# Design & Development of Plastic Recycling Machine by Using FEA

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Abstract–*Plastic causes serious environmental problems. Although they are not intrinsically dangerous, they take up a huge amount of space in landfills and they are made from a non-renewable resources, namely fossil fuels .for this reasons it is important that, where possible plastics are recycled.*
*The use of plastic is increased now days in many industries like automobile, packaging, medical, etc. The reason behind this is that the plastic made things are quiet easier to manufacture, handle and reliable to use. So the plastic goods manufacturing industries are striving hard to produce good quality products at large scale and cheaper cost. The hydraulically operated machines solve the problem, but they are too costlier for smallscale and medium scale industries. This paper deals with design and fabrication of pneumatically operated injection plastic moulding machine.*

*The manually operated machine is converted into pneumatically operated machine by applying proper design procedure.A plastic recycle machine includes assembly of mechanical components like hopper, frame, heating-coil, pneumatic cylinder.We have made product in die. Due to that the die becomes hot, because we have made FEA of the die & compare the result on the basis of geometry of die, i.e. thickness of die.Some recycled plastic is then used in applications similar to those for which virgin plastic is used the remaining plastic is made into a variety of objects.*

*Key Words: Design and Development, FEA, Plastic molding die, Pneumatic Cylinder, Static structural Analysis, Thermal Analysis.*

## 1. INTRODUCTION

Recycling has been debated endlessly for many years now. There are two points of view regarding this issue. The argument in support of recycling concerns the negative impact of waste and emissions on our planet. The counter case is that costs undertaken to recycle are larger than the revenue returns. Only recycles 5% of its plastic waste even though it is one of the largest industrial cities in the country and there is growing concern about its part in the release of greenhouse gases from industry and the waste system.
Decreasing greenhouse gas emissions is also favorable to all for environmental reasons. The trend between the emissions and the cost can be deduced. It will be a strong, positive, linear correlation. The cost and the emissions can be kept low simultaneously using an increased recycle rate. It is important to note that several assumptions were made in the calculations. One assumption made is that only the production Energy contributes emissions; incineration has not been taken into account. Actually, incineration contributes largely to the outcome as 30% of waste in Houston is incinerated, emitting large volumes of gases. The cost of raw material is assumed as the price of crude oil. Methane, an emission from landfill plastic waste, has been omitted. Together with other such assumptions, results can alter greatly. One should realize that Tierney has also made assumptions in his work. He may have chosen specific assumptions to induce his data to imitate his viewpoint. We states that a loss will
always be incurred by the faction attempting to recycle because the cost of plastic production is already at its cheapest. We believe that the current 5% recycle rate is too low a recycle rate as the money saved is not enough incentive for large-scale process. 4% is saved economically and emissions are reduced by 2.4%. These numbers are much too small to have a substantial current effect.

## 2. PROBLEM IDENTIFICATION AND PROBLEM DEFINITION

Problem Identification :( Recycling waste plastic)
Now a days the plastic bottles ,supporting frames etc. are normally used after use these plastics are disposed of they take lot of space and as it is this increases pollution .Hence this can have to be recycled taking in consideration and environmental concerns

Plastics crushed can be melted and can be used to produce different kind of product but it is an extremely laborious work .Hence we need a simple machine which will reduce the human efforts.

Problem Definition:(Plastic Recycling Machine)

Plastic recycling machine is a simple machine, compact, light-weight. A pneumatic cylinder is used to compressed the molten plastic heated by coil heater of capacity 100W.Liquid plastic is than delivered t under high pressure(10 bar) to the die to produce a required product.

