

Design and Fabrication of Electromagnetic Embossing Machine

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Abstract—Conventionally in many manufacturing industries, embossing operation is carried out manually using jigs and fixtures or by means of a machine. These machines are mechanical, pneumatic or hydraulic. These machines are costlier for manufacturing, installation and maintenance also. The running cost of these types of machines is also high. An electromagnetic embossing machine proves itself better against these machines in respect with above said points. In this machine embossing operation is carried out in project work on very thin aluminum sheet or other soft material.

In the machine there is an electromagnet which incorporates a plunger passing through it. The plunger is allowed for vertical motion through electromagnet. The plunger carries an iron core fixed to its upper end, and to the lower end of the same a tool holder is attached, this tool holder holds an embossing tool that is used for embossing. The plunger is hanged with the help of springs. A working material is placed just below the embossing tool. Entire assembly is fixed into some kind of housing or body. Whenever electromagnet is made on it pulls the iron core towards it the plunger is forced into downward direction, which pushes the embossing tool against the work (raw) material, thus embossing is carried out, after making the electromagnet dead the spring pull back the plunger into its original position making it ready for another working stroke, meanwhile the embossed piece of material is retracted.

Keywords: -Coils, Current, Electromagnet, Punching Die, springs.

I. INTRODUCTION

Today's world is going fast at an amazing rate to cope with this fast changing environment the technological manufacturing process needs to be speed up and efficient. This leads to developed various new types of machines that are efficient, economical and easy on maintenance.

Our main aim is to develop a low cost, efficient, low power consuming embossing machine for lower capacity works like plastic embossing and aluminium foil embossing as well.

It was decided to construct said machine using electromagnetic force as main power source for the operations.

As industrialization is ginning up across the globe various invention and innovation are being carried by human to fasten various processes associated with manufacturing and aligned things one such thing is industrial automation unit. In this automation unit various machine those can be adopted easily are also getting developed. Considering the example of canned food industry (baby food, weight gainer powder) in which embossing machines are used to print manufacturing dates, expiry dates, batch number etc. There can be various type of embossing machine depending upon material to be embossed. Now a day's hydraulic embossing machine, pneumatic embossing machine, mechanical type embossing machine are popular type of embossing machine used in above industries.

In this project compact embossing machine of a new type i.e. electromagnetic shearing machine is decided to be fabricated.

As simple layout and tricky operation enables this type of machine to work practically at low cost, low maintenance, low capital investment in less space. This machine is able to emboss invitation cards which are currently manufacture with the help of manual machine on small scale. This machine can also be used for stamping on ATM, credit card etc. Expiry dates, product specification can be embossed on food container made up of aluminum foil. As far as the actual project work is concerned the magnetic effect can be increased by increasing the number of copper coil turns to enhance the capacity as per the requirement in the industry.

II. PROBLEM DEFINATION

Pneumatic embossing machines:-

- More floor area is required due to compressor, air filter; lube tube, dryer, regulators etc.
- Seal leakages can cause energy loss.
- Operation becomes noisy.

Hydraulic embossing machines:-

- Hydraulic fluid is often corrosive.
- Loss of energy due to friction.
- Aeration will cause foaming, degradation of hydraulic fluid, damage to the internal parts.

Mechanical embossing machines:-

- Power losses due to friction.
- Operation becomes noisy operation.

III. CONSTRUCTION AND WORKING

The base platform, middle plate and top plate are designed and drawn on MDF sheet. These materials are then cut with jig saw cutter. This are arranged / attached at fixed position with help of studs, nuts and bolts. The electromagnet is drafted ground a plastic core of diameter 5.08cm. A twenty gauge copper insulator wire is used for manufacturing electromagnet. In all thousand turns are made towards completion of electromagnet. The iron core is of 2.54cm diameter and 10.16cm length is forcefully fitted in plastic pipe.

