

Development and Modification of Waste Paper Recycling Machine

Mo Mohseen

Mechanical Engineering, RGPV Bhopal

Abstract

Paper is used daily with learning institutions such as universities and schools being the main consumers. Due to its single usage it ends up being disposed hence most of the paper waste remains idle and unutilized although it is a valuable resource. Therefore, this paper explores the design of a cheap and efficient manually operated paper recycling machine. The design used integration of acquired knowledge on the recycling technology, existing manually operated and available paper recycling machines to form a cheap but efficient paper recycling machine. The benefits of the machine are not only centered on the merits of recycling paper but by the in-cooperation of the manually driving system which will also curb the high unemployment rates in developing countries. Due to the design being not 100% efficient due to the gear box, belt and chain transmission, the estimated efficiency is equal to 90% but using the 90% for design, the design power input is 450 watts and since an average person can produce 100 Watts constantly therefore 2 people are necessary to drive the machine.

Keywords: Design, manually operated, paper recycling, machine.

Introduction

The **recycling of paper** is the process by which waste paper is turned or transformed into new paper products. It has a number of important benefits. It prevents waste paper from taking up space in homes and releasing methane during its decomposition.

Recycling keeps the carbon in paper fiber, which was initially absorbed by the tree from which it was made, locked up for a longer period of time and out of the atmosphere.

though not all of them are recycled into new paper, over two thirds of all paper products in the US are currently recovered and recycled.

After repeated processing the fibers become too short for the production of new paper, which is why **virgin fiber** (from sustainably farmed trees) is frequently added to the pulp recipe.

Three types of paper—mill broken, pre-consumer waste, and post-consumer trash—can be utilized as feed stocks to create recycled paper.

Mill broke is paper trimmings and other paper scrap from the manufacture of paper, and is recycled in a paper mill, Like extra material or finished chips material waste.

Pre-consumer : Material that left the paper mill but was thrown away before it was suitable for consumer use is known as pre-consumer waste.

Post-consumer waste is material discarded after consumer use, such as old corrugated containers (OCC), old magazines, and newspapers. "Scrap paper" is paper that may be recycled and is frequently used to make molded pulp packaging. The Germans invented deinking, which is the industrial technique

of removing printing ink from recycled paper fibers to create deinked pulp.

Background to the Study

Paper is a material that can be used for writing, drawing, printing, and wrapping that is made in thin sheets from the pulp of wood or other fibrous materials. SILKROAD claims that one of the first inventions made by the Chinese in 105 A.D. was the production of paper. Writing emerged as a way to preserve information throughout time as a result of the ability to mass make paper. Although digital storage has numerous advantages, paper still has certain important advantages that make it a prominent information storage medium in our culture. These advantages include its vital participation in all phases of education (learning), secure information storage because paper can be manufactured sustainably and doesn't require file conversions or hacking, It has a unique place in history as well, and many of our most recent learning's about the past come from examining the written remnants of cultures that have been Preserved until now. Due to the improved technological advances in communications people have taken a blind towards the consequences of disposal of used papers both proper and improper without the consideration that Paper remains the most significant medium for carrying out paperwork, advertising, communication, and education. Landfills, air and soil pollution, and other forms of environmental degradation are caused by inappropriate disposal of paper waste and a disregard for recycling. The Environmental Management Agency (EMA) in Zimbabwe has previously clarified that one of the main causes of the country's failing environmental health standards is the use of improper solid waste management techniques in schools, both in rural and urban areas.

The Paper Recycling Process Explained

By Christopher Witherspoon, Director of Vendor Relations, January 7, 2022



Fig.1 Paper Recycling cycle

- There is paper and paper goods in every aspect of our life. A lot of us begin our days with the aid of

paper goods; both the carton of milk we use and the container for our preferred cereal for breakfast are made of paperboard. You can quickly wipe up any spilled milk using a paper towel. Our kids write, draw, take notes, build crafts, and read from textbooks every day in school using paper products. Adults perform the same tasks in our offices and workplaces (often without the crafts and textbooks).

- Even at the grocery store, we are often asked the age-old question, "Paper or plastic?" When the time comes to check out, you should always say, "I brought my own!" of course.
- Because we depend so largely on the advantages of paper goods, we need to be able to increase their production in an environmentally friendly way. Fortunately, paper is among the elements that may be recycled the most widely worldwide.

10 Facts About Paper Recycling

- A significant amount of paper waste is produced in the US.
- In 2018 alone, the total generation of paper and paper board waste was 67.4 million tons, according to the Environmental Protection Agency (EPA), which accounted for 23.1 percent of overall production of municipal solid waste (MSW) in that year.
- America also recycles a lot of paper. Approximately 46 million tons of the 67.4 million tons of paper trash produced in the same year were recycled, yielding a recycling rate of 68.2 percent, the highest rate compared to other materials found in MSW. In fact, we recycle so much paper that our paper recycling rate has either met or exceeded 63 percent every year dating back to 2009. There are other types of recycling that are even more impressive, with the American Forest & Paper Association reporting an OCC recycling rate of 88 percent in 2017.
- Paper is so recyclable that it allows us to recycle this much of it. Paper may be reused five to seven times, however other materials, including shrink wrap plastic or used cooking oil (UCO), can only be used twice or three times before the fibers become too short and weak to be used again.
- The total increase in recycling rates over the past few years can be attributed to the paper sector. The paper industry has made great strides to educate consumers about the importance of recycling and to establish community recycling efforts to make the process even more straightforward. Their efforts have proven successful; in 2020, around 80 percent of US paper mills produced new goods using recycled paper.
- The Benefits of Paper Recycling: Trash is piling up in American landfills at an alarming rate. These landfills are the main source of greenhouse gases that harm our planet and occupy huge portions of potentially useful land.
- In 2018, paper made up 11.8 percent of MSW land filled, a total of 17.2 million tons of MSW paper and paperboard. Paper recycling helps to keep these landfills from filling up too quickly and frees up space for rubbish that can't be recycled.
- One cannot overstate the advantages recycling paper has for the environment. One ton of recycled paper can save 7,000 gallons of water, 380 gallons of oil, and enough energy to power an ordinary American home for up to six months, according to the EPA. Recycling paper also helps to preserve natural resources. One ton of recycled paper can save the removal of seventeen trees. More than 2,303 tons of paper were recycled at Ford University lately, saving over 32,115 trees. Businesses can also reap great benefits from recycling paper. Diverting paper from the landfill can dramatically reduce business waste costs, especially if your business churns through a lot of paper products.

