

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY**

**Belagavi-590018**



**A Project report on**

**“DESIGN AND FABRICATION OF PAPER RECYCLING MACHINE”**

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**In partial fulfillment of the requirements for the Degree of**

**BACHELOR OF ENGINEERING**

**IN**

**MECHANICAL ENGINEERING**

**Under the guidance of**

**Prof. GANGADHARA RAO**

**Associate Professor**



**Department of Mechanical Engineering**

**SRINIVAS INSTITUTE OF TECHNOLOGY**

**(Accredited by NAAC)**

**MANGALURU-574143, KARNATAKA**

**2019-2020**

Guide's Signature

**SRINIVAS INSTITUTE OF TECHNOLOGY**  
**MANGALURU - 574 143, KARNATAKA**

**DEPARTMENT OF MECHANICAL ENGINEERING**



**CERTIFICATE**

Certified that the project work entitled “**DESIGN AND FABRICATION OF PAPER RECYCLING MACHINE**” is a Bonafide work carried out by

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In partial fulfillment for the award of **BACHELOR OF ENGINEERING** in **MECHANICAL ENGINEERING** of the **VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI** during the year 2019-20. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the Departmental library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering Degree.

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**EXTERNAL VIVA**

**Name of the Examiners**

- 1.
- 2.

**Signature with Date**

## **ABSTRACT**

In any big institution, especially educational institutions like schools or colleges, generation of large quantity of waste papers is quite apparent. And effective use of recycled paper is also possible (craft papers, registers etc.). So, instead of disposing off the waste papers into trash, recycling them makes sense. This not only helps the institute in cost saving but will also ensure its contribution towards the protection of the environment. Designing manually operated small-scaled paper recycling plant, which can be used in schools and colleges, ensures that a cheap and non-complex method of production of paper product is guaranteed. Accordingly design of the machine unit has been prepared with all necessary component specifications.

## ACKNOWLEDGEMENT

It is my proud privilege and duty to acknowledge the kind help and guidance received from several people in preparation of this report. It would not have been possible to prepare this report in this form without their valuable help, cooperation and guidance.

We thank our project guide **Mr. GANGADHARA RAO**, Associate Professor Department of Mechanical Engineering, who has been our source of inspiration. He has been especially enthusiastic in giving his opinion and critical reviews.

The Selection of this project work as well as the timely completion is mainly due to the interest and persuasion of our project co-ordinators **Mr. JAYARAM TUMBE**, Associate Professor, Department of Mechanical Engineering and **Mr. VENKATESH RAO**, Assistant Professor, Department of Mechanical Engineering. We will remember their contribution for ever.

We express our deep sense of gratitude to **Dr. SHANKAR K S**, Professor and Head, Department of Mechanical Engineering, SIT, Valachil, Mangaluru. Who has been the constant driving force behind the completion of project.

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**1.****INTRODUCTION**

Paper is one of the essential things that are present in our lives. Paper is used for storing data and also for packaging works. The paper manufacturing industries helps in tremendous employment across the world. Paper preparation process is a huge process were a solution of pulp less than 0.5% fiber is used which is diluted. This process of recycling is followed in several steps; pulping, forming, pressing and finally drying.

In pulping paper is mixed is water and chemicals in a large pulper. The chemicals used are acetone, NaOH, hydrogen per oxide and starch. The pulp is used to reduce size of paper in smaller amount and then even heat can be added so that paper breaks down in fine fibers. The mixture that is obtained is known as the pulp. The process of ink removal which is known as de-inking is done here. This method removes unwanted glue with floatation method by the help of foam. In the method of press rolling the removal of additional quantity of water takes place with help of mechanical pressure by application of pressure and rollers.

In other section that is drying heated cylinder are used in removal of surplus amount of water. The main problem faced by paper industry is the unavailability of required raw material. As the main raw material that is used in paper industry being wood would harm the environment. So to prevent cutting down of trees industries are implementing recycling of paper. In the process of recycling waste paper is used instead of raw material wood. Waste Paper is used in preparation of pulp in paper recycling process. Designing of fully automated machine can be used in the production of paper and hence reducing the cost of paper production. The modeling is done in 3D and will be shown in CATIA and the same model will be built. The method of paper recycling saves the nature by reducing used of wood and hence it decreases the investment. By this method water consumed by the industry decreases and even this helps in preservation of environment. As we recycle paper it reduces the use of power. Use of automated recycling machine results in cheap method of producing paper and the process is also simple. As the paper recycling process introduces collection of paper from the scrap, it results in employment for those who collects paper. The recycling plant contains many major component units that include refiner, hydropulper, head box, felt conveyor and rollers.