For constructing the project work entitled "Electromagnetic embossing machine", various materials like steel pipe, MDF sheet, copper wire, embossing tool, springs, power cord, PVC pipe etc are used.

The base framework of steel of dimensions 600x300x300mm is made using cast iron pipe of 2.54cm x 2.54cm screws section. This support framework is from one side and the top and bottom plates are covered using 12mm MDF sheets of 300 x 300mm size at the bottom plate supports the die. This die is used for resting the work piece.

The top plate of the frame structure supports a bobbin of diameter 17.78cm and stem rod of diameter 5.08cm the stem height is 7cm. On this main suspension of bobbin first laminated paper is wrapped. On this laminated paper a glass wool paper is wrapped that supports copper coil. The copper wire of 20 gauge number is wrapped 1000 times on the stem of the bobbin then the glass wool paper is again wrapped and the laminated sheet is covered thus this electromagnet is formed. Through the hole of this bobbin a PVC plunger of internal diameter 2.54cm is passed.

This iron core gets attracts towards the electromagnet when the same is worked. To the centre of this plunger two helical springs are attached. At the other end of this PVC plunger the embossing tool is fitted using attachments.

Whenever the electricity is supplied to the electromagnet it gets magnetized and pulls the iron core at the top of the plunger unit makes the plunger moves in downward direction suddenly thus the embossing tool get pressed against the work piece thereby embossing operations is carried out and when the electrical energy is cut off the plunger regains its position using spring tension thus the embossing operation is carried out. This machine does not require electricity for return stroke. Thus this machine is constructed and it works.

Two types of embossing operations perform on this machine are as follows:

1. Hot embossing (plastic and paper)
2. Cold embossing (aluminium)



Fig 1:- Actual Machine Model

IV. DESIGN CALCULATION

❖ *Calculation for required force for embossing aluminium foil:-*

$$F = \delta_{Al} \times \text{Area}$$

$$= 0.08844 \times 1000$$

$$= 88.44\text{N}$$

❖ *Calculate Volume of Small Frame:-*

$$V_1 = 300 \times 25 \times 25$$

$$= 1875 \text{ mm}^3$$

$$V_1 = 1875 \times 6$$

$$= 11250 \text{ mm}^3$$

❖ *Calculate Volume of Large Frame:-*

$$V_2 = 550 \times 25 \times 25$$

$$= 343750 \text{ mm}^3$$

$$V_2 = 343750 \times 2$$

$$= 687500 \text{ mm}^3$$

Total Volume (V):

$$V = V_1 + V_2$$

$$= 11250 + 687500$$

$$= 698750 \text{ mm}^3$$

$$= 698.50 \text{ cm}^3$$

❖ *Mass of steel:-*

$$M = \rho \times V$$

$$= 7.8 \times 698.50$$

$$= 5450.25 \text{ gm}$$

$$= 5.45025 \text{ kg}$$

❖ *Design of Top & Bottom Sheet:-*

Material Used: MDF (Medium Density Fibre)
Density of Plate: 840 kg/ m³
Thickness = 8 mm
Area = 300 × 270 mm
Volume = 300 × 270 × 8 mm

$$= 648000 \text{ mm}^3$$

$$= 6.48 \times 10^{-4} \text{ m}^3$$

❖ *Mass of Top & Bottom MDF Sheet (M):-*

$$M = \rho \times V$$

$$= 840 \times 6.48 \times 10^{-4}$$

$$= 0.544 \text{ kg}$$

❖ *Large Circle MDF Sheet:*

Diameter = 190 mm
Circle thickness = 8 mm

$$V = \pi / 4 \times D^2 \times t$$

$$= \pi / 4 \times 190^2 \times 8$$

$$V = 226822.98 \text{ mm}^3$$

No. of large circles are two

$$= 2.268 \times 10^{-4} \times 2\text{m}^3$$

$$= 4.536 \times 10^{-4} \text{ m}^3$$

❖ *Mass of Two Large Circles MDF Sheet*

$$m = \rho \times v$$

$$= 840 \times 4.536 \times 10^{-4}$$

$$= 0.38 \text{ kg}$$

❖ *Electromagnet:-*

Current = 16 amp
Voltage = 230 v
No. of turns (N) = 1000
Diameter of rod (D) = 0.0508 m

