conductivities of the various materials used in the sealing process and the activation energy which is needed to insure that the effects of the adhesive are activated. Using derivations of this equation in tandem with the computational methods mentioned later in the report, fundamentals based models for the heat sealing process and seal strength which are driven by the key process and material parameters will be constructed. For the purposes of this project, the following is a representation of the number and types of boundaries which will be of concern for the heat transfer.



Fig.5.3 .Heat transfer relevant to the sealing process

The current assumption is that the heat will be applied from above via a heated press plate which is heated up before making contact with the desired sealing surface. The press plate must reach a temperature which will result in the proper amount of heat transferring through the layers in order to insure that both adhesive layers reach their activation energies.

The three different layers in the figure represent the three layers found in the typical cup sealing in this project. As can be seen in Figure , the heat is first transferred heating die to a layer of aluminium foil, then plastic cup. Next, a set of boundary conditions will need to be developed to describe what happens at the edge of this setup.

The final boundary layer condition to be determined is the upper interface where heat is being applied to the system. To further the simplification of the setup, an assumption was made that there was perfect heat transfer through the contact between the press and the first aluminium foil layer and then plastic cup . Furthermore, it was determined that this heat transfer could be described as a constant temperature or temperature gradient at the top boundary representing the press. The assumption that this temperature or temperature gradient would not change much with time as the process went on was based on the idea that the thermal mass of

the press system would be much larger than the system of the package receiving this heat. This means that the press system will have large reserves of heat in its own mass that can be used to replenish the surface temperature and keep it from falling.

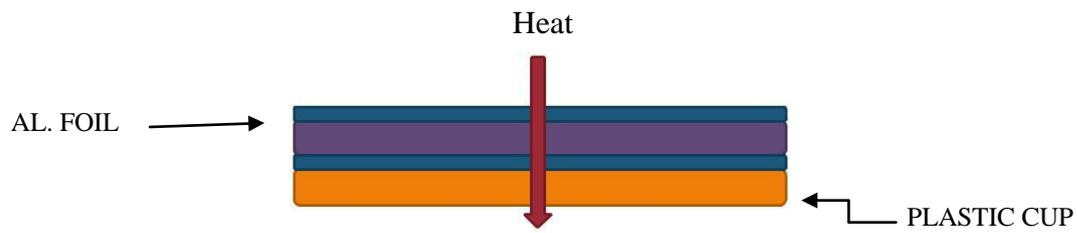


Fig.5.4 Representation of conduction through multiple layers

## VI. DEVELOPED MODEL

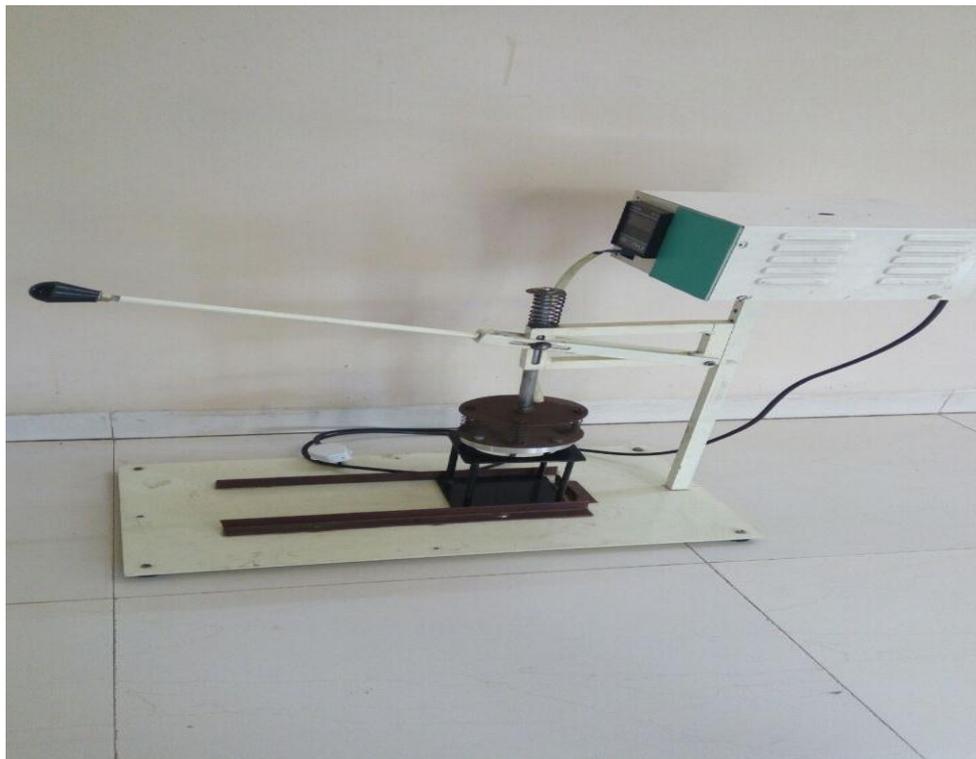


Fig.5.5 Side View Of Developed Model



Fig.5.6 Front view of developed model

## VII PRODUCT COST

The main feature of these machine is to make available for at cheapest rate so that small seller can afford it and these is achieved by reducing the access component and also making it better in ergonomic point of view.

Component	Material	Dimension	Estimated Cost
Stand	M.S.	BASE300×220×50 S.ROD $\phi$ 40×360	1200+600 (MACHINING+TURNING)
Spring	M.S.	$\phi$ 28×100	600
Heating Coil	MICA INSULATOR	$\phi$ 100×10	150
Thermostat (Themp.Control)	AS AVAILABLE IN MARKET		1300
		<b>TOTAL</b>	3850

## CONCLUSION

Throughout the duration of the heat seal simulation, thermocouples were used to measure the temperature of the important layers during the sealing process. These thermocouples were placed strategically on top of the plastic cup and between the al. foil, representing the heat sealer principle used to melt and do the seal. The handmade sealing machine is ultimate solution for filling and sealing plastic glass with different materials. It enjoys the art of design made mechanism with task.

Heat seal technology has improved at very fast pace within the production environment. Simple impulse type sealing is now not sufficient or accurate enough to seal most high specification polymers, plastic films, laminates, foils or even breathable materials, therefore we have introduced the machine with its advanced heat sealing controls and feature which will suit the production type application.

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