

Design and Fabrication of Paper Recycling Unit

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Abstract: *In bigger institutes, offices like schools, colleges, and industries a large number of used papers can be generated. And throwing it in the trash does not make good sense, so instead of throwing it in the trash, we can recycle it. So, designing & fabricating manually operated small- scaled paper recycling plant which can be used in schools & colleges, makes a cheap & simple method of production of the new paper. According to it, 3-D modelling design of the machines can be developed using CATIA with all the required specifications & fabricated accordingly. Instead of using new material for fabrication, scrap material can be used which reduces the cost of a plant. This makes plant best from waste. Hence, both fabrication of plant & production of new paper ensures its contribution towards the protection of the environment.*

Keywords: Waste, Recycling

I. INTRODUCTION

For the production of paper, the raw material required is mainly wood. For producing 1 ton of paper near about 24 trees to be cut down. According to the survey by Global Forest Resource Assessment roughly 80,000 to 160,000 trees are cut down each day around the world with a significant percentage to be used by the paper industry. Also, at the same time, it requires 2,50,035 litres of water, 46 kg of sulphur, 159 kg of lime, 131 kg of clay, 1.2 tons of coal, 112- kilowatt-hours of power, 9 kg of dye and pigments, and 49 kg of starch, as well as other ingredients [1].

The primary raw material for paper production is the pulp fibers obtained by complicated chemical processes from natural materials, mainly from wood. The first step in a typical paper manufacturing process is to produce pulp from the wood chips. There are two methods for making wood pulp as, chemical pulping or mechanical pulping. Mechanical pulping is a process in which fibers are separated without the addition of any chemicals. The second way of making pulp is chemical pulping which consists of breaking down the chemical structure of lignin into a liquid using different chemicals, including sodium hydroxide and sodium sulphide. Cooking liquor is a by-product of the process, which is washed from cellulose fibers to produce pulp. Chemical pulping is used to produce higher quality paper with more expensive production costs than mechanical pulping [2].

II. IMPORTANCE OF PAPER RECYCLING

The paper manufacturing industry faces a major problem of the unavailability of raw materials. The primary raw material wood is of great environmental concern. The problems that exist are,

1. Paper mills do not have all the processes of paper recycling incorporated in one.
2. Paper mills require a large floor area.
3. Separate process plant leads to delay in delivery of raw material for next stage due to transportation.
4. Due to large the floor area paper mills are located at the outskirts of the city away from the waste generation zone. So, transportation costs are high.

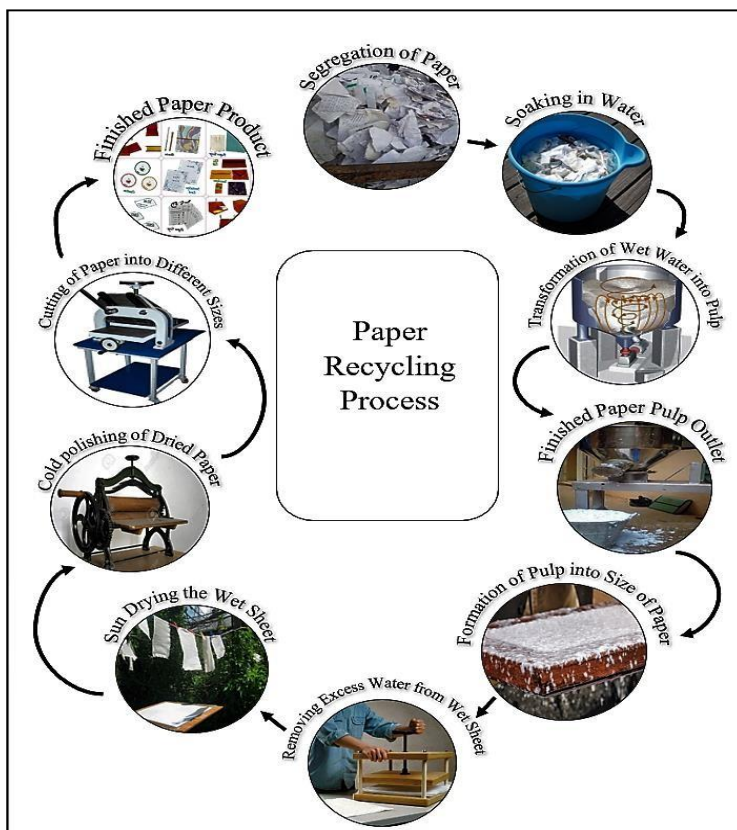
So, to overcome all the above problems recycling is the best solution. According to the discussion on collection and recycling in India:

1. 1 ton of recycled paper saves about 17 trees, 2.5 barrels of oil, 4100 kW-hr of electrical energy, and 4 m³ of landfill [3].
2. And 1 ton of waste paper recycling results in saving 70% of raw material, 60% of coal, 43% of energy, and 70% water [3].

III. RECYCLING PROCESS

Paper recycling is the process of forming new paper products from used/waste papers.

It has several important benefits like it saves waste paper from occupying the homes of people and producing methane



as it breaks down. The paper recycling process undergoes several steps as,

Figure: Paper Recycling Process

- 1. Segregation of Paper:** Segregation means separation. It is the first step involved in the recycling of paper. In recycling, waste papers are segregated into various grades as they are subjected to different recycling processes. After the segregation, the paper can be shredded using a paper shredder machine.
- 2. Soaking in Water:** It is the second step, in which shredded paper can be soaked in water for 5hrs, so the paper gets wet & this soaked paper gives easiness for transforming it into the pulp.
- 3. Transformation of wet paper into pulp:** It is an important step in the recycling of paper, where the soaked paper gets transformed into pulp. The process involves the pulping machine called 'Hydra Pulper'. In this step, paper and water are mixed with equal proportion to make a pulp.
- 4. Finished paper pulp outlet:** After the pulp is made some chemicals are to be added to the pulp for deinking purposes (whitening) & binding the pulp particles. Mainly Bleaching powder, alum is used for deinking of pulp. Deinking means the removal of ink from the pulp. So, the output made from this is the white pulp.
- 5. Formation of pulp into the size of paper:** The white pulp so formed is then put in a 'Uni-Vat', which consist of one wooden box with a net at bottom of the box & it is dipped in water. The pulp is then poured into the wooden box & by spreading it equally a wet sheet of paper is formed. The wet sheet is then taken out of the box & put on a cotton cloth.
- 6. Removing excess water from wet sheet:** This step uses a pressing unit for removing excess water from the sheet. Some 12- 15 wet sheets with cotton clothes are placed between two wooden boards and pressure can be applied on them to remove the excess water from the wet sheet.
- 7. Sun drying the wet sheet:** After removing the excess water from the wet sheet, the sheets are exposed to sunlight for drying purposes.

8. **Cold polishing of dried paper:** The dried paper so formed is rough & have un-uniformity in thickness, so to make it smooth & uniform we have to calendar/polish it. For this, it uses a calendaring machine which has 2 rollers & between them sheets are passed.
9. **Cutting of paper into different sizes:** This is the second last step in the paper recycling process where, the calendared paper can be cut into desired size and shape, according to our requirements.
10. **Finished paper products:** It is the last step where we get various finished paper products like papers, paper bags, card sheets, etc.

IV. EXPERIMENTAL DATA AND RESULT

4.1 Experimental Data

The output from the recycling plant is white cardboard paper having GSM vary from 190 to 500 on the basis of application. So, by referring the standard GSM values are compared with our output cardboard.