## 3. LITERATURE SURVEY:

*[1] AlirezaAkbarzadeh and Mohammad Sadeghi"Parameter Study in Plastic Injection Molding Process using Statistical Methods and IWO Algorithm" International Journal of Modeling and Optimization, Vol. 1, No. 2, June 2011 pp-141*

Dimensional changes because of shrinkage is one of the most important problems in production of plastic parts using injection molding. In this study, effect of injectionmolding parameters on the shrinkage in polypropylene (PP) and polystyrene (PS) is investigated. The relationship between input and output of the process is studied using regression method and Analysis of Variance (ANOVA) technique. To do this, existing data is used. The selected input parameters are melting temperature, injection pressure, packing pressure and packing time. Effect of these parameters on the shrinkage ofabove mentioned materials is studied using mathematical modelling. For modelling the process, different types of regression equations including linear polynomial, Quadratic polynomial and logarithmic function, are used to interpolate experiment data

*[2]Prof. S. B. Khedkar1, Prof. R. D. Thakre2, Prof. Y. V.* ***Mahantare3, Mr. Ravi Gondne4*** *"Study of* ***Implementing 5S Techniques in Plastic Moulding"*** *International Journal of Modern Engineering Research (IJMER) Vol.2, Issue.5, Sep.-Oct. 2012 pp-3653-3656.*It will impact the instructors and workman of Industry that work within the selected place. By following the 5S methodology, this research effort may show significant improvements to safety, productivity, efficiency, and housekeeping. The research documents improvements by using before and after pictures. It also intends to build a stronger work ethic within the workman and engineer who would be expected to continue the good practices.

*[3]****Poonam G. Shukla, Gaurav P. Shukla"Design&*** *Fabrication of Pneumatically Operated Plastic* ***Injection Molding Machine"*** *International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 7, January 2013 pp-98.*The use of plastic is increased now days in many industries like automobile, packaging, medical, etc. The reason behind this is that the plastic made things are quiet easier to manufacture, handle and reliable to use. So the plastic goods manufacturing industries are striving hard to produce good quality products at large scale and cheaper cost. The hydraulically operated machines solve the problem, but they are too costlier for small scale and medium scale industries. This paper deals with design and fabrication of pneumatically operated injection plastic molding machine. The manually operated machine is converted into pneumatically operated machine by applying proper design procedure.

## 4. SCOPE OF WORK:

We can produce different types of domestic and industry al products by recycling the west plastic. Using compound dies we can produce components on scale and avoid the time consumption. By using automation and multi stage heating coils we can increase the production rate.The results above counter exactly that showing that by recycling, companies can further reduce these cheap production costs. The main point of difference between the two articles is that he does not deal with the full life cycle of the materials directly. He mainly looks at the recycling section and makes his deductions from there. He also talks generally about waste instead of specifically plastic. The trivial life cycle is the cheapest method but it does not show us data that can be compared with the type of data that was collected for this report such as environmental (less emission) benefits.Whether the city is cleaner to reduce emissions or keener to reduce the costs of the plastic life cycle, the solution is to recycle at a higher rate as both will be affected by this. Under F.E.A. for further analysis purpose we can do Dynamic, Transient, Modal Analysis. Automation can be done on the actual model for mass production purpose.

## 5. OBJECTIVES OF PROJECT:

1) Optimization of Plastic Recycling Machine by using F.E.A.
2) To utilize the plastic from domestic and industrial waste to reproduce useful components like washers and bushes.
3) To reduce the solid plastic waste.
4) Innovative use of scrap machinery.

## 6. METHODOLOGY:

### 6.1 Analytical Design of Die Thickness:

Lets take DIE material as MILD STEEL

$$\sigma = \frac{S_{yt}}{F.S}$$

Lets consider F.S 3.5 for better results.

$$\Sigma = \frac{460}{3.5}$$

$\sigma_{max}$ = 131.43 N/mm2

usingClavarino's equation as our DIE is a closed vessel

$$t = \frac{D_i}{2}\left[\sqrt{\frac{\sigma + (1 - 2\mu)P_i}{\sigma - (1 + \mu)P_i}} - 1\right]$$

t=6.54mm.

i.e. t=7mm.....(app.)

