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Fabrication of Metal Chips Briquetting Machine

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***Abstract* – Metal chips are widely recycled and used to form metals further. The handling, storage and transportation are an important aspect in recycling process. This project mainly focuses on the fabrication of metal chips briquetting machine for compaction and creation of metal chips briquettes for ease in handling and transportation. The briquettes are made by applying hydraulic pressure with the help of hydraulic cylinder. No heating unit is used to reduce the overall cost of the project. Storage capacity and transportation cost before and after forming the briquettes is been compared.**

Keywords: Metal Chips, Briquetting Machine, Fabrication, hydraulic cylinder.

I. INTRODUCTION

Metal chips briquetting machines are widely used in the small scale and large scale industries where tons of amount of metal chips are formed on daily basis. Metal chip Briquetting machine is mainly used to reduce the volume of the metal chips generated in different machining processes. It is done by applying the compressive force in downward direction the metal chips in a die of a particular shape; in this case cylindrical shape. Hydraulic pressure is applied on the chips in die with the help of a hydraulic cylinder. The change in shape of the formed briquettes for different pressures for a fixed size of die is studied.

This paper mainly focuses on making briquettes of Mild Steel metal chips. The project is mainly carried out in two parts, first is to calculate the amount of force required to form a briquette of a fixed size and shape with help of testing on UTM machine. Second part of the project is to design and fabricate parts of the machine from the results obtained from test on UTM machine.

The design and material used are presented. All conceptual design in the project is drafted with the help of NX-cad.

II. FUNCTIONAL REQUIREMENTS

- To fabricate a machine which can form briquettes of cylindrical shapes.
- Weight of machine should not be greater than 200kg.
- Briquettes should be formed without any heating effect.
- Coolant adhered to the metal chips should be extracted after forming briquettes.

III. METHODOLOGY

The methodology includes mainly two steps, experimentation on UTM, design and fabrication of actual parts of the machine.

a) Experimentation

The main aim of the project is to reduce the volume of the metal chips in a cylindrical die of height 250mm and diameter of 128mm. For that, an experiment is carried out on the UTM machine to calculate the force required to from briquette of different heights. It is been observed that for different forces, heights of the briquette and compactness varies.

More amount of force leads to compact briquette for a fixed size of die. The results obtained from the experimentation are given below in a table format. A graph is also provided showing the variation of length with the variation of force for better understanding.

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Initial force, F_i (kN)	Final Force, F_o (kN)	Height of briquette, h (cm)
4.75	17.45	17.45
4.75	19	17
4..75	23.40	12.5
4.75	25	12
4.75	32.50	11
4.75	35	8.5
4.75	40.5	8.3