Parameters	Sample 1	Sample 2
Pulp Quantity (gm)	250	250
Alum Powder (gm)	10	15
Resin (Fevicol) (ml)	5	5
GSM	627	450
Thickness (mm)	0.8	0.6
Whiteness	Less	Medium

Table 1: Samples using Alum Powder

Parameters	Sample 1	Sample 2	Sample 3	Sample 4
Pulp Quantity (gm)	250	250	250	250
Bleaching Powder (gm)	10	15	20	20
Resin (Fevicol) (ml)	5	5	5	5
GSM	705	549	400	392
Thickness (mm)	0.9	0.7	0.52	0.5
Whiteness	Medium	Moderate	High	High

Table 2: Samples using Bleaching Powder

V. RESULT

From the above experimental data, it can be seen that by using the alum powder as deinking agent the whiteness of the recycled paper cannot be achieved. Instead of using alum powder, bleaching powder can be used as deinking agent. BY using bleaching powder, the whiteness of recycled paper can be improved. The resultant recycled paper samples are shown below

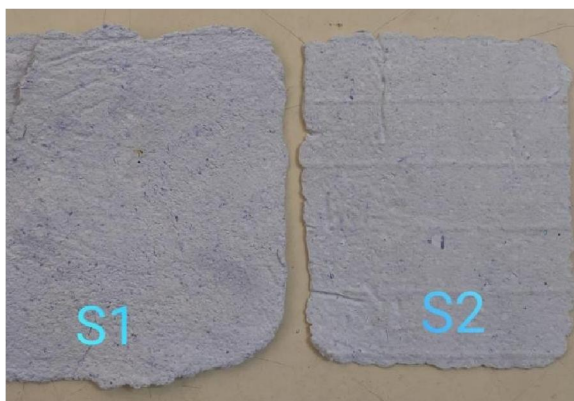


Figure: Resultant Samples using Alum Powder

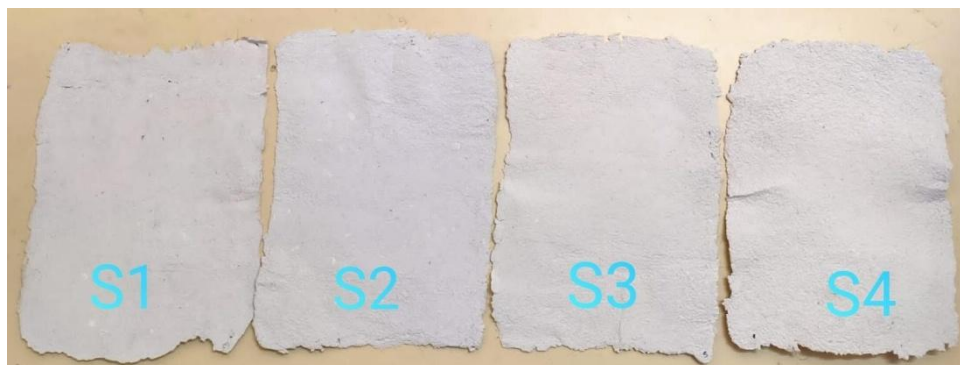


Figure: Resultant Samples using Bleaching Powder

GSM- For white cardboard standard GSM values are 190, 210, 250, 300, 350, 400, 450, 500 etc. [4]

- Alum Powder Sample: For the 1st sample & 2nd sample, we got 56% & 100% accuracy respectively.
- Bleaching Powder Sample: Here we have taken 4 samples and got GSM values like 705, 549, 400, 392 respectively; which are close to the standard GSM values.

The GSM values which we got are not standard because of the prototype model.

Whiteness- After taking 6 trials, we came to know that more whiteness can be achieved by using bleaching powder compared to alum powder of recycled paper.

VI. CONCLUSION

- From study and survey, we can get the knowledge that larger institutions are generating hundreds and thousands of tons of waste paper every year.
- The big problem of disposal of used papers is resolved by saving the environment.
- The simplicity of operation of this machine ensures that less technical skilled laborers are needed to operate the recycling unit.
- The development of a semi-automatic paper recycling machine is much cheaper as compared to machines in the recycling industries.
- This machine can be used in schools, colleges, or institutes to solve the problem of used paper which institutions are facing right now.

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