Dimensions of DIE as,

Inner dia.= 40mm

Outer dia.= 55mm

Young's Modulus = 200GPa,

Pressure= 3bar (Force= $3\times 10^5$N)

Total Deformation:

$$\partial = \frac{P\,L}{A\,E}$$

$$\partial = 1.0051 \times 10^{-6}\ mm$$

Stress:

$$\sigma = \frac{F}{A}$$

$$\sigma = 2.68 \times 10^{8}\ N/mm^2$$

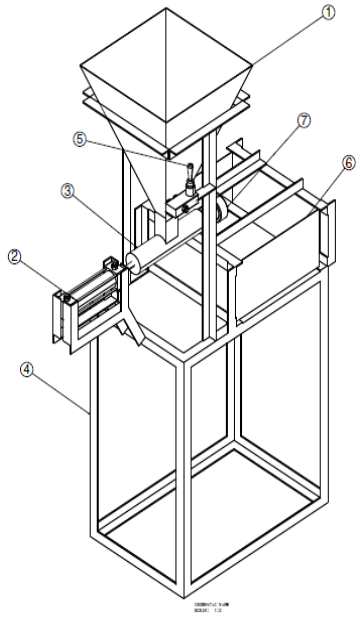
Strain:

$$\sigma = E\,\varepsilon$$

$$\varepsilon = \frac{\sigma}{E}$$

$$\varepsilon = 0.00134$$

6.2 Preparation of CAD model:




*Fi-1g. Project Model*

| NO. | COMPONENTS |
|---|---|
| 1 | HOPPER |
| 2 | PNUEMATIC CYLINDER |
| 3 | HEATING CHAMBER |
| 4 | BASE FRAME |
| 5 | 5/2 CONTROL VALVE |
| 6 | TANK |
| 7 | DIE |

6.3Preparation of F.E.A. model:

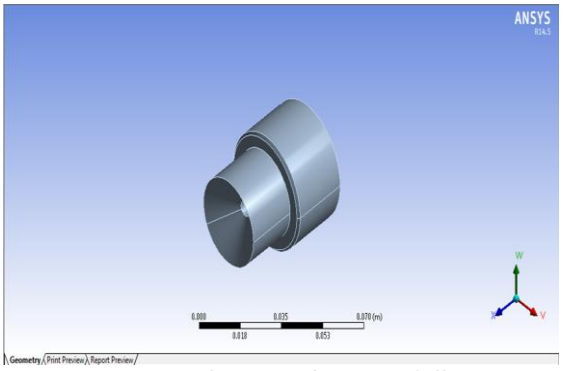



*Fig.-2: Male Part of die.*

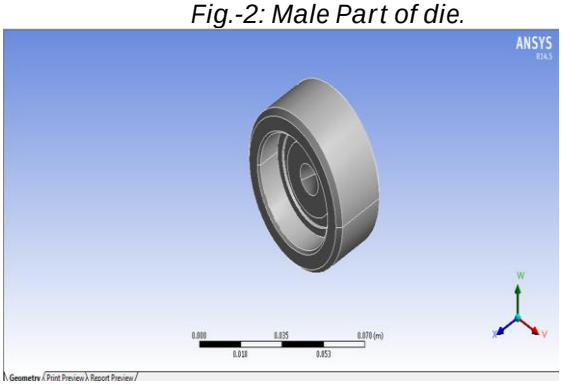



*Fig.-3 Female Part of die.*

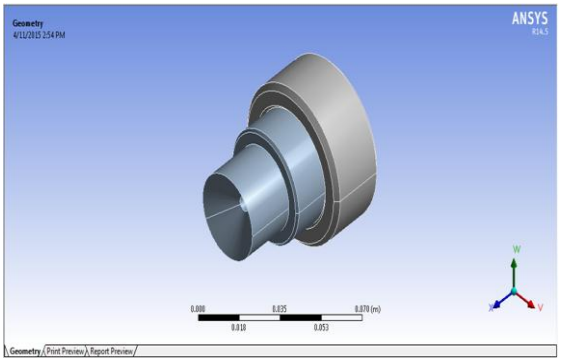



*Fig-4.: Assembly of die.*

6.4 FEA model and meshing by using ANSYS:

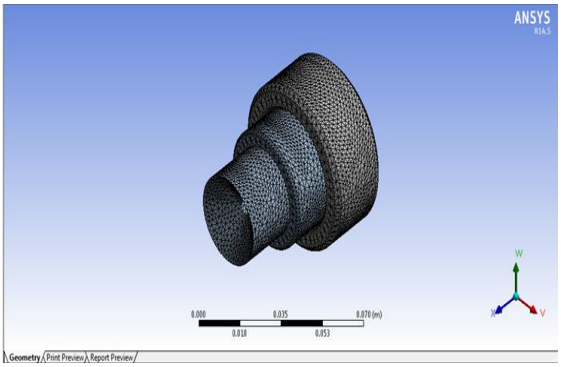



*Fig.-5 Meshing of assembly die.*

Meshing of Assembly DIE can be done in the ansys itself and total number of nodes and element are as shown in the table below.

