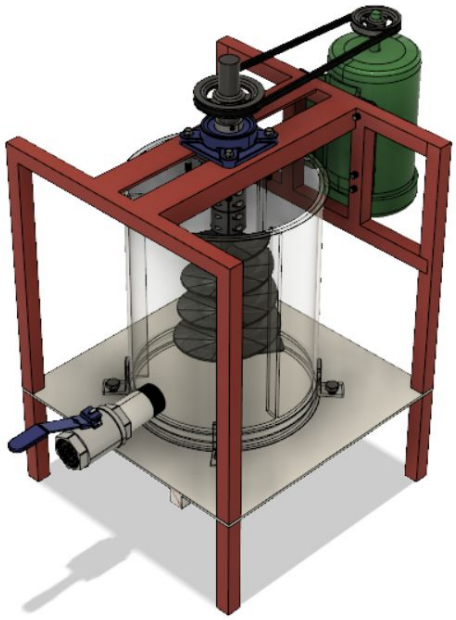
HYDRAPULPER



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Project by

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DESIGN AND FABRICATION OF HYDRAPULPER FOR RECYCLING WASTE PAPER

PROBLEM STATEMENT :-

CONVERTING WASTE PAPER INTO PAPIER-MACHE :-

Lots of paper waste is being generated at IIT every semester. These are shredded and disposed of or incinerated. This volume will only increase as we grow in size. One interesting way is to convert this paper into pulp using a blender (kitchen mixer for small volumes) and then drain it using a mesh. A customized blender can also be designed to automatically manage this operation. We also need to make a rigid mesh supported on wooden frames that can drain the water from pulp. This will be drained, dried and used for making hand-made paper for craft items or paper bags.

MOTIVATION BEHIND THE WORK :-

In IIT's lots of paper waste is being generated and this paper is being shredded. This shredded paper cannot be used in any way until we recycle the paper. Hence, there is a need to separately collect paper waste from household waste and locally fabricate a machine, which will be cost effective, not complex to operate and easy to maintain, to recover quality fibres from the waste paper so as to meet the growing demand for paper products.

ABSTRACT :-

The project is aimed at producing paper from disused waste papers creating environmental problems. Their use will reduce the overexploitation of trees in the forest for papermaking. A hydrapulper was designed and fabricated using locally sourced materials to make the disintegration process cost effective. It can be concluded that most of the paper components can be recovered for papermaking. The designed hydrapulper can recycle 1kg of shredded paper using 20L of water per charge.

DESIGN CONSIDERATIONS AND PARAMETERS :-

1) The hydrapulper cylindrical container was designed to be strong enough to withstand the internal stresses that might develop inside the container through the collision of the agitated water-diluted stock with the wall of the container.

2) Mild steel and angle iron were used as the major construction materials because they are readily available, possess adequate strength and can be easily formed and joined together through screwing and welding.

3) Baffles are long, flat plates that attach to the side of the tank to prevent swirling & promote top to bottom fluid movement.

4) A high consistency rotor blade, attached to the shaft, was used to promote high shear action and smooth repulping in order to produce high quality fibres.

5) The machine was painted to prevent corrosion and improve its aesthetics.

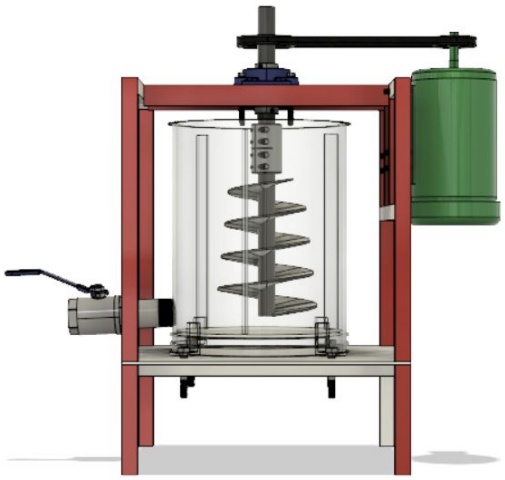
TECHNICAL DETAILS :-

1) **Container Design :-**
   - ➢ It is made up of stainless steel.
   - ➢ Radius of the container = 14.7cm
   - ➢ Height of the container = 35cm
   - ➢ Thickness of the container = 0.6cm
2) **Blade :-**
   - ➢ Required Speed of the rotor blade = 900 -1000 rpm
   - ➢ Required torque = 3 – 7 N.m
3) **Motor :-**
   - ➢ Standard three phase induction AC Motor
   - ➢ Speed of motor = 1415rpm
   - ➢ Power of motor = 1hp
4) **Pulleys and Belt :-**
   - ➢ Power transmission is required in order to achieve the required speed and torque. Generally, gears are the best power transmitters. But, due to the complexity of gears, pulleys and belts are considered.
   - ➢ Based on the calculations made, the required ratio of speed reduction is approximately 1.5:1.
   - ➢ V – Belt pulleys are used in the design.

- Power required to be transmitted = 1hp
- By trial and error analysis the best power transmission can be done with the following details
- Radius of smaller pulley = 7.62cm
- Radius of larger pulley = 10.16cm
- Length of belt = 91.44cm

5) Rotor :-

- Helico pulpers, comprise a vertical-axis turbine having the shape of an helix, which imparts to the material an axial downward motion followed by a centrifugal motion along a smooth bottom. In these devices, fibre separation is achieved by the friction of fibres against fibres, while the centrifuged material is ejected against relatively immobile material. There is only a small amount of shredding, so that the contaminants are left intact and do not become divided, while the paper fibres are separated.
- The speed difference between the material flowing from the rotor and the surrounding material causes the paper pieces to be subjected to friction forces which disintegrate the fibres. Therefore, helical blade of varying radius is used.