The invention of paper is the most important thing in history because it has resulted in the development of children through books and as a result of recycling; more children can get education by this method. The source of raw material will be vegetable fibers obtained from plants. So to stop that, paper recycling is used as alternate method so that environment can be saved. To ensure that forest is not depleted this is the right method. As a result paper is produced more and the production is doubled as the industry can produce paper with wood and even the paper they produce can be recycled.



**2.****LITERATURE REVIEW**

1. AJIT K GHOSH (2011), fundamentals of paper drying theory and application from industrial perspective.

Ajay K Ghosh explains a process in which contact drying with steam heated cylinders method of drying is used. Besides the conductive heat transfer between hot cylinder surface and wet web and the roll of air that is either the drying medium or surrounds the drying atmosphere is very significant. The final moisture content of the finished product is between 6-8%.

2. VIKRAM DANDEKAR (2014), Twin roll press pulp washing.

Vikram Dandekar studied twin rolling press system and concluded that it helps to develop a new pulp feeding system which helps to wash the dirty pulp away compared to existing pulp feeding system. This introduced the design concept twin roll press pulp wash which is cost efficient. But beside the drum other accessories for example, agitators and vacuum pump are required and the discharge pulp contains residual moisture and the energy consumption by the vacuum pump will be high.

3. VIJAY KUMAR C VENUGOPAL (2016), Design of deinking process for recycling mixed wastepaper.

Vijay Kumar C Venugopal's paper gives various process of deinking like pulping conventional deinking, enzymatic de-inking, floatation deinking ultrasonic and sludge treatment. The deinking process is an attempt to incorporate promising results at the laboratory stage into existing conventional process in order to achieve efficiency.

4. SHAUN ANTONY REARDON (1994), Simulation of paper drying energy consumption.

Shaun Antony's paper covers different parameters related to paper making such as machine speed, specific steam consumption, boundary conditions etc. In his method numerous variables have been researched and mathematical model has been tested against actual machine. Machine data and found to predict moisture content within several percent.

## **PROBLEM DEFINITION**

The paper mills do not have all the processes of paper recycling incorporated in one. The separate processes in the plant leads to delay in the delivery of raw materials for next stage due to transportation and paper mills require large floor area for this purpose so that they are located outskirt of the city. So the transportation costs are high. So this concept is used to overcome the above problems and increase the percentage of paper recycling

## **OBJECTIVES**

- The objective is to design a compact machine which integrates all the processes of paper recycling.
- To do a 3D modeling and fabrication of the machine.
- To reduce the delay between waste paper collection and recycling of the paper.

**3.****METHODOLOGY**

The steps involved in the process are as follows:

**PULPING:**

At first shredded paper with hot water is fed into a pulper with the help of binder. Binder blends the solution of water and paper with the help of whitening agents. Pulped paper fibers are separated from the solution and there will be a formation of thin paper pulp solution.

**FORMING:**

When the pulper flows down through the valves on the felt conveyor, some fraction of water is drained out due to gravity through felt mesh.

**PRESS ROLLING:**

Conveyor felt moves through a series of rollers and through this pressing action press rolling is done. In this water will be squeezed out and there will be a formation of thin sheets of recycled paper. Idler rollers will be followed and out of these only one roller is the main and is known as driver roller and the others rollers will be driven from motion of the felt conveyor.

**DRYING:**

After the formation of sheets felt will be passed through a heated roller and then to air blower section, which will evaporate the water left in the sheet and finally dried sheet is obtained.

## **4. COMPONENTS AND DESCRIPTION**

The components involved in the fabrication of the PAPER RECYCLING are as follows.