*Table -2: Number of Nodes and Elements for Meshing.*

| Sr. No. | Name of components | Number of Nodes | Number of Element |
|---|---|---|---|
| 1 | Die | 66048 | 39167 |

6.5 Procedure for Static structural analysis& Thermal structural analysis in ANSYS:

Following is the procedure of actual analysis of individual parts of Die.

Part 1: DIE

The static analysis of base flange is done by means ANSYS Workbench 14.5.7 following are important steps which carried during the analysis

Step 1:

First of all we have to select the analysis type from main menu i.e. static structural analysis. After that we have use drag and drop option in order import the and apply the material properties.

Step 2:

In this step we have to call the existing model of dieANSYS Workbench.

Step 3:

The most important step is to enter into the analysis window by double clicking on geometry icon.

Step 4:

The object which calls in step number 3 is followed by the boundary condition, constraints and mesh tool.

Step 5:

To mesh the import model we have to define the method of meshing, size of meshing and element size of mesh.

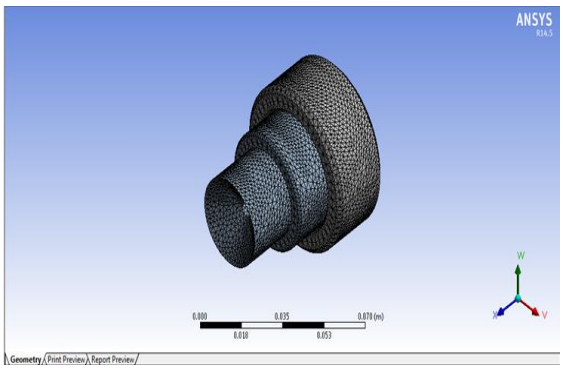



*Fig.-6 Meshing of assembly die*

Step 6:

Now we have to apply the boundary condition like fixed support, force, pressure. In this step we fix the outer end of the die and apply the pressure on inner surface of male and female part of die.