➤ Electrical power = V × I

$$= 230 \times 16$$

$$= 3.6 \text{ KW}$$

➤ Magnetic field intensity (H) :-

$$H = N \times I / \text{length}$$

$$= 1000 \times 16 / 0.07$$

$$= 228571.42 \text{ AT/m}$$

➤ Magnetic Flux Density (B) :-

$$B = H \times \mu_0$$

$$= 228571.42 \times 4\pi \times 10^{-7} \quad (\mu_0 = 4\pi \times 10^{-7})$$

$$= 0.2872 \text{ tesla or wb/m}^2$$

➤ Force:-

$$F_e = B^2 \times A / 2 \times \mu_o$$

$$= 0.2872^2 \times 2.1 \times 10^{-3} / 2 \times 4\pi \times 10^{-7}$$

$$= 68.92 \text{ N}$$

❖ Total force= Electromagnetic force + Self weight

$$= 68.92 + 19.52$$

$$= 88.44 \text{ N}$$

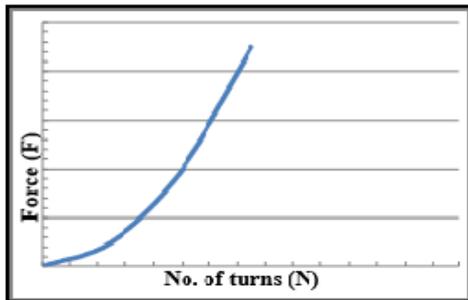


Fig:-Graph of force vs no. of turns.

I. RESULT

TABLE NO.I – RESULT

SR.NO.	Operations	Result
1.	Cold Embossing	0.5 mm aluminium foil can be embossed with 88.44N force.
2.	Hot Embossing	0.1 to 0.5 mm embossing depth can be possible with 88.44N and 90 to 140 degree Celsius tool temperature.

V. CONCLUSION

The project work and testing shows that this machine, simultaneously solve some problems from various types of embossing machines there exhibiting a good integrated result. This machine can be fixed in less place ,requires low maintenance ,does not require skilled labour has high rate of action , has longer span of time , require less capital investment , has low running cost hence can be implemented in the industry to help to lower down the production cost . Automating this unit gives a unique advantage of interfacing this unit in industrial automation unit. For more fast production rate and virtually endless working hour's .This very basic and unique ability this machine exhibits can put itself at remarkable less in the industry.

After clearing disadvantage associated with and after few further modification suggested in the relevant chapter, the project work thus execute can find its way directing in the industry for implementation.

The project work being cost solution can work best in the industry and thus lower down production, manufacturing cost of goods thereby reduction in the cost of the product.

VI. ADVANTAGES

➤ Advantages

1. It is simple in construction and working.
2. Its capital investment is low.
3. Its running cost is low.
4. It requires very low space.
5. It does not require skilled labour.

6. It does not require periodic check up and maintenance.

VII. APPLICATIONS

➤ Applications

1. Numbers on ATM cards.
2. Dog Tacks.
3. Expiry and manufacturing dates on food containers.
4. Wedding cards.

VIII. FUTURE SCOPE

The project work can further be modified on the following basis –

- ✓ The flux of electromagnet can be increased by increasing size of the same and by increasing the coil turns. So this modification enables this machine to emboss harder materials such as steel.
- ✓ Automation can be implementing by adding roller and feeder mechanism.
- ✓ The PVC pipe can be replaced by non magnetic metal.
- ✓ MDF can be replaced with aluminium.
- ✓ Overall capacity can be increased.

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