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Dewaterizer for the Application of Extracting Moisture from Organic Waste/Slurry

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Abstract: *This project is aimed at the design and fabrication of moisture extraction machine from organic waste. The main objective is commercialization of machine for low cost waste treatment. As, India is developing country we face a lot of problem of waste management, and its disposal. The main aim of this project is to solve this problem of proper disposal of organic waste. The main component of this machine is variable pitch shaft, resistor plate, resistor block, slotted pipe. The cake obtained is further treated to convert it into compost, and proper disposal of Organic waste.*
Keywords - *Organic waste, Extraction, Variable Pitch, Resistor plate, Screw press*

I. INTRODUCTION

Dewaterizer is used to remove the moisture from the organic waste. so, that the dry waste may be processed as per requirement. As, the organic waste contains some amount of moisture in it. This moisture may cause a problem in compost making and the efficiency of the machine decreases. Thus, by using dewaterizer the excess of moisture is removed from the organic waste thus making it ready for compost making, rather than leaving the waste drying for few days. Thus, making the compost making process faster. Further dewaterizer can be also used to extract oil from nuts, and juice from fruits by further modifications.[4] Dewatering lowers the volume and weight of solid wastes, reducing costs (such as transport and landfill) and increasing its suitability for subsequent utilisation. Stabilises waste – reduced leachates and provides a more uniform product. While polymer use can enhance dewatering, it is expensive and can be problematic.

II. DESIGN METHODOLOGY

Dewaterization can be achieved in various ways such as-(1) Centrifuging. (2) Thermal drying. (3) Conveyor belt press. (4) Screw press. We selected the screw press due to its compact design, less processing time, less power consuming and ease of use. It works on the principle of 'Compression and Shear'.[1] The screw is designed in such a way that its pitch decreases along the length in a uniform way. At the inlet the pitch is large and it decreases till the end. The pitch at the end being the smallest to achieve higher degree of compression. Further to shred the large organic waste chunk resistor block are provided. For cleaning the interior of the machine, hole is drilled on the resistor block through this hole pressurized water is sprayed. Five resistor block are placed along the length of machine.[2] The pitch along the shaft is cut accordingly to adjust the resistor block. Resistor plate of mounted at the outlet of the dewaterizer. The main purpose of resistor plate is to exert compressive force on the waste that flows from the shaft. This further removes the moisture from the organic waste. This resistor plate is mounted axially along the shaft and at the back of the resistor plate mechanical spring is attached. Instead of mechanical spring nut and bolt arrangement can also be used, but the main drawback of using the nut and bolt arrangement is that once the machine is set under operation the setting of the nut and bolt cannot be altered. Hence, for providing the flexibility during operation mechanical spring is used. The shaft is covered with slotted pipe for the removal of moisture which is expelled out of organic waste due to the compression between the pitch. There are total twelve slits along the length of allotted pipe. The slits are designed in Y shape. So that only moisture is expelled through them and not the waste. An electric motor is provided at the end to run the machine. A proper frame is designed to hold the assembly. A hopper is provided at the inlet of the machine to maintain uniform flow of organic waste in the machine.

2.1 Compressive Mechanism In a Screw Press.

The function of screw press is to separate liquids from solids by expelling the liquids through a screen that surrounds the compression screw.it takes pressure to make the fluid flow through the hole or slots in the screen. compression can be achieved by gradually deceased by y the pitch of the screw this forces material out against the screen so that the liquid is expelled through the screen. that is,if the flight has 200mm pitch at the inlet material will move 200mm with each revolution of the screw .if the pitch is reduced to 60mm at the discharge this same material move only 60mm per revolution. Thus, with each turn off the screw there is more material being forced into the screw press than there is being removed. The consequences is compressive force, which tends to push liquids through the screen.

An another way to achieve compression is to install a cone at the discharge. The cone is also referred to as a choke stopper or door. In many screw press it is bolted into a fixed position, creating a fixed discharge orifice. Through which the press cake must pass. More, commonly the cone is pushed into the discharge opening by either an air or hydraulic cylinder. The greater the back pressure in the press, the greater the dewatering that occur.