HOPEER

PULLEY

ACMOTOR

CONTROL UNIT

FRAME

PNEUMATIC CYLINDER

SOLENOID VALVE

COMPRESSOR

### **4.1 HOPPER**

Hopper is a storage container used to dispense granular materials through the use of a chute to restrict flow, sometimes assisted by mechanical agitation. A hopper may also use as a storage container that is used to collect granular materials designed to easily dispense these materials through the use of gravity. In other words, a hopper is a large, pyramidal shaped container used in industrial processes to dispense particulate matter that is usually fed manually. Most hoppers are made of steel and can be of any size as per the requirement. The purpose of the hopper in our project is to dispense the waste papers to the sieve drum. The hopper delivers the materials fed into it at as low rate. This is because of its pyramidal shape. A hopper can be used as a container, as a crafting ingredient, and as a Redstone component. A hopper has an "output" tube at its bottom that can face down or sideways and provides visual feedback of which direction the hopper will output items to if a container is present

### **4.2 PULLEY**

A pulley may also be called a sheave or drum and may have a grooves between two flanges around its circumference. The drive element of a pulley system can be a chain that runs over the pulley inside the groove or grooves.

### 4.3 AC MOTOR

An AC motor is an electric motor which is driven by an alternating current (AC). The AC motor consists of two basic parts, an outside stationary stator having coils supplied with alternating current which produces a rotating magnetic field, and an inside rotor attached to the output shaft which produces a second rotating magnetic field. The rotor magnetic field can be produced by permanent magnets, reluctance saliency, DC or AC electrical windings. Less commonly, linear AC motors operate on similar principles as rotating motors but have their stationary and moving parts arranged in a straight line configuration, producing linear motion instead of rotation.



Figure 4.3

### 4.4 FRAME

Material used for the production of frame is mild steel material; whole recycling machine set up will be mounted on the frame structure with suitable placing. Bearings are fixed so that the structure is aligned properly and grease is applied to the bearings

### 4.5 PNEUMATIC CYLINDER

Pneumatic cylinders are also called as air cylinders. It is a mechanical device. Force is produced by the power obtained from compressed gas in a reciprocating linear motion. These forces push the position to move in the required direction. Piston is of like a disc or cylinder, the produced force pushes the object through the piston rod so that object can be moved. Pneumatic cylinder is used widely due to their property of less noise production and for the storage of the fluid large amount of space is not required. As the operating fluid is air leakage of air will not cause a big problem. Cylinders are the devices which convert the power produced from the fluid into linear mechanical force. These cylinders have wide variety of application in industries.

## **4.5 SOLENOID VALVE**

The directional valve is one of the important parts of a pneumatic system. It is commonly known as DCV, and this valve is used to control the direction of air flow in the pneumatic system. The directional valve does this by changing the position of its internal parts that can be moved. This valve was selected for speedy operation and to reduce the manual effort and also for the modification of the machine into automatic machine by means of using a solenoid valve. A solenoid is an electrical device that converts electrical energy into straight line of motion and force. This is also used to operate a mechanical operation which in turn operates the valve mechanism. Solenoids may be push type or pull type. The push type solenoid is one in which the plunger is pushed when the solenoid is energized electrically. The pull type solenoid is one in which the plunger is pulled when the solenoid is energized.

## 5. WORKING PRINCIPLE

- First the raw materials are fed into the hopper.
- This process is made automatically so that the correct amount of raw materials is fed properly and consistently.
- The raw materials (waste paper) move from the hopper to the chamber which contains a pulper inside it.
- The pulper is simply a set of blades which rotates at speed greater than the normal one so that the raw materials fed are crushed into small granules.
- After this process thru a channel it is passed to the chamber. The pneumatic cylinder present above helps to suck out the water from the paper pulp and rectangular granules like structure is formed.
- The pneumatic cylinder is operated with the help of air compressor, which is controlled by solenoid valve.