Table-1: Results of Testing on UTM machine

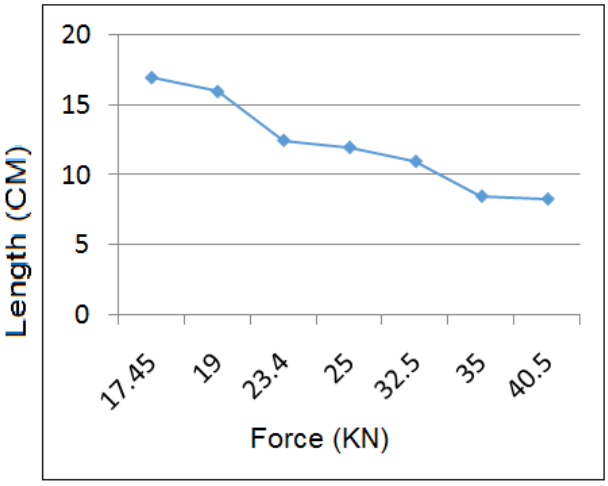

Figure-1: Graph of Force Vs Change in length of briquette

b) Design and Fabrication of Parts of the Briquetting Machine

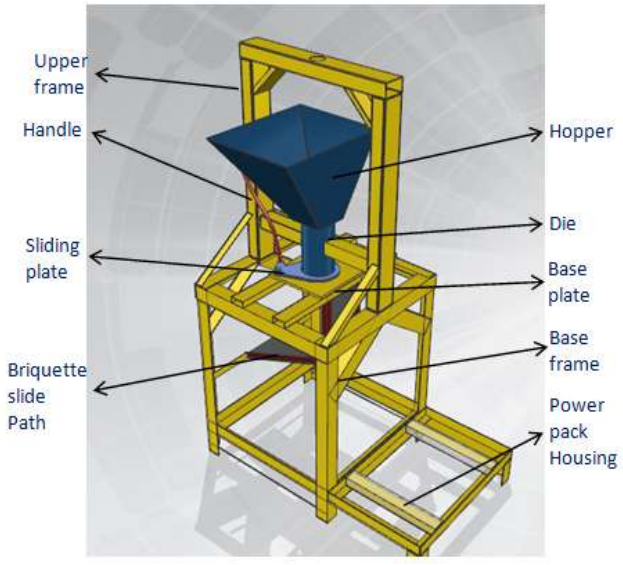

Figure-2: Parts of Briquetting machine

Sr. No.	Name of Component	Dimensions (mm) (l*b*t)	Weight (kg)	Quantity
1	Rectangular Pipes	(96*41*3) L = 900mm	14.6 kg	2
2	Rectangular Pipes	(96*41*3) L = 775mm	6.3 kg	1
3	Tapping Plate for Hydraulic Cylinder	(260*110*14)	3.14 kg	1
4	Hopper	t = 2mm	9.5 kg	1
5	Die	I.D. = 128mm h = 250mm t = 12mm	5 kg	1
6	C-Channels	(70*30*3.5)	6.4 kg	2
7	L-angles	(50*50*6)	14 kg	4
8	L-angles	(64*64*5)		4
9	Fixed Plate	(314*310*10)	7.2 kg	1
10	Moving Plate	d = 195mm t = 10mm	4 kg	1
11.	Hydraulic Cylinder	I.D. = 65mm Stoke = 550mm	20 kg	1

Table-2: Components used and their specifications

All the parts of the machine are made of Mild Steel only. Different parts of the machine and their function is given below.

1) Hydraulic Cylinder and Power Pack

The power pack and the hydraulic cylinder is been provided by the Akshar Industries, MIDC, Ahmednagar. Hydraulic cylinder is mounted on the upper frame by tapping it on a plate to 14mm thickness. Following is the required information of the both –

Hydraulic Power pack:

- Min press : 25 kg/ cm*cm
- Motor rating : 2 hp
- Reservoir cap : 40ltrs
- Discharge rate : 1.585 gallons/min

Cylinder:

- ID : 65 mm
- Stroke : 550mm
- Double acting
- Pressure capacity : 70kg/cm2

Calculation for force generated by power pack:

Force generated by the power pack,

$F_{generated} = p * A = 1.5386$ Tons

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Where, p = pressure generated by power pack
A = area of cross section of cylinder

By experimentation, force required for making briquette,
F_N = 1.29459 tons

Therefore, $F_{generated} > F_N$

2) Die and Hopper

A cylindrical die is made of mild steel having length of 225mm and diameter of 128mm. Hopper is used to direct the metal chips poured in it. The primary requirement is to form one briquette from the metal chips poured once in the hopper. Volume of hopper is 0.023187 m3.

Figure-3: Die

Figure-4: Hopper

3) Upper Frame

It is made from the three rectangular pipes. This frame bears the weight of the hydraulic cylinder. It is rested on the base frame of the machine. Rectangular pipes are having dimensions 96*41 mm with thickness of 3mm. two 900mm and one 775mm length of pipe is used.

The horizontal pipe carries the weight of cylinder & cylinder plate, hence it should be checked for bending failure.

Now, for bending moment,

$б = (M*y)/I = 3133.08$ kN/m^2

Where, б - bending moment

M - Moment due to forces

y - Distance of horizontal surface from center

I - moment of inertia

A vertical rectangular pipe carries the weight of whole upper frame assembly with horizontal rectangular pipe. Therefore, total weight carried by the vertical pipes = 493.653N

Also it bears the pressure applied by the hydraulic cylinder. Hence it is to be checked for bending as well as buckling failure.

Bending load it can sustain,

$б_{applied} = F_{on\ single\ pipe}/A = 239.173$ kN/m^2

Buckling load pipe can sustain is,

$F_{cr} = (\pi^2 * E * I)/L_e^2 = 701.424$ Kn

Figure-5: Upper Frame

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4) Moving and Fixed Plate

Fixed plate is welded on two C-channels which are rested on the base frame. On the fixed plate, moving plate is pivoted. Together these two plates take the load applied by the hydraulic cylinder. These plates are having the thickness of 10mm each. Fixed plate is rectangular in shape with dimensions (310*314mm). The shape of moving plate has been fixed according to the hole diameter of die and according to the rotating mechanism.