- Height of the rotor = 32.3cm
- Smallest radius of the helical blade = 4.84cm

- Largest radius of the helical blade = 7.28cm
- Thickness of Blade = 0.3cm
- Pitch = 5.48cm
- No. of turns = 4

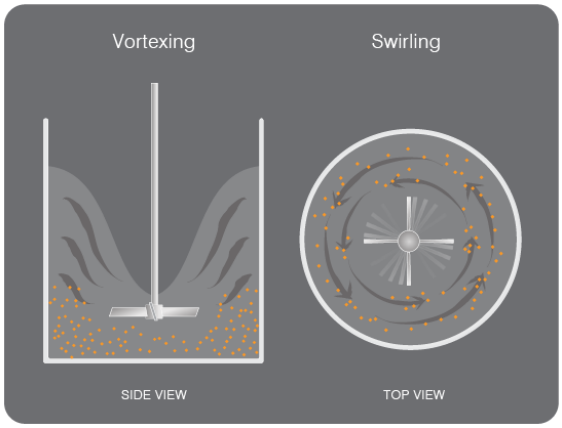
6) Mechanical Components :-

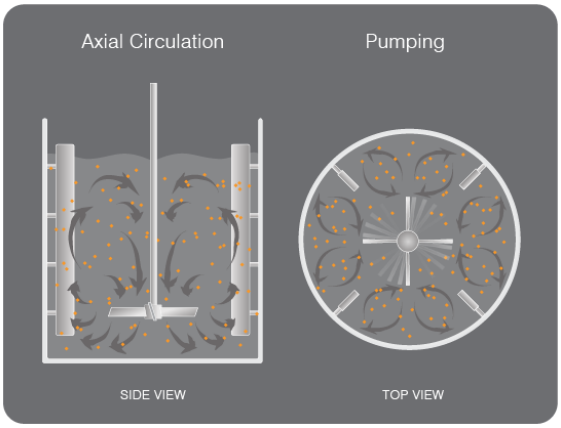
- **Collar**
  - Housing number = F206
  - Bearing number = UC206-20
  - Shaft Size = 3cm
  - Bolt Size = M10 3/8 in
  - Weight = 1.1 kg
  - Locking Style = Set Screw Locking
  - Grease Fitting = A-1/4-28UNF

- **Coupling**

  Flange Coupling is a driving coupling between rotating shafts that consists of flanges one of which is fixed at the end of each shaft, the two Flanges being bolted together with a ring of bolts to complete the drive.

- **Baffles**
  - If a mixer is centre-mounted in an unbaffled tank, we see an inefficient flow pattern i.e., the tangential velocities coming from the rotor cause the entire fluid mass to spin as shown in below fig.





- Baffles are long, flat plates that attach to the side of the tank to prevent swirling & promote top to bottom fluid movement. They are most commonly used for blending and solid suspensions because these applications often use vertical, cylindrical tanks that tend to create swirling patterns, regardless of the type of impeller being used.
- The flow pattern illustrated here shows that the use of baffles results in excellent top-to-bottom circulation and great radial mixing.

- **Anti-Vibration Pads**
  - If the system doesn't have an anti-vibration isolator, the system may displace or parts may wear down.
  - The purpose of using the anti-vibration isolators was to resist shock or vibration.
  - This specific anti-vibration system is made using Sorbothane, which is a visco-elastic polymer.
  - The Sorbothane Anti-Vibration System refers to a highly advanced shock absorbent system.
  - So, the Sorbothane Anti Vibration System pads can be customized to your preference.

CHEMICALS :-

- The chemicals are mainly used to bind the paper fibres together and increase the quality of the paper.
- Rosin is used for internal sizing (resist liquid penetration)

- Alum is used to precipitate rosin sizing on to the fibres. It fixes additives to fibres and improves pulp fibres retention.
- For 1kg of paper 10L of water is needed to recycle.
- The quantities of chemicals needed for 1kg of paper are: -
  - Rosin resin – 30 g
  - White alum – 60 g

FABRICATION AND ASSEMBLY :-

The major processes undertaken during the fabrication were grinding, marking out, cutting, beating, welding, sharpening, drilling and boring, from which the cylindrical container, the rotor blade, the container cover, metal based plate and the hydrapulper legs were fabricated and assembled together.

CHALLENGES FACED :-

- Difficulties have been faced during selection of motor.
- The required motor is not available within the budget.
- Weight and size of the motor became a constraint.
- Due to less thickness of the container, few leakages occurred during welding of nipple to the container.
- The blade started wobbling due to its asymmetric shape.
- Housing is not available for the required bearing.
- Translation and vibration of the system due to obling of the blade.

OVERCOMING CHALLENGES :-

- Bearing's contact surface area has been increased by bolting two collars, one over the other, which reduces obling of the blade which in turn reduces the translations and vibrations of the system.

- ➢ Anti-Vibration isolators absorb the vibrations and reduce the translatory motion of the system.
- ➢ Wooden plank underneath the frame has a larger surface area which transmits the vibrations to the anti-vibration isolators equally.