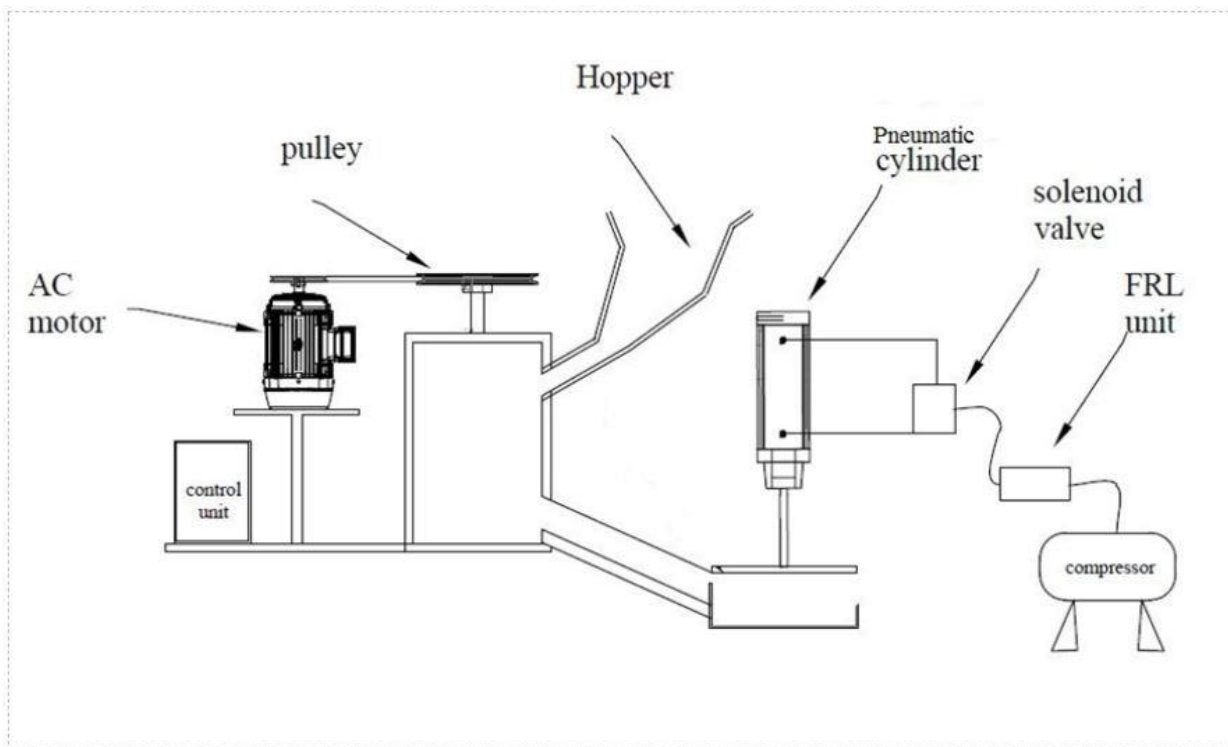


Figure 5.1: Working Principle

## 6. CAD MODEL

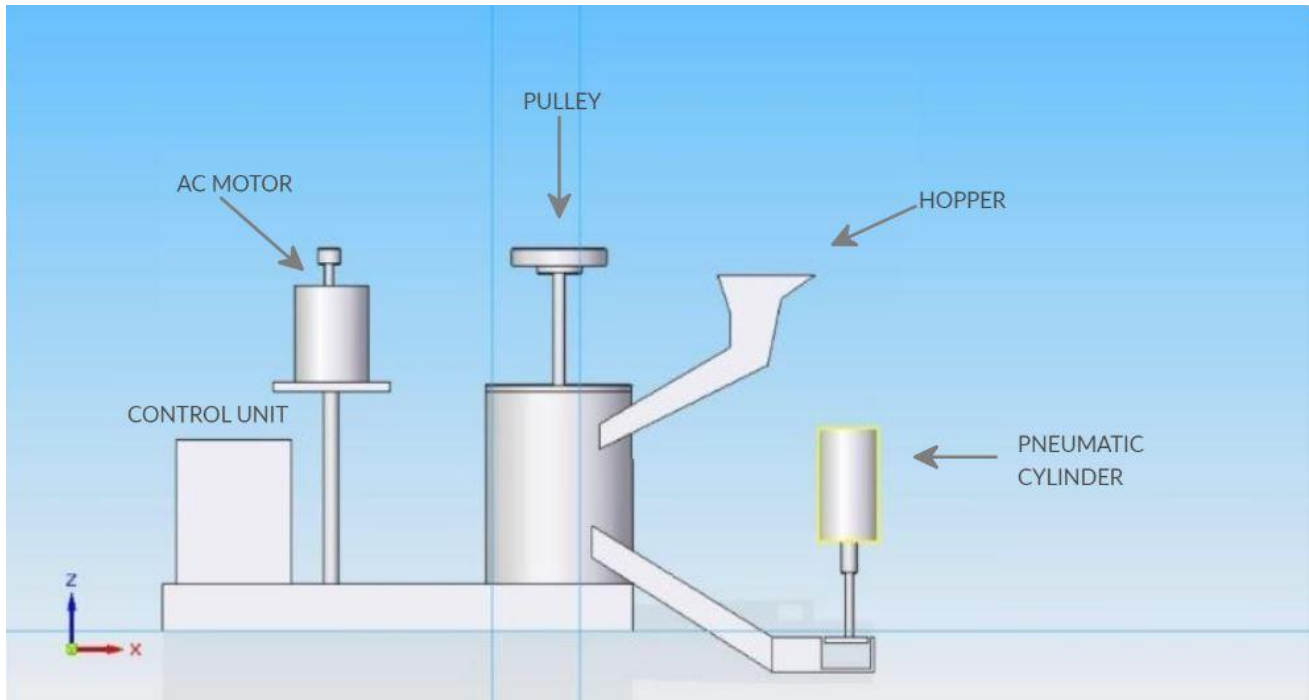


Fig 6.1: Illustrates front view of machine

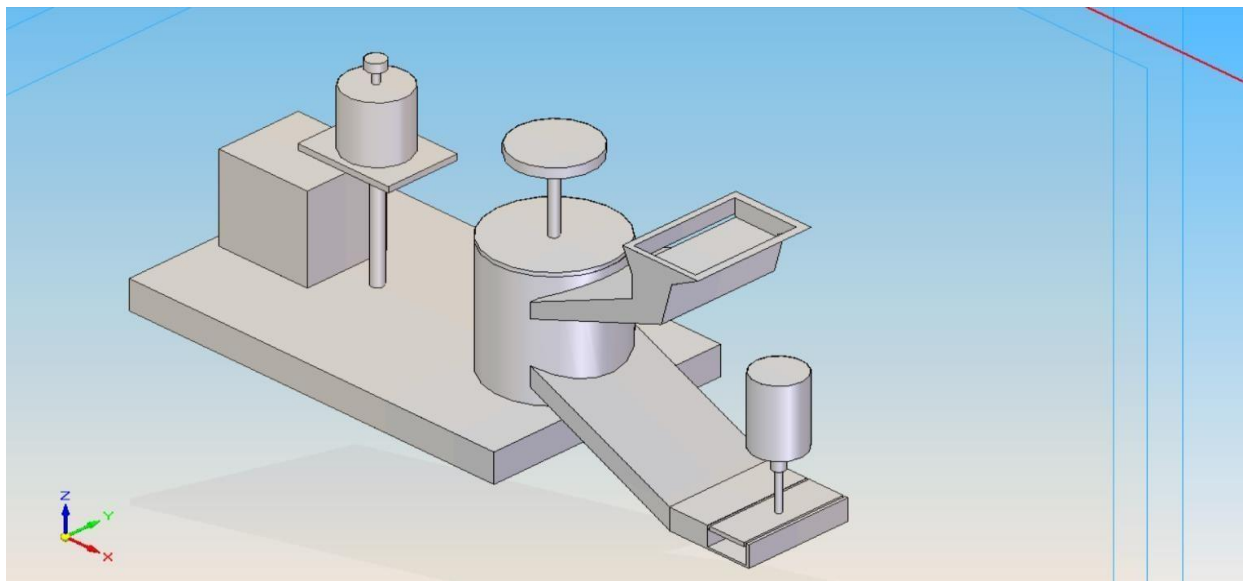


Fig 6.2: Illustrates isometric view of machine



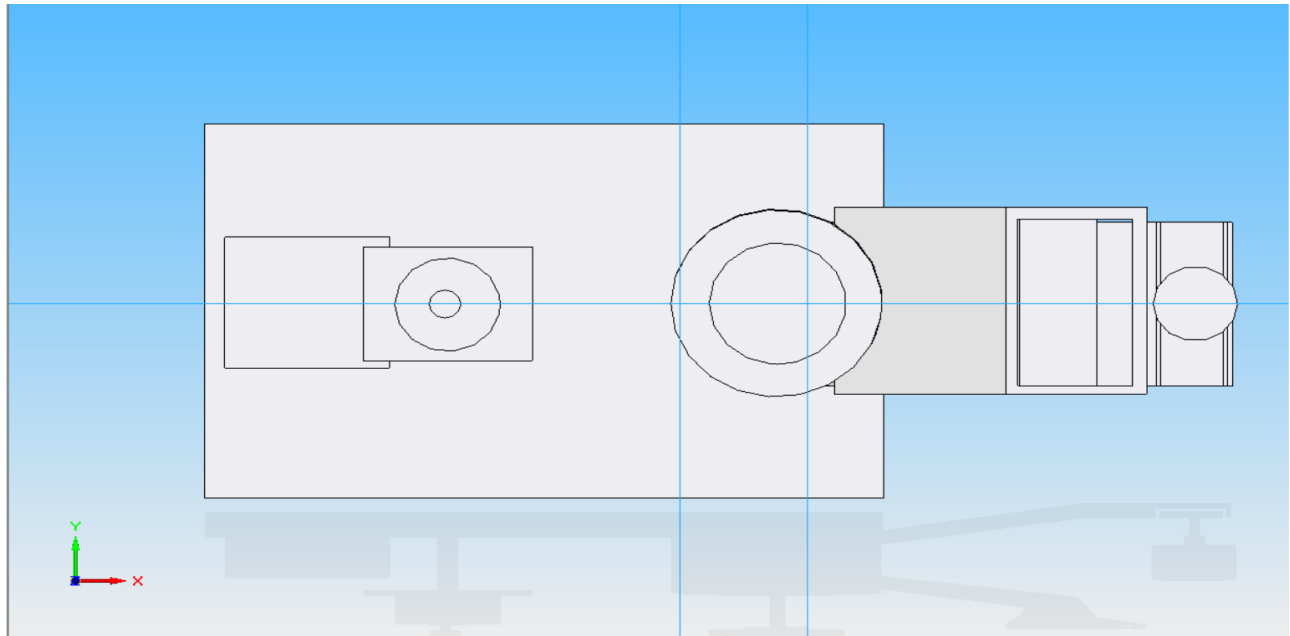
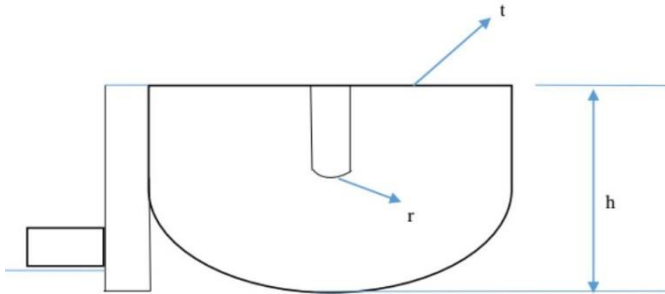


Fig 6.3: Illustrates top view of machine

## 7. CALCULATIONS:

### Hydropulper



Thickness of the pulper,  $t = 0.022\text{cm}$

Radius of the pulper,  $r = 0.95\text{cm}$

Total height,  $h = 50\text{cm}$

Hydropulper is an open cylindrical vessel which is open in the upper side and it consists of one bladed element rotating element which helps to circulate slurry in the vessel and