Businesses who engage in recycling activities stand a better chance of attracting environmentally concerned customers who only want to do business with sustainable companies, as well as receiving tax credits from the Internal Revenue Service (IRS).

- The Paper Recycling Process: Prior to discussing the recycling process, it is vital to clarify the kinds of paper products that paper mills are able to recycle. These goods consist of, but are not restricted to
 - Copy paper
 - Envelopes
 - Newspapers
 - Phonebooks
 - Notebooks
 - Catalogs
 - Magazines
 - Receipts

While paper shredders are useful for keeping private information safe from prying eyes, they complicate recycling. The recycling facility's intricate machinery is prone to catching tiny strips of shredded paper, which can cause damage to the machinery or impede its progress altogether as it must halt to free the stuck pieces. Shredded paper is not usually accepted by curbside recycling services, but some do, so make sure to inquire with your local facility before leaving any out.

Step1: Collection or Gathering

Gathering used paper to be sent to recycling centers is the first stage in the paper recycling process. Paper cannot be recycled and will be sent to a landfill if it is contaminated with food, grease, or other hazardous chemicals. Instead, it should be placed in a separate recycling bin to keep it distinct from other waste materials.

Step2: Transportation and Sorting

Once the paper is properly disposed of, it will be picked up by a trash and recycling hauler and taken to a materials recovery facility (MRF) for sorting.

Paper is weighed and divided into distinct categories at the MRF because some paper products may be handled differently based on the kind. For example, glossy magazine material should be separated separately from regular printer paper because they will be handled differently.

Step3: Shredding and Pulping

The recycling process really starts at a paper mill, where the paper is baled together and delivered after being sorted and examined for pollutants.

Paper is shredded at the paper mill into tiny fragments. To further separate the paper fibers, a lot of water and chemicals such as sodium hydroxide, hydrogen peroxide, and sodium silicate are added to the shreds. The end product is a mushy mixture called pulp, which is the starting point for the production of recycled paper.

(This process is known as **pulping**.)

Larger contaminants, such as paperclips, staples, and tape, are screened for and removed from the pulp before it moves on to the next step.

Step4: De-Inking

Once the large contaminants have been removed, the pulp is put into a large floatation tank with more chemicals and air bubbles. By removing dyes and inks from the pulp, the chemicals and air bubbles improve the pulp's purity and whiteness.

During this procedure, dye scan is also added to produce colored paper.

After that, the pulp which at this time is roughly 99 percent water and 1 percent fiber is fed into a paper machine.

Step5: Drying

The recycling procedure for paper ends at this step. After being de-inked, the pulp is run through enormous rollers to remove any remaining water from the blend. The pulp is heated rollers to create long rolls of continuous sheets of paper once the moisture has been removed. The rolls of paper are then shipped to different producers to be turned into paper goods.

Rubicon's Paper Recycling Solution

In order to keep as much material out of landfills as possible, Rubicon assists companies of all sizes in identifying suitable recycling options for each and every one of their waste streams and live by our mission to end waste.

If you have any questions, or you are interested in learning more about Rubicon's [paper recycling services](#), please reach out to me directly at chris.witherspoon@rubicon.com.

1. Harvesting trees

Main article: [Logging a](#)

The majority of pulp factories cut trees in accordance with sound forest management methods to provide a steady supply of raw materials. The reduction of the harvested forest's biodiversity is one of the main grievances against the harvesting of wood for pulp mills. The world's pulp production is made up of 16 percent pulp tree plantations, 9 percent old-growth forests, and the remaining portion consisting of second, third, and more generation forests. Since most places engage in reforestation, trees constitute a renewable resource. Paper created from trees that are harvested in accordance with regulations intended to promote good forestry practices is certified by the Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI), Programme for the Endorsement of Forest Certification (PEFC), and other organizations.

The number of trees consumed depends on whether mechanical processes or chemical processes are used Based on a combination of softwoods and hardwoods measuring 12 meters (40 feet) in height and 15-20 centimeters (6–8 inches) in diameter, it has been calculated that it would require about average of 24 trees to produce

0.9 tone (1 ton) of printing and writing paper, using the [Kraft process](#) (chemical pulping). Mechanical pulping is about twice as efficient in using trees, since almost all of the wood is used to make fibre, therefore it takes about 12 trees to make 0.9 tone (1 ton) of mechanical pulp or [newsprint](#).

A cord of wood is around two short tons in weight.

2. Preparation for pulping

Main article: [Woodchips](#)

Wood chipping is the act and industry of chipping wood for pulp, but also for other [processed wood](#) products and [much](#). For manufacturing pulp, only the sapwood and heartwood are needed. Bark is removed and burned to produce steam for the pulp mill since it has comparatively few usable fibers. To produce chips of consistent size, the wood must be chipped and screened for the majority of pulping operations.

tearing. The wood fiber can be separated using a variety of methods, including:

pulp made by machine. To make stone pulp, little wood logs known as "bolts" can be ground using manufactured grind stones that have silicon carbide or aluminum oxide imbedded in them (SGW). Pressure-ground wood pulp is what's known if the wood is steam-roasted before being ground (PGW)

Most modern mills use chips rather than logs and ridged metal discs called refiner plates instead of grind stones. Refiner mechanical pulp (RMP) is the pulp that is created when the chips are simply crushed up with the plates; thermo mechanical pulp (TMP) is the pulp that is created when the chips are steam-cooked during the refining process. Both the overall energy required to produce the pulp and the amount of fiber damage (cutting) are greatly reduced by steam treatment.