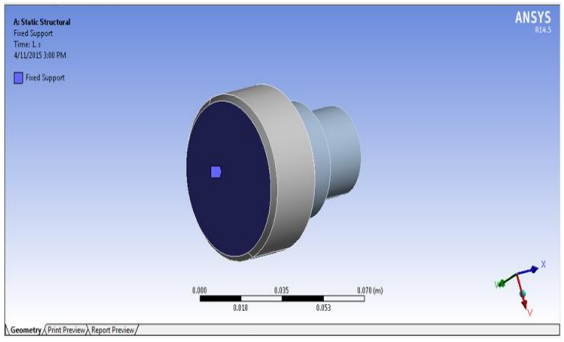



*Fig.-7 Fixed support on face.*

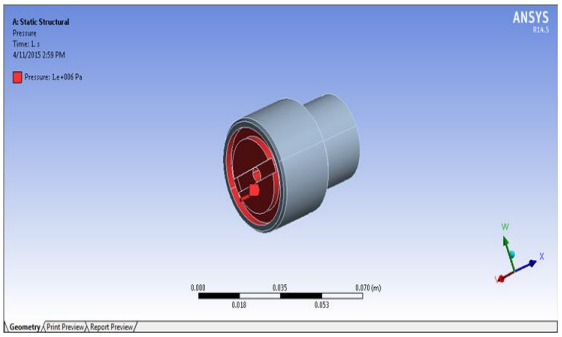



*Fig.-8 Inner pressure on male part.*

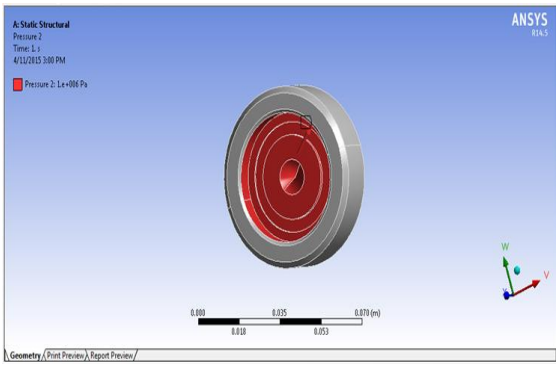



*Fig.-9 Inner pressure on female part.*

Step 7:
To follow the thermal conditions of die we have consider the atmospheric temperature as 24℃ .

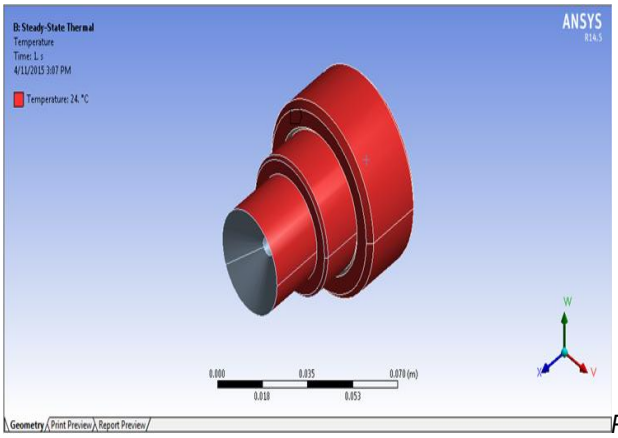



*Fig.-10Thermal structural analysis.*

Step 8:
As the temperature of Die becomes up to 120℃ due to molten plastic. For analysis we have taken the inner temperature of die as 150℃ for die safty.

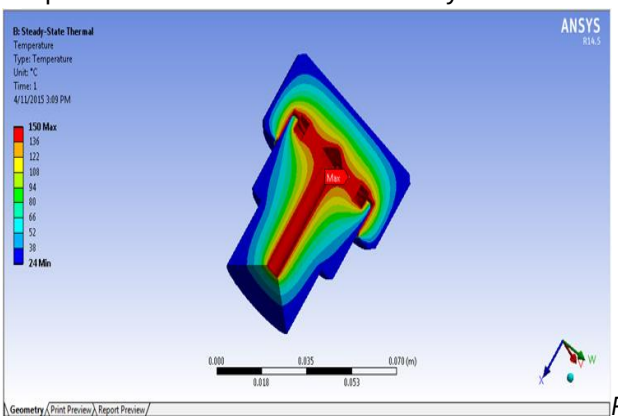



*Fig.-11Temperature effect on assembly of die*

Step 9:

We have to insert the actual parameters that we want like Total deformation, Equivalent stress.
Equivalent Strain. Now solve this analysis by considering the above stress at each node of the die and it gives the Equivalentstress, strain regarding static analysis of die. This value of Equivalentstress executes the safe and failure region in the Die