Maximum Stress induced on the moving plate is,

$\sigma = (0.48* F/t^2) * [1+1.3*\ln(r/0.325*t)-0.0185*9(t^2 / r^2)]$

Where, $t = 12 *10^{-3}$ m

$R = 195 * 10^{-3}$ m

$F = 13.021$ kN

Maximum deflection that can occur in the plate is,

$d = (0.55*F*R^2) / E*t^3$

$= 0.638$ m

Figure-6: Moving Plate

Figure-7: Fixed Plate

5) Base Frame

It carries the weight of the whole assembly. Base frame is made of L-angles. In that four vertical L-angles are of dimensions 64*64 mm having thickness of 5mm and four horizontal angles of dimensions 50*50 mm with thickness of 6mm.

1) Force acting on single horizontal angle,
   F = ½ *(total wt. of upper frame + cylinder weight)
   = 318.531 N
   Bending moment of horizontal angle supporting upper frame,
   $\sigma_{max} = M*y_c/ I_t = 7.037*10^6$ N/m^2

2) Bending stress acting on the horizontal angles on which C-channels are welded,
   $\sigma_b = M*y/I = 97.5*10^6$ N/m^2

3) Total force acting on vertical angles of base frame
   F = 31621.993N
   Buckling load vertical angles can sustain is,
   $F_{cr} = (\pi^2 * E * I)/L_e^2 = 1705.37*10^3$ kN

   Compressive stress vertical angles can sustain is,
   $\sigma_c = F_{t1} / A = 5.55 * 10^3$kN/m^2

Figure-8: Base Frame

IV. WORKING

Main aim of the project is to form briquettes with minimum manufacturing cost and in less time with less power consumption. For that purpose, heating unit is not used in the machine like that of traditional briquetting

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machines. This machine forms briquettes solely by using hydraulic pressure. The Power pack generates hydraulic pressure in the double acting cylinder with the help of hydraulic oil supplied from hose pipes. Direction of stroke of the cylinder is controlled by 4/3 DCV.

Firstly, to compress the burr filled in the hopper, pressure is to be applied in the downward direction. Due to the downward pressure applied by the hydraulic cylinder, burr in the hopper gets compressed into the die and takes its shape. During this operation, moving/rotating plate is such that it closes the hole in the fixed plate. After compression of burr is compacted, rotating plate is rotated with the help of handle provided. Briquette doesn't fall down from the die itself, so it has to be pushed manually with the help of a pushing rod. This formed briquette falls into a briquettes carrying container sliding over the Briquette sliding path below the fixed plate assembly. In company, one worker is needed for operating the machine and removing and carrying briquettes formed in the machine. It takes about 3 to 4 minutes to form a single briquette. It is observed that 20 briquettes per hour is the average rate of briquette formation.

Figure-9: Complete assembly of Briquetting Machine

V. RESULTS

- Total weight of the machine without assembling hydraulic cylinder is 130 kg and with hydraulic cylinder is 150 kg. The goal to keep the machine weight under 200 kg is successfully achieved.
- It has been observed that, total volume of hopper is 0.069561 m^3. This much volume can contains roughly 5 kg of unprocessed metal chips at a time. But as hopper cannot be filled completely at once due to handling issues, less amount of burr is utilized to form briquette which weights 2-3 kg.
- We get total volume reduced from 0.069561 m^3 to 0.012861 m^3. Which is about 80% of volume reduction achieved by compressing the burr. But as the burr is fed in the hopper manually, the compaction percentage may vary for each briquette as per variation in amount of burr fed in the hopper.
- Briquetting machine takes about 2 to 3 minutes to from a single briquette.20 to 25 briquettes can be formed in 1 hr. operation of the machine. One briquette costs 0.36Rs.to form.
- Coolant adhered to the metal chips are mostly get extracted while compressing it. It has been observed that 50% of coolant waste is minimized due to extraction and reuse of coolant adhered to the metal chips.

VI. CONCLUSION

The Briquetting Machine fabricated is capable of forming the briquettes of cylindrical shape with diameter 128mm without any heating effect. Also some amount of coolant adhered to the burr (around 30% of coolant) is been extracted during the briquette forming operation. The machine weights around 150 kg, which ensures easy movement of machine within the industry with hydraulic jack.

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