. Mechanical pulps are used for products that require less strength, such as newsprint and paper boards.

Thermo mechanical pulp

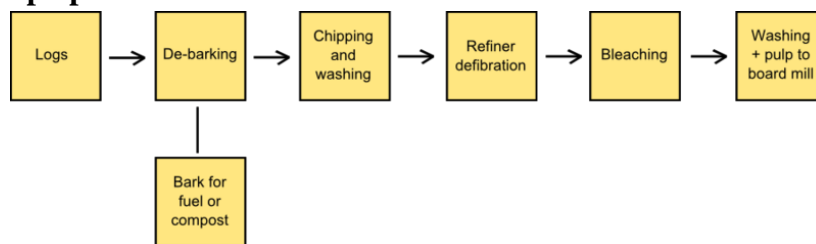


Fig.2 Mechanical pulping process

Thermo mechanical pulp is pulp produced by processing wood chips using heat (thus "thermo-") and a mechanical refining movement (thus "-mechanical"). The logs are first stripped of their bark and made into tiny chips in a two-stage procedure. There is about 25–30 percent moisture content in these chips. The wood chips are subjected to a mechanical force during a crushing or grinding process that releases heat and water vapor, softens the lignin, and separates the individual fibers. The pulp is then screened and cleaned any clumps of fibre are reprocessed. This process gives a high yield of fibre from the timber (around 95 percent) and as the lignin has not been removed, the fibres are hard and rigid.

Chemi-thermo mechanical pulp

Wood chips can be pre-treated with sodium carbonate, sodium hydroxide, sodium sulfate and other **chemical spriortore fining with equipment similar to a mechanical mill**. Since the aim of the chemical treatment is to make the fibers simpler to refine rather than to remove lignin as in a completely chemical process, the conditions are significantly less harsh (lower temperature, shorter time, less extreme pH) than in a chemical pulping process..

Pulps made using these hybrid processes are known as chemi-thermo mechanical pulps (CTMP).

Chemical pulp

Main articles: Kraft process, Sulfite process, and Soda pulping See also: Dissolving pulp, Fluff pulp, NBSK, and SBSK(pulp)

In big tanks known as digesters, wood chips and chemicals are combined to create chemical pulp. The lignin that holds cellulose fibers together is broken down there by heat and chemicals without significantly deteriorating the cellulose fibers. When materials need to be strengthened or blended with mechanical pulps to offer a product distinct qualities, chemical pulp is utilized. The most used chemical pulping technique is the kraft process, followed by the lifted process. In the past, the first effective chemical pulping technique was soda pulping.

Recycled pulp

Main articles: [Paper recycling](#) and [Deinking](#)

Recycled pulp is also called **deinked pulp** (DIP). DIP is [recycled paper](#) which has been processed by chemicals, thus removing [printing ink](#) and other unwanted elements and freed the paper fibres. The process is called [deinking](#).

DIP is used as raw material [in paper making](#) Deinking Pulp(DIP). Many [newsprint](#), [toilet paper](#) and [facial tissue](#) grades commonly contain 100 percent deinked pulp and in many other grades, such as lightweight coated for offset and printing and writing papers for office and home use, DIP makes up a Substantial proportion of the furnish.

Organosolv pulping

Main article: [organosolv](#)

Organosolv pulping uses organic solvents at temperatures above 140° C to breakdown lignin and hemi cellulose into soluble fragments. Distillation makes it simple to recover the pulping fluid. The reason for using a solvent is to make the [lignin](#) more soluble in the cooking liquor. Most common used solvents are [methanol](#), [ethanol](#), [formic acid](#) and [acetic acid](#) often in combination with [water](#).

Alternative pulping methods

The development of "bio pulping," or "biological pulping," which is akin to "chemical pulping" but uses certain fungal species that can degrade undesirable lignin but not cellulose fibers, is currently being researched. In the bio pulping process, the fungal enzyme [lignin per oxides](#) selectively digests lignin to leave remaining cellulose fibres. This might significantly lessen the pollution that comes with chemical pulping, which would be good for the environment. Chlorine dioxide bleaching is used on the pulp, and then calcium hypochlorite neutralization is used. In either scenario, the wood's sulfides strengthen the colors created by the tannins, which are oxidized and destroyed by the oxidizing agent. A pulping and extraction method called "steam exploded fiber" has been used on wood and other fibrous organic materials.

Bleaching

Main article :[Bleaching of wood pulp](#)

The pulp produced up to this point in the process can be [bleached](#) to produce a [white paper](#) product Concerns about the environmental effects of the chemicals used to bleach pulp have led to the pulp industry switching to chlorine substitutes in recent years, [dioxide](#), [oxygen](#), [ozone](#) and [hydrogen peroxide](#).

Literature Review

Stages of Paper Making

There are 5 Stages of Paper Making

Paper making involves 5 steps:

1. Chipping (shredder)
2. Making of wood pulp (or) old paper chip to pulp, 3. Spreading the pulp,
3. Pressing-Drying-Rolling and
4. Cutting Sheets.

BEST PAPER SHREDDERS

More and more, privacy is becoming the primary concern of many individuals. Any document, even junk mail, can contain enough information to allow some unscrupulous opportunist an opening to inconvenience or damage your life. Paper shredders are essential appliances that have become staples in most homes.

When considering a paper shredder machine, you want one that offers a cross-cut or micro-cut for the best protection. If you need to shred credit cards or CDs, you will need to be sure the model you pick has that ability. A shredder that is easy to use, has overload protection, and can shred a number of pages at once at an acceptable speed is ideal.



Fig.3 Paper shredder machine

TYPES OF PAPERS SHREDDERS

Strip-cut

Strip-cut shredders slice paper into strips of long, straight shreds. While this does offer some degree of security, it's not too hard for some one to reassemble shredded documents, recovering the data. More thorough types of paper shredder have made this variety all but obsolete.

Cross-cut or diamond cut

Cross-cut or diamond-cut shredders cut paper cross ways, as well as lengthwise.

This results in much smaller chunks that would be too tricky to reassemble for all but the most determined of criminals.

