PLANT DESIGN PROJECT OF 10Kg/hr WASTEPAPER INTO FRESH PRODUCTS

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Dedication

Dedicated to those Personalities
who took me by the finger,
to teach me how to walk,
and also those
who rewarded me with pen,
and taught me how to write.

Certificate of Approval

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“Submission to ALLAHS’ Will is the best companion; wisdom is the noblest heritage; theoretical and practical knowledge are the best signs of distinction; deep thinking will present the clearest picture of every problem”.

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LIST OF ABBREVIATIONS

FAO	=	Food and Agriculture Organization
US	=	United States
CEPI	=	Confederation of European Paper Industries
COVID-19	=	Corona Virus Disease of 2019
Kg/d	=	Kilogram per Day
PH	=	Potential Hydrogen
L/d	=	Liter per Day
Kg/m^3	=	Kilogram per meter cube
Kj/hr.	=	Kilojoule per hour
V	=	Volume
PPE	=	Personal Protective Equipment
UK	=	United Kingdom
HAZOP	=	hazard and operability study
H_2S	=	Hydrogen sulfide
SOPs	=	Standard operating Procedure
FC	=	Flow controller
Ft	=	Flow transmitter
PC	=	pressure controller
LT	=	Level transmitter
LC	=	Level controller
Tt	=	Temperature transmitter
TC	=	Transmitter controller

LIST OF NOTATIONS

%	=	Percentage
M	=	Mass
T	=	Temperature
P	=	Pressure
m^3	=	Meter cube
L	=	Liter
°C	=	Degree Centigrade
Cp	=	specific heat capacity
Q	=	Heat
A	=	Area
ΔT	=	Change in temperature
V	=	Velocity
Q	=	Flow rate
RE	=	Retention Efficiency
$	=	Dollar

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ABSTRACT

Recycling paper involves turning used paper into new paper goods. It is a beneficial economic and environmental practice that can aid in lowering the usage of energy, water, and forests. The steps involved in recycling paper typically include collecting, transport, sorting, pulping, de-inking, and papermaking.

Used paper is gathered from homes, businesses, and other sources during the collecting stage. After that, the paper is taken to a recycling center. The paper is divided into several grades and types at the recycling facility. For instance, office paper, cardboard, and newspapers are all categorized separately. The next step in the process is pulping. In this step, the paper is shredded into small pieces and mixed with water. The paper is de-inked after it has been pulped. The paper's ink is cleaned off in this stage. Several techniques, including chemical processing and mechanical separation, are used to get rid of the ink.

A new sheet of paper can then be created from the de-inked pulp. After being combined with water and additional chemicals, the pulp is dumped onto a screen. The paper fibers are left behind as the water drains away. To create a new sheet of paper, the paper fibers are then compressed and dried.

Recycling paper is a beneficial economic and environmental practice. It can aid in lowering the use of energy, water, and trees. Additionally, it can aid in lowering emissions of greenhouse gases and pollution.

The method for recycling paper is always being improved. To make the process more effective and environmentally friendly, new technologies are being developed. Paper recycling is thus playing a bigger role in our attempts to preserve resources and safeguard the environment.

CHAPTER 01

INTRODUCTION

1.1Introduction

In Pakistan, paper is frequently utilized for a variety of tasks, including the printing of books, newspapers, magazines, and other publications. Paper is also extensively used in writing, packaging, and the production of several paper-based items. A strong printing sector exists in Pakistan that creates a wide variety of printed items utilizing paper, such as books, newspapers, magazines, and brochures.

Apart from printing, paper is commonly used for writing in Pakistan[1] Paper is used by students for taking notes, completing writing projects, and studying for tests. Business people also utilize paper for communications, presentations, and proposal writing, among other things. Paper is also widely utilized in Pakistan for packaging needs. [2]Many consumer products are packaged in paper boxes or bags, and paper-based packaging is widely utilized in the restaurant industry for things such as disposable cups, plates, and napkins. Overall, paper continues to be a necessary good in Pakistan, and as the economy of the nation expands, more people will likely utilize it

Figure 1.1: paper waste

However, there are also worries about how producing and using paper may affect the environment, so initiatives are being made to encourage sustainable paper usage in the nation[3]. We produce a tremendous amount of trash paper. It was primarily created as a tool for communication, but it is now also utilized as a source for packing. Paper products are frequently used, then discarded, which results in the production of wastepaper. This can occur

in a number of ways, including when outdated books, newspapers, magazines, or other publications are discarded, or when paper is used for packaging, wrapping, or other temporary uses. The production of wastepaper can have a detrimental effect on the environment since it takes up space in landfills and causes pollution. To lessen the amount of wastepaper that ends up in landfills, many cities have created recycling programs. To reduce wastepaper in your own life, consider using electronic papers instead of printed copies, reusing paper for scrap or note-taking, and recycling paper products whenever possible. In many towns throughout the world, recycling paper trash is a popular activity. The amount of garbage that is dumped in landfills and the use of natural resources can both be decreased by recycling paper. [4]. Individuals and businesses can gather used paper goods including newspapers, magazines, and cardboard boxes to make wastepaper for recycling. After being sorted and cleaned to eliminate impurities like plastic or metal, this wastepaper can then be turned into new paper products. Due to its ability to save energy and natural resources, reduce pollution, and slow the effects of climate change, recycling wastepaper can have a substantial positive impact on the environment. Additionally, it promotes the circular economy and adds to job growth in the recycling sector. Individuals can help the recycling of wastepaper by printing on both sides of the paper and adopting digital alternatives whenever possible. By taking these small steps