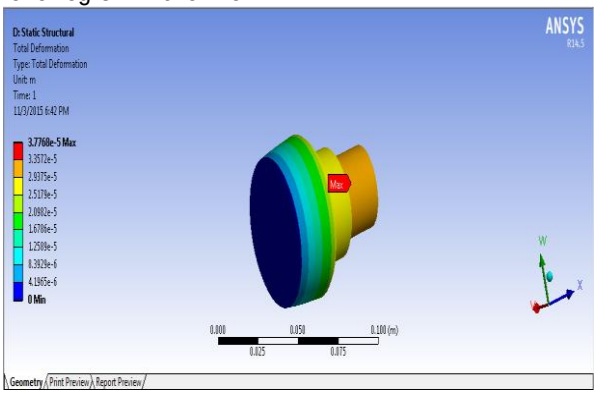



*Fig.-12 Result of Total Deformation.*

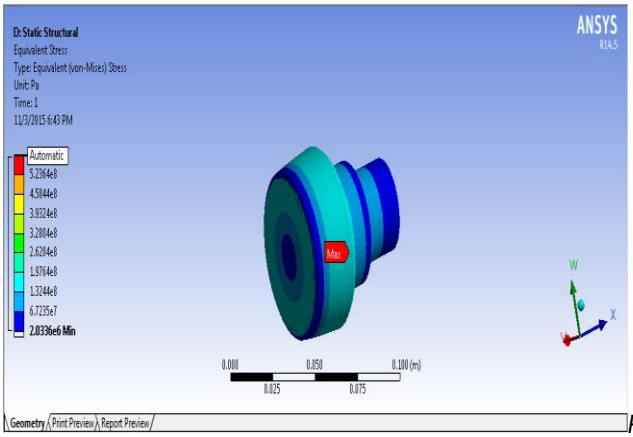



*Fig.-13Result of equivalent stress.*

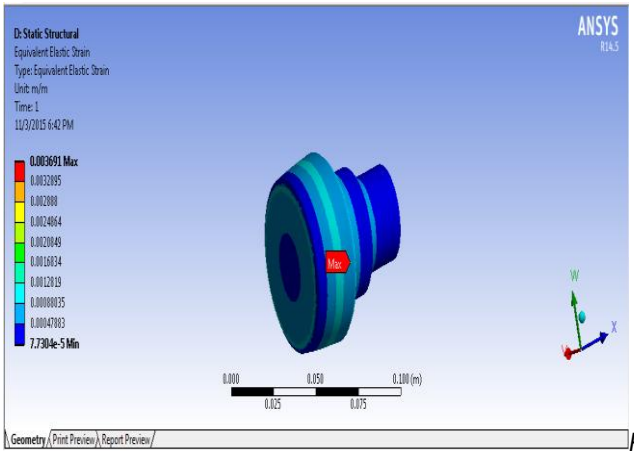



*Fig.-14.Result of equivalent strain.*

## 7. Results and Discussion:

By Analytical Method and experimental approach ,we conclude that the obtained results of each component that is Total deformation, Equivalent stress and Equivalent strain are correlated with FEA Results which are shown in the following table. Based on allowable strength (120 MPa) for MS material and rigidity of MS material, Design is safe.As we know that results of FEA are ever proven. The results shown in the following table are equivalent to each other by taking factor of safety into account.

Table-3: Theoretical and F. E. A. Results

| Mtl. | Parameter | Theoretical Results | F. E. A. Results |
|---|---|---|---|
| M.S. | Total Deformation (mm) | $1.0051 \times 10^{-6}$ | 3.7768e-5 (MAX), 4.1965e-6 (MIN) |
| | Stress ($N/mm^2$) | $2.68 \times 10^{8}$ | 5.2364e8 (MAX), 2.0336e6 (MIN) |
| | Strain | 0.00134 | 0.003691 (MAX), 7.7304e-5 (MIN) |

## 8. CONCLUSIONS:

- We have compare the results of the actual model with the FEA results and the result obtain were similar to the FEA results hence we can say that our design of die is safe.
- We produce different varieties of product by just the changing the die design.
- Waste materials are usually found littering all over the places in our urban cities and villages. A polythene recycling machine was therefore designed and manufactured using locally sourced and available materials. The manufactured recycling machine was found to very useful absorbing the huge waste materials in our country.
- We have made washer by using plastic recycling machine this washer can be used in assembling to absorb the vibrations like the plastic springs are used in suspension system

Fig.-15washer

## 9. REFERENCES:

### 9.1 PAPER REFERENCES:

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(2) Prof. S. B. Khedkar1, Prof. R. D. Thakre2, Prof. Y. V. Mahantare3, Mr. Ravi Gondne4 "Study of Implementing 5S Techniques in Plastic Moulding" International Journal of Modern Engineering Research (IJMER) Vol.2, Issue.5, Sep.-Oct. 2012 pp-3653-3656

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*APPENDIX – ACTUAL MODEL OF PLASTIC RECYCLING MACHINE*

Image:-Model of Plastic Recycling Machine

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