When emptying your shredder, think about wearing a mask, doing it outside, or somewhere with plenty of air, as shredding large amounts of paper at once produces a lot of dust.

Micro-cut

If you want the gold standard of paper shredders, opt for a micro-cut shredder.

This masticates paper into tiny, confetti-like chips, making it virtually impossible to re-assemble a document in any meaningful way.

PAPER SHREDDER TIPS

Want to shred like a pro? Check out these tips.

- Keep any on the amount of paper in your shredder's waste basket. Over load it and you can damage the motor or cause jams. Models with a clear viewing window are invaluable.
- Paper shredders with pull-out bins are much easier and more convenient to empty shredder papers, compared to the kind where you have to lift the entire shredding mechanism off the waste bin.
- Unless you only want to shred the odd document the re-and there, pay attention to the length of each

paper shredder's duty cycle — some are frustratingly short.

- Most paper shredders are much more effective when you shred one or two sheets less than the maximum sheets per pass. So, if a shredder can tackle 12 sheets per pass, try feeding no more than 10 or 11 in one go.
- If you have kids or pets, we recommend a model that has a safety shut-off feature. If paws or fingers come too close to the blades, this turns the shredder off automatically. Before destroying CDs or credit cards, empty the paper waste container. While credit cards and CDs might not be recyclable (based on your local recycling laws), shredded paper is, and you don't want to spend hours sorting through a full paper bin to find a chip or credit card.

Clean out your paper shredder bin at frequent intervals, lubricate and sharpen the blades, and remove any lodged paper bits or pins from the machine to keep it working smoothly.

Pulpers

The function of the pulper is to gently slush the recycled paper raw material into a pump able pulp, which is suitable for processing in stock preparation while facilitating the efficient removal of contaminants from the pulp.

From: [Pulp and Paper Industry, 2016](#)

Energy conservation measurement for recovered fiber processing

Drum Pulpers

In the preparation of recovered paper stock, pulpers are crucial. The recovered paper is mechanically broken down by the pulpers while water is added simultaneously. The pulping system has a major impact on the quality of the final product as well as the economical design of the overall stock preparation line.

All pulping systems slush down the paper completely, without damaging fibers and without breaking down non paper components. Additional significant considerations include minimum energy usage, minimal operational costs, and minimum investment. The pulper's job is to gradually slush the raw recycled paper material into a pump able pulp that can be processed for stock preparation while enabling the efficient removal of contaminants from the pulp. The design of the pulping and de trashing equipment should satisfy a number of process requirements presented as follows:

Reduce the fragmentation of pollutants and smooch down the recycled paper to individual fibers without harming the fibers, allowing for effective removal in the subsequent cleaning and screening operations. A productive de-trash method to eliminate impurities during the initial step of stock preparation

- Undertake ink detachment
- Effective blending of chemicals

To meet these process requirements, several pulping and de trashing systems have been developed and operated successfully.

Vat-type pulpers often with batch operation are being used in many deinking plants. Recovered paper and water are charged to the vat, re pulped, and afterwards drained from the vat. A batch process consumes more energy. When the pulper is charged with paper, the demand for power peaks. Because a batch pulper is offline during unloading, it experiences a larger downtime. Energy usage can be decreased by installing dry pulpers or continuous drum pulpers. Additionally, this might lessen the need for water heating and the amount of water used. Fiber from Recycled Paper and Utilization

Continuous Pulper

Recycled fiber recovery begins at the pulper, Figs. 23.3 and 23.4, which is nothing more than a large blender to disperse pulp into an aqueous slurry. Pulping can be done at high or low consistencies using a variety of rotors. Figure 23.4 depicts a low consistency pulper with garbage removal, while Figure 23.3 depicts a high consistency pulper. During pulping, some of the gross contaminants are removed. A ragger is a chain that is gradually removed over an extended length of time (maybe one meter every few hours). As the stock rotates in the pulper, the ragger captures baling wire, wires, plastic sheeting, stringy materials, tapes, wet strength paper, and other long materials that wrap around it. When removed, the collected material produces a ragrope that is more than a foot in diameter. A diagram of a ragger with cutter is shown in Fig. 23.5. trash chute on the pulper's lower edge. There are multiple ways to get rid of this stuff. A long tube with an above grapple is called a junk tower, and it is used to manually remove debris that builds up at the bottom of the tower.

A continuous junk remover is an enclosed bucket conveyor used to automatically remove heavy and floating debris on a continuous basis (Fig. 23.6). It has been applied frequently to OCC processing. New equipment does not use bucket and chain trash-removing setups because of the expensive maintenance required owing to the age of the chain break and the inability to maintain a clean pulper. To separate the junk trap from the pulper, it is made of a vertical tube with valves at the top and bottom. Normally, the bottom valve is closed to keep the contents within and the top valve is open to let trash in. To empty the garbage trap, close the top valve and open the bottom valve to release the debris. After that, the top valve is opened, the bottom valve is closed, and the procedure is repeated as needed.

Paper Cutting Machine

Pioneers in the industry, we offer programmable paper cutting machine, semi automatic paper cutting machine, fully automatic paper cutting machines (with worm gear), guillotine paper cutting machine, paper cutting machine and fully automatic paper cutting machine from India.



Fig.4 Semi automatic paper cutting machine

Process Overview

The manufacture of recycled paper is conducted according to the following flow chart.