2.2 Interrupted Screw Design.

Since the continuous flight arrangement of a screw, there are tendencies for slippery material either to co-rotate with the screw or to pass through the minimal dewatering. So, to avoid these problems interrupted screw design was introduced, there is no flighting at certain points on the shaft, so the material tends to stop moving towards the discharge. It is only after solids accumulate upstream, in sufficient consistency, that the material in the gap is pushed to where downstream flight catches this material. when this happens material is forced along its way. This results in better dewatering and more consistent press cake.

2.3 Torque

Torque is very important design consideration in screw press. The more work a press has to do, the more torque that is required. Gearboxes are made according to their torque rating, not their horsepower input or speed output. The bigger the torque rating, the bigger the gearbox, and higher is the price.

Power= 5HP

N= 10-40 RPM

$$P = \frac{2 * \pi * N * T}{60000} \quad [1]$$

T= 4774.64 N-m

Therefore, TORQUE=4774.64 N-m.

2.4 Shaft With Varying Pitch

The dewaterizer is designed for capacity of 1tonn/hr

Density of organic waste=600 kg/m^3

Shaft being the main component of the dewaterizer is designed as per the ASME rules for shaft design.

- Material used for shaft =mild steel
- Ultimate tensile strength of shaft=S_{ut}= 560MPa
- Yield strength of shaft= S_{yt}= 380MPa

As per ASME rule,

τ= 0.3* S_{yt} or,

τ= 0.18* S_{ut} (minimum value is selected)

now

diameter of shaft=d

$$\tau = \frac{16 * \sqrt{(k_b * M_b)^2 + (k_t * M_t)^2}}{\pi * d^3} \quad [3]$$

thus diameter is found to be 60mm. for a mass flow rate of 1 tonn/hr.

The slotted pipe of 204mm as a inner diameter is available in market thus it is being used.

The Varying pitch of the shaft is calculated using the formulae

L= 4*V/(π*d^2)

The various pitch length found are as follow:

Table1: Volume to length

Volume (m^3)	Length by calculation (m)	Pitch length for design (m)
0.0416	0.1964	0.20
0.0384	0.1842	0.18
0.0354	0.1781	0.18

0.0325	0.1535	0.15
0.030	0.1228	0.12
0.028	0.0921	0.09
0.0265	0.0736	0.07
0.0253	0.0553	0.06
0.0244	0.0553	0.06
	Total=1.1113	Total=1.11

The pitch is thus calculated and the modelling of the shaft is done in Catia: The following Figs.3 show the model of shaft with varying pitch. there are total nine pitch of varying length. As the pitch reduces the moisture from the organic waste starts flowing due to the compressive force. The density of the organic waste at the inlet is around 600kg/m^3. but due to compression the density changes to 1029 kg/m^3. Thus, the moisture is reduced and the solid waste is obtained.

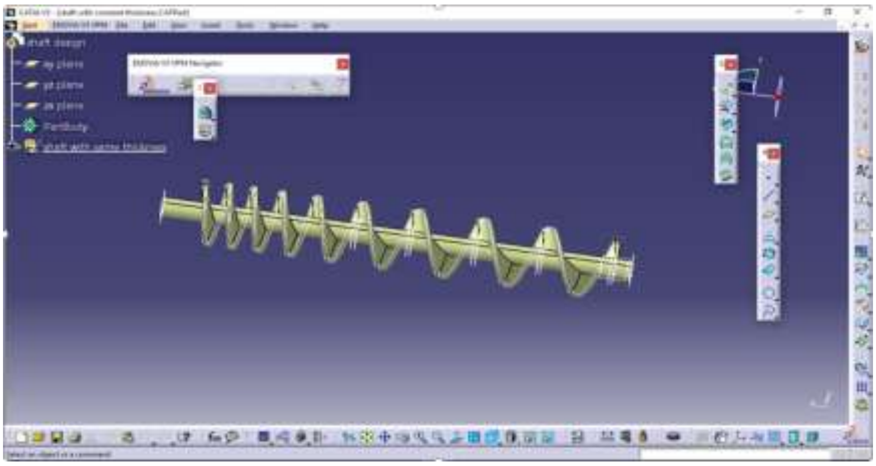

Fig. 1. Modelling of shaft in catia

2.5 Screw To Screen Clearance:

A critical element in screw press design is the screw to screen clearance. This clearance is important because of the action of the screw pushing fiber over the screen. This movement wipes the screen clear, brushing the screen to permit the free passage of press liquor. Thus, the tighter the screw to screen clearance, the better the dewatering action. The screw diameter is machine to within a few millimeters thus the screw outer diameter has fixed reference surface. screens are fabricated not machined of stainless steel, ring, gussets and honeycomb reinforcing are used for strength and rigidity