separating the fibres. This process makes the waste paper transformed into well blended fiber slurry and the operation of the unit is manual.

Volume of the hydropulper

Scale factor = 10

Volume = mass \* density of the hydropupler

Mass,  $m = 7.14675 \times 10 \text{ Kg}$

$= 71.46750 \text{ Kg}$

$= \underline{71467.5 \text{ g}}$

Density is  $1.172 \text{ g/cm}^3$ , then volume of pulp slurry ( $V_c$ ),

Volume,  $V_c = 1.1729 \times 7147$

$= \underline{60979.096\text{cm}^3}$

Total Volume of Hydropulper:

$V_r = 1.032 V_c$

$= \underline{62930.427\text{cm}^3}$

To find

Diameter of the cylindrical vessel  $v = \pi r^2 h$

Height,  $h = 50 \text{ cm}$

Radius of the vessel,  $r^2 = v / \pi h$

$$= 62934.47 / (\pi * h)$$

$$= \frac{(400)^{0.5}}{\pi}$$

Radius of the vessel =  $20.01 \text{ cm}$

Diameter of the vessel =  $2r$

$$= 2 * 20.01$$

$$= \underline{40 \text{ cm}}$$

Total surface area of cylinder  $A = 2\pi r (h + r)$

$$= 2 * 3.14 * 20.02 (50 + 20.02)$$

$$= \underline{8805.52 \text{ cm}^2}$$

**CONVEYOR FELT:**

- Conveyor felt is made up of nylon material.
- Length of felt conveyor - 3.9m to 4m
- Width of conveyor felt - 13"

The design of the felt is to serve three main purposes:

1. A conveyor is used to assist the sheet through the manufacturing process
2. A porous media is used to provide void volume and channels for effective water removal
3. A texture cushion which helps in passing moist sheet without crushing or significant marking.