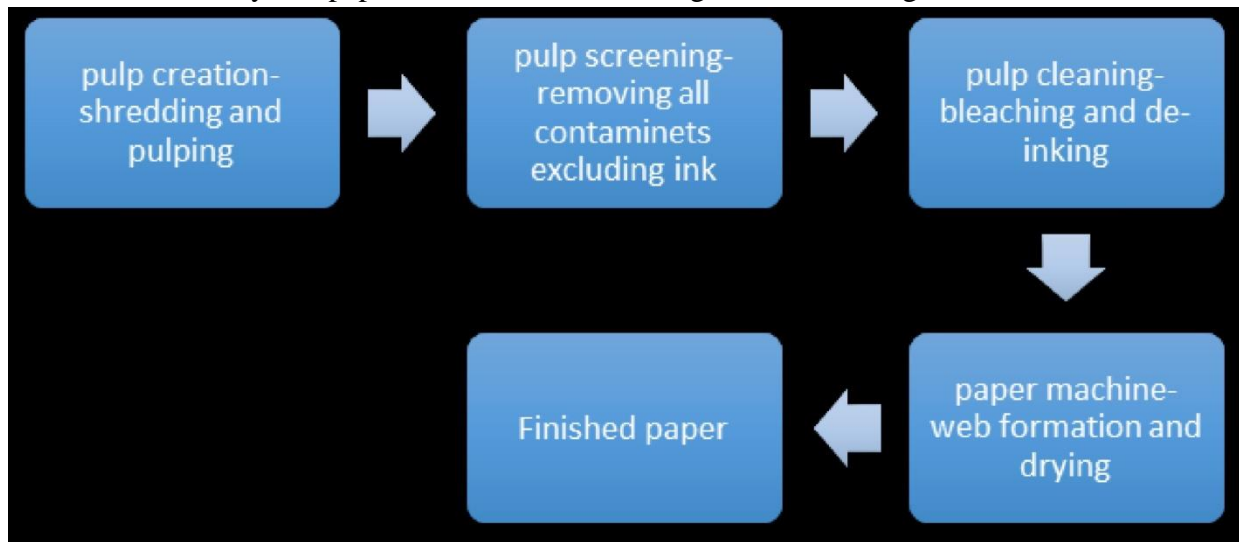


Fig.5 Process flow in the paper

Newsprint, tissue, and paperboard are the main products made primarily from recycled paper as raw material, according to Paper Online. Recycled paper is defined as a type of paper that is made entirely or partially of recycled fibers. These fibers can have very different origins and, consequently, very different characteristics when it comes to being a component in new paper.

Waste paper is placed in a pulper - a huge tank that liberates the paper fibres from the paper web by agitation with large quantities of water - and broken down to slurry. The process of pulping involves breaking down wood (or any other plant) to extract the main ingredient needed to make paper, which is typically cellulose fiber. According to Princeton University, the process also aims to free the fibers by removing as much lignin as possible without compromising the strength of the fibers. Lignin is an organic substance that binds the cells, fibers, and vessels that constitute wood and the lignified elements of plants, like in straw. The machine design is aimed at converting pulp into paper.

According to Olson and Plueger (2007, pg.1), screening is the process of contaminant removal from waste paper in order to cope up with the raw material quality decrease and the quality demands of the papermaker. Coarser fibers, foreign objects, plastic tape, staple pins, and dirt, such as fragments of bark, digester brick, and cement, are examples of contaminants. The Pulp Paper Mill website lists a number of variables that can impact the effectiveness of a screening process, including stock consistency, fiber type, hole size and type, plate cleaning mechanism type, coarse fiber level, foreign matter, rejection rate, flow configuration, flow rate, and stock temperature. Water, which alters consistency, is crucial at each stage of the pulp screening process. The fiber is conveyed by water in the screening portion.

According to Jiang and Mag (2000, pg. 1-2) The process of de-inking involves separating waste paper from inks and other non-fibrous impurities. The capacity to separate ink from fibers is essential to the deinking procedure. This is accomplished via a procedure that combines chemical and mechanical action, namely washing and flotation.

The waste paper is put into a pulper with a large quantity of water and broken down into a slurry. Staples and plastic are examples of "contraries" that are removed using wire mesh machines and mechanical action.

One of the main techniques for de-inking printed paper pulp, according to Drelich et al., is flotation, which gathers scattered ink particles on air bubbles and traps them in a froth layer. The technique of flotation de-inking is a kind of selective separation that makes use of the differences in the physicochemical properties of the ink and fiber surfaces.

Flotation chemicals are fed to the waste paper slurry to render the ink particles selectively more hydrophobic and hence to increase the floatability. When the air bubbles are sparged into the flotation cell containing the waste paper slurry, Because of their comparatively high hydrophobicity, the ink particles attach themselves to the air bubbles and float to the surface of suspension, while the hydrophilic fibers stay in the aqueous phase.

According to Hart and Rudie (2012), bleaching is the process of removing colorants from inks and brightening pulp by adding bleaching chemicals such sodium dithionite and hydrogen peroxide either during the pulping stage or in a separate bleaching step. In order to produce higher quality graphic papers, such as better newspaper, other high brightness recycled printing sheets, and hygiene papers, bleaching is usually employed to brighten recovered pulp.

It is a multi component continuous-operation aggregate on which paper and several types of cardboard are made from a highly dilute aqueous suspension of fibres. The prepared paper pulp, at a concentration of approximately 3-4 percent, is transferred by means of a pump from the pulp processing compartment to the machine chest and then to the paper machine. The pulp is first diluted with white water (because of dehydration of the paper pulp on the wire screen of the paper machine to a concentration of 0.1-1.5 percent) and then passed to the head box. The head box allows for the uniformed is tribution of the pulp on to the felts in which the paper web is continuously formed from a dilute suspension and This removes the majority of the excess water, moves the web to the press section for dehydration and thickening, then to the drying section for the last stage of moisture removal, and finally to the finishing end, where the web receives the necessary processing to give it gloss, density, and smoothness. Current recycling machinery is depicted in Figure 3.



Fig.6 .(a)Current existing machines,(b) Hydra pulper

Research Methodology

Paper Machine research

Sufficient in-depth study was conducted using books, journals, internet resources, industry visits, and consultations to develop the design. After that, three concepts were produced, and an appropriate answer was selected. After that, the selected solution was constructed and the required computations were

completed. The modified design was then drawn, modeled and simulated using CAD soft wares such Solid Works 2016 and AutoCAD Inventor.

Table No.01 Machine Specification of the recycling machine

Capacity	170 kg/day
Water	17m ³ /day
Area requirement	20m ²
Paper machine man power	5 people (max)
Charge	3m ³ /charge
Pump	<1KW
Size of paper	885mm-width;length>0.5m
Hydra pulper	Not included in design
Flotation and bleacher cells	Turbine agitated (mixed) or 45 pitched turbine blade

Vision Sensor

Vision sensors are industrial devices that use video cameras connected to application-specific software on a user interface to automate choices and procedures. These are also referred to as machine vision systems, and they are helpful for inspection, measurement, and pass/fail determinations.

In pulp supply line we can install vision sensor this detect color contamination when we make white papers, during pulp supply when color impurities come in supply line so that time Vision sensor will be indicate us by al red lamp indication we can install this sensor easily in pulp filter storage tank, In pulp tank after filtering also come impurity so we can easily detect by this sensor. By this idea we can also improve its quality.

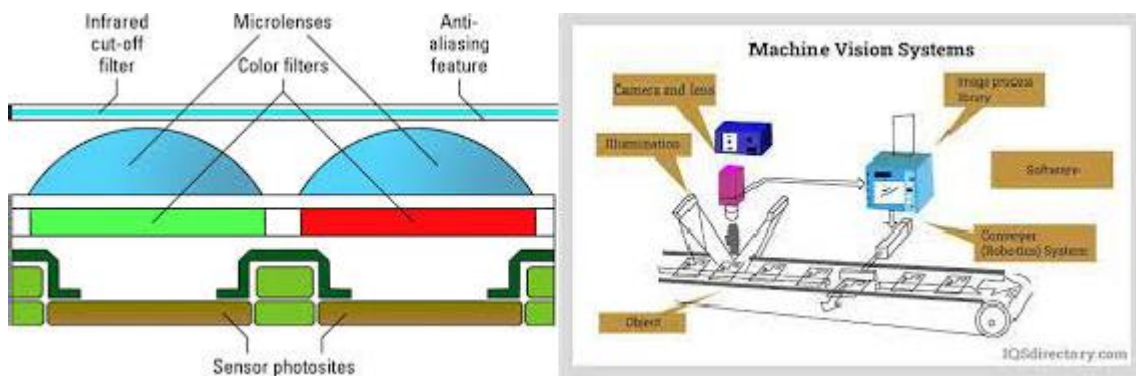


Fig.7 (a) Vision sensor,(b) Machine Vision system

Pulp Web Guide Installation

When we pulp suppliinrollerbypumpbyasawebformsolittelpulpsometimeoutfromroller conveyor so there we can attach two stripper as a guide and conveyor cleaning part.

This guide we can use made of rubber material its durable for use and cheap. We can easily set it web length size of paper.

Strippermadeoftheisoprene-isobutylenerubbermicellewaterthatconventionalbutylrubbers unit stripping vessel comes first removes most of free-water with water extractors.



Fig.8 Rubber Stripper guide

Isobutylene Isoprene Rubber (IIR)

Butyl is a common term used for the isobutylene isoprene elastomer. As the name implies, butyl is comprised of isobutylene with a small amount of isoprene. It is known for its excellent features minimal gas penetration. Butyl is capable of offering good hot tear strength and great energy absorption (dampening).

Good resistance to oxygen, ozone, heat, abrasion, and sunlight is contingent upon the saturation level of butyl polymer. However, butyl shows little resistance to hydrocarbon solvents, gasoline, and petroleum oil.

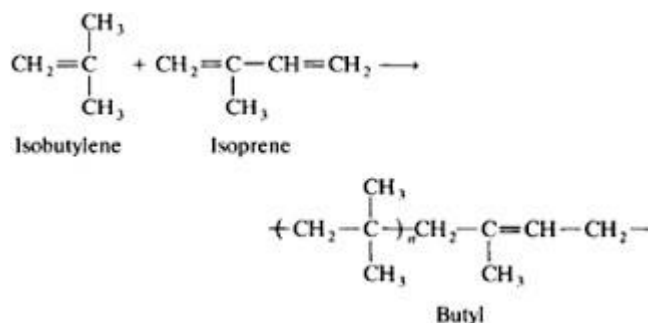


Fig.17 Isobutylene Isoprene Rubber (IIR) Formula

Compounds 487KC, 487KD, 487KE, 487KF

- Very low out gassing
- Excellent vibration dampening compounds • Low extractable

Compounds 359DQ, 501C, 359DN

- Good acid and base resistance
- Weather and high temperature resistant

Table No.02 of Rubber Strength

Compound	Hardness Shore A	Tensile MPa	Tensile psi	Elongation (%)
359DQ	60	8.3	1200	400
501C	70	13.8	2000	320
359DN	80	8.3	1200	370
487KC	40	9.0	1300	850

487KD	50	9.0	1300	650
487KE	60	9.7	1400	420
487KF	70	8.3	1200	300

Results and discussion

Design Sieve drum

Volume of sieve drum=cross section area x length= $5.58 \times 10^{-3} \text{m}^3$; Mass of sieve drum=density x volume= $5.58 \times 10^{-3} \times 7800 = 43.6 \text{kg}$; Moment of inertia $I = \frac{mr^2}{2} = 68.88 \times (250 \times 10^{-3})^2 / 2 = 2.1525 \text{kgm}^2$; Required angular acceleration= 2.72rads^{-2} , for attaining 52 rev/min in 2seconds; Torque = $I \alpha = 2.1525 \times 2.72 = 5.8548 \text{Nm}$;

Require power to rotate sieve drum= $T \omega = 5.8548 \times 5.45 = 31.9 \text{Watts}$. **Turbine**

Determining the power needed to enable mixing in the bleaching or flotation cells; For curved turbine blades, the constant k is given as 4.80 in $P = k \rho n^3 D^5$. ρ = density of pulp, n =revs/sec, D =diameter of turbine. For turbulent flow;

$P = 4.80 \times 997.78 \times 0.53 \times 0.85 = 196.17 \text{ Watts}$

for each flotation or bleacher cell. The 450 pitched turbine blade can also be used to provide axial mixing flow where the new diameter of impeller =0.5 for a baffled smaller tank and $n = 1.5$ revs per second.

The required power for power number=1.5 would be **158watts Head box and pump**

Required mass flow rate= 0.9339kg/s ;

Volumetric flow rate=mass flow rate/density= $0.9339/997.84 = 0.936 \times 10^{-3} \text{m}^3/\text{s}$; hence it will require less than one hour to empty the tank;

Static head =1.6m,

$k=0.45$ for 90 degree elbow, $k=0.15$ for sharp area reduction where k is the velocity head loss;

$Q = Av$

There for $v = Q/A = 0.936 \times 10^{-3} / 8.85 \times 10^{-3} = 105.76 \times 10^{-3} \text{m/s}$; Velocity head = $u^2/2g = (105.76 \times 10^{-3})^2 / 9.81 = 0.570$;

There for total velocity head losses= $0.57 \times (2 \times 0.45 + 0.15) = 0.598 \text{m}$; Reynolds number, $Re = D \rho u / \mu = 0.106 \times 997.84 \times 105.76 \times 10^{-3} / 0.890 \times 10^{-3} = 12569$ turbulent; From moody diagram,

The friction factor, $f = 0.0065$;

The friction head loss= $8f(L/d)(\rho u^2/2)$; $= 8 \times 0.0065 \times [(0.4 + 1.6 + 0.01) / 0.106] \times [(997.84 \times 0.10576^2) / 2]$; $= 5.50 \text{m}$

Diff $z = 1.6$, $P_1 - P_2 = 0$

Pump head = $5.5 + 1.6 + 0.57 = 7.67 \text{ m}$,

There for required pump power= $7.67 \times 9.81 \times 997.84 \times 0.936 \times 10^{-3} = 70.3 \text{Watts}$ (can be easily supplied by solar)

Table Roll

$q = D u \sqrt{f}$ where q is the water removed by table per unit length and width D is the diameter of roll; f is drainage factor, $f = 6$ and u =speed of wire;

Using efflux ratio =speed of discharge jet/ speed of wire = 1; There for $q = [200 \times 10^{-3} \times (105.76 \times 10^{-3})^2 / 6] = 0.374 \times 10^{-3} \text{m}^3/\text{s}$ **Rollers**

$Q = d L s / 2.96$

Where d is diameter of rollers, L is length of rolls and s is peripheral speed and Q is the capacity of rolls;

$$Q=300 \times 10^{-3} \times 0.8 \times 110 \times 10^{-3} = 8.92 \times 10^{-3} \text{ m}^3/\text{s};$$

Finding the power required to drive each roller;

For conveyer rollers the required power=2.72watts for each roller, for the 9 rollers the total power required= **24.48watts**;

$$v = \omega r$$

hence $\omega = v/r = 110 \times 10^{-3} / 0.150 = 0.733 \text{ rad/s}$; is to be attained in 0.5 second $\alpha = 1.467 \text{ rad/s}^2$;

Moment of inertia, $I = 0.5m(R1^2 + R2^2)$;

$$I = 0.5 \times 181.73 \times (0.152^2 + 0.1252^2) = 3.4642 \text{ kgm}^2; \text{ Torque} = I\alpha = 3.4642 \times 1.4667 = 5.1 \text{ Nm};$$

$$P = (T + T_c)\omega = 251 \times 0.733 = 184 \text{ Watts};$$

The total power required to power the paper machine=power of each roller x number rollers+ conveyer rollers = $(184 \times 2) + 24.48 = 392.48 \text{ Watts}$

The oven

For the design of the dryer oven, the results from the drying experiment conducted by Reardon (1994,p86) we reused. When drying paper on nylon felt with a tension of 1780 Nm, hot air should enter the oven at a rate of 5 m/s.

How it functions

The recycling machine is divided into two sections: the paper machine section and the cleaning section. Receiving pulp and cleaning it are the responsibilities of the cleaning unit.

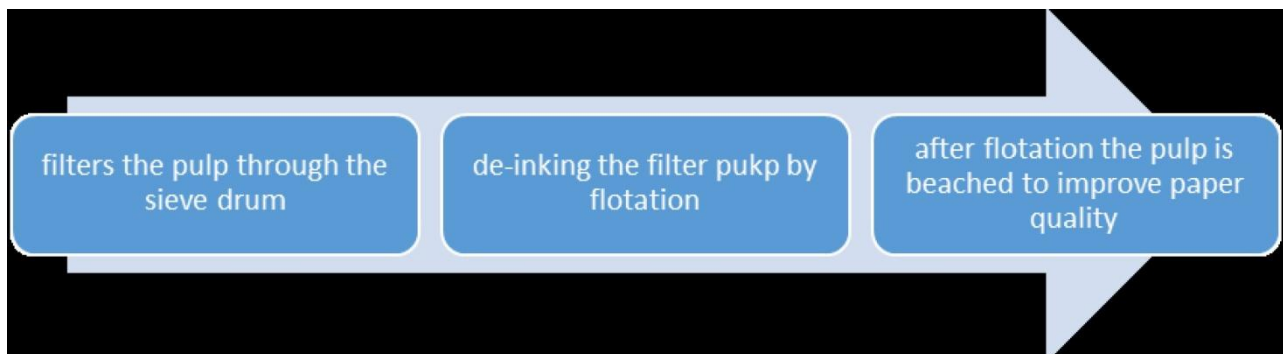


Fig.9 Cleaning system

Paper machine Unit

Is responsible for the conversion of pulp into paper.

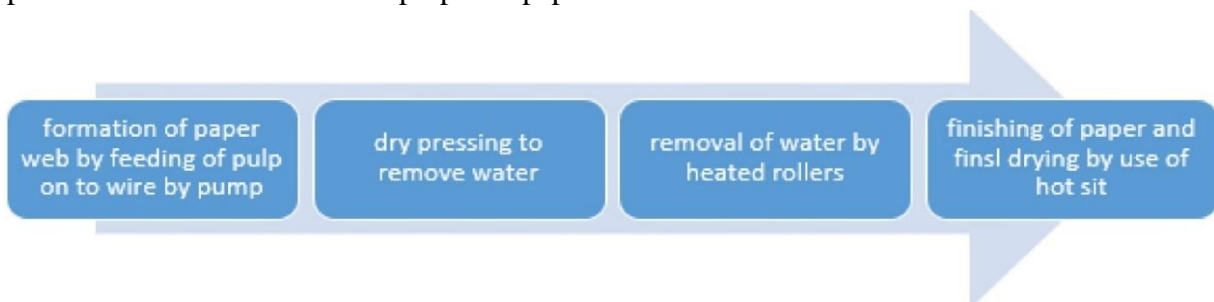


Fig.10 Paper machine system

The author came up with the design that is solving the mentioned problem at the university and where necessarily required as shown in figure 5.

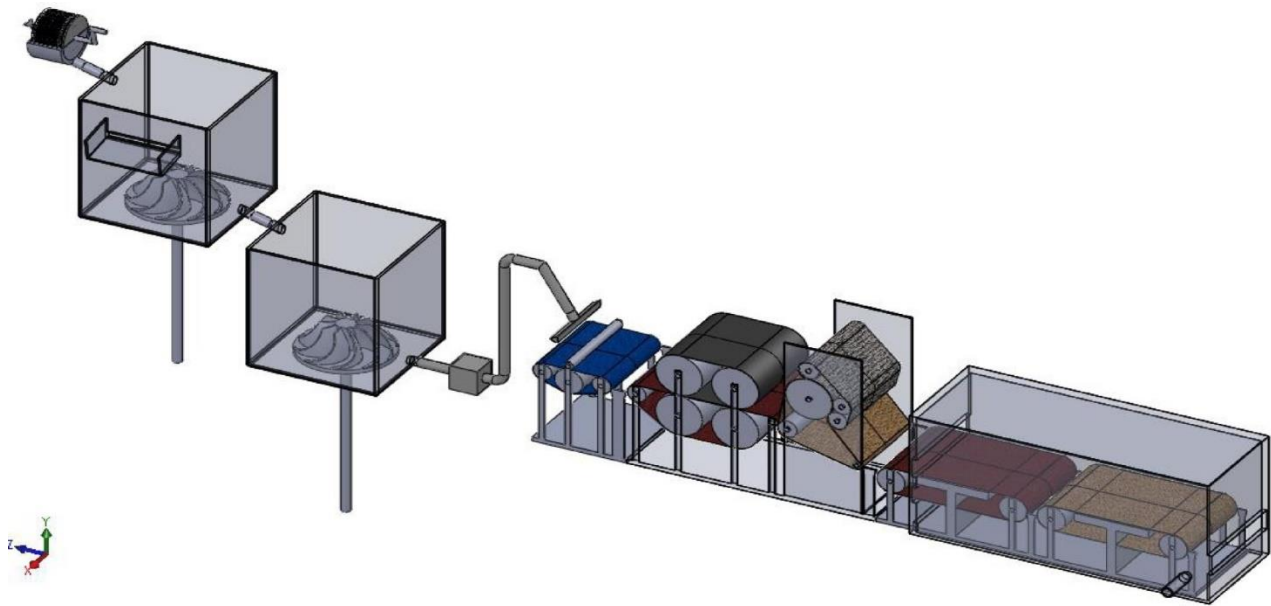


Fig.11 Designed manual paper recycling machine by the researchers.

Limitations and effects

Paper can include up to 10,000 distinct compounds in addition to fibers, and these organic and inorganic elements have the potential to contaminate freshly made paper goods. As an example, bisphenol A (a chemical commonly found internal papers) has been verified as a contaminant in a variety of paper products resulting from paper recycling. Further more, groups of chemicals as phthalates, phenols, mineral oils, poly chlorinated biphenyls(PCBs) and toxic metals have all been identified in paper material. Although several measures might reduce the chemical load in paper recycling (e.g., improved decontamination, optimized collection of paper for recycling), even completely terminating the use of a particular chemical (phase-out) might still result in its circulation in the paper cycle for decades.

- Deinked pulp cardboard
- Paper
- Tree-free paper
- Wood-free paper
- Environmental impact of paper
- USPS Post Office Box Lobby Recycling program

Conclusions and Recommendations

Conclusions

The required specs and requirements can be satisfied by the design. An average person can use the machine because it doesn't require any specialized expertise to operate. The machine is not projected to fail during its allotted lifetime because of its modest power, speed, and load requirements; however, as bearings and compression rollers are the parts most likely to break while in use, they will need extra care and maintenance. The quality of recycled paper produced mainly the thickness, may be slightly be below the standard due to limitations of design power. Overall the continuous production of paper by use of the machine is quite effective when compared to other existing machines. The machine will meet the demands of the paper market, enable the generation of income from trash, and assist reduce unemployment. It will also significantly minimize landfill and environmental problems in key

consumers of waste, such as universities and schools. In order to improve the speed and quality of the article, more research must be done.

Recommendations

It is recommended to use the machine in a suitable temperature environment of range 20oC to 40oC and the machine must be not exposed to rain at any given time. The flow rates of pulp feeding to the cleaning section and to the paper machine section as well as the machine design speeds should be within 3% tolerance range. For high-quality recycled paper, all machine processes, including flotation and bleaching, must be completed. Additionally, 90% of the pulp's raw mass that is fed into the machine must be high- or medium-quality writing or print paper. The machine's chains and bearings need to be regularly serviced and oiled. A number of improvements can be made on this device such as an easy powering mechanism that can switch from man power to an electric power (motor) should be included in the implementation of the machine. The machine should cater for the safety of users due to exposure of high drying temperatures and a wet environment together with electric heating element and include a water retention or recycling system since paper recycling consumes large volumes of water. The designers also recommends the further development and testing of this system into a functioning prototype to illustrate the functionality of the design therein and its relevance to the art of paper recycling.

Future Scope

In a future we can implement in a Paper recycling machine automatic working like vision sensor when detect and color impurity so it will auto ejection and heater rollers movements use motors will be reduce mechanical work.

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