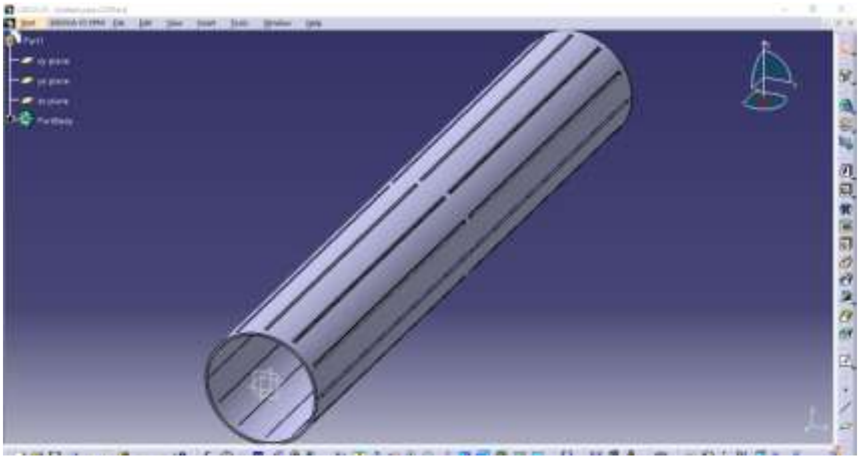

Fig.2 modelling of slotted pipe.

2.6 Clean In Place For Screw Press

Sometimes screw press are used to squeeze material and sanitation is required, which is important consideration for human health this leads to clean in place(CIP). There are two type of CIP: external and internal

EXTERNAL: external CIP system is used for spraying outside of the screen.
INTERNAL: For internal CIP most, we drill the top resistor teeth so that the steam, and high pressure water can be injected into the press. This is done with the press in operation, empty but with the screw turning. Thus for internal cleaning, there is no need of opening the machine every time for cleaning using these drilled holes for cleaning.

Fig.3 holes drilled over the resistor block for cleaning.

III. CONCLUSION

An dewaterizer was designed, constructed for extraction of moisture from organic waste. The screw press was simple enough for local fabrication, operation, repair and maintenance. Powered by a 5 HP three-phase three-phase electric motor. The dewaterizer will be used for a medium or small-scale industry. The dewaterizer is operated, with an RPM range of 10-40. The expected output is 60% moisture reduction as per calculations.

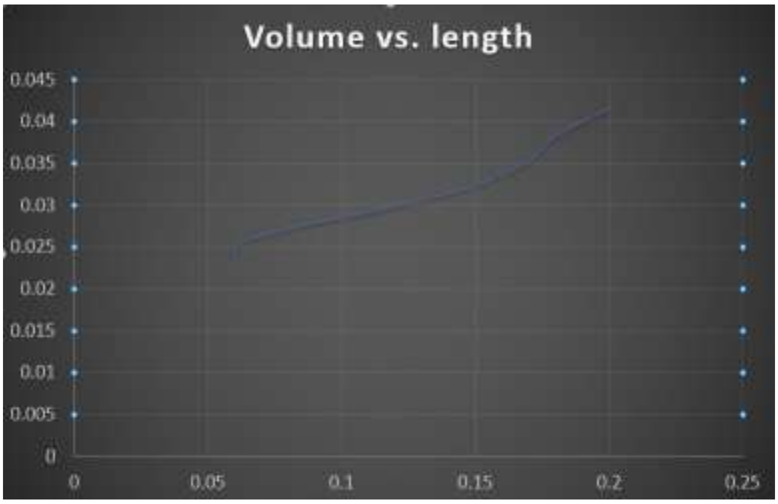

Fig. 4 graph of volume (m^3) vs. length of shaft (m.)

Thus from the above fig.4. we can conclude that when the organic waste passes through the machine its volume decreases which leads to reduction in moisture of the organic waste. Thus we get the dry product at the outlet.

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