A tension band is used to maintain sheet felt ness and ultimate contact with

followings: Hot dry surface length of cylinder,  $l = 50\text{cm}$

Radius of cylinder,  $r = 7\text{cm}$

Circumference of cylinder,  $C = 2\pi r$   
 $= \underline{43.99\text{ cm}}$

**Details of the driving System:****Electric Motor and the integrated Gear Box -**

Motor – 1 HP, A.C., 3-phase, 900 rpm

Gear-box – 42:1 speed reduction, attached to

**motor Belt and pulleys -**

Speed increment ratio – 1:2

Belt – ‘V’ shaped, Leather, B-type, 46 cm long

## **8. ADVANTAGES, DISADVANTAGES AND APPLICATIONS**

### **ADVANTAGES**

- Power consumption is low due to less use of power.
- Cost of development is low.
- Transportation of machine is easy.
- It can be used for both small scale and large scale industries.
- Maintenance cost is low as machine doesn't have complex part.
- Due to recycling wood is preserved.
- Conservation of energy takes place due to recycling.
- Recycling helps in environmental protection.

### **DISADVANTAGES**

- Regular maintenance is a must.
- Cleaning of the machine must be done periodically.

### **APPLICATIONS**

These types of manually operated paper recycling machines have wide range of applications in the fields like,

1. All sorts of small-scale industries,
2. In all schools and colleges.
3. Large offices and Companies.
4. Pulp making industries.

## **10. FUTURE SCOPE**

- One of the underestimated industries.
- Huge Potentials and increasing demand.
- Government ranks 35th in priority list.
- Growth rate expected to go from 8% to 10%.
- Trees can be saved towards a large extent.
- Huge amount of paper waste can be reused and hence reduce waste generation.

## **11. CONCLUSION**

Finally it has been concluded that the compact paper recycling reduces the time required for paper recycling. This machine can be used in many places such as offices, schools, colleges and even in small scale industries. Only a single operator is sufficient to carry out the entire process. The design is able to meet the necessary requirements and specifications. The operation of the machine does not require any skilled trainer hence an average person can operate it. The quality of the recycled paper produced mainly the thickness, may be slightly below the standards due to limitations of design power. Landfill and pollution problems in primary consumers of waste such as schools and colleges will be considerably reduced by use of this machine and the users will be benefited by meeting the demands of the paper market.

## REFERENCE

1. Ajay Takur, Swash monore ( 2017) , “ design and fabrication of compact paper recycling machine” , paper technology 139;250-261.
2. Ajith Ghosh (2011) , fundamentals of paper drying theory and applications from industrial perspective , “paper recycling technology 178;65-71.
3. Jiang c. &Ma, J. (2000). Deinking of waste paper Floatation. Enzymatic Deinking Technologies,1-2

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## APPENDIX

### COST ANALYSIS

EQUIPMENTS	MATERIAL	COST
MIXING GRINDER	STAINLESS STEEL	3000/-
AC MOTOR	ALUMINIUM	3500/-
CONVEYOR BELT	PVC COATED	800/-
PULLEY BELT(2)	RUBBER	200/-
CONVEYOR ROLLER(2)	MILD STEEL	700/-
PRESS ROLLER(2)	MILD STEEL	500/-
BEARING(2)	MILD STEEL	1000/-
NUTS AND BOLTS	MILD STEEL	150/-
FRAME	MILD STEEL	1900/-
<b>TOTAL COST</b>	<b>11700/-</b>	

**TABLE : TOTAL COST ANALYSIS**



## **BIODATA**

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## PLAGIARISM REPORT

### “DESIGN AND FABRICATION OF PAPER RECYCLING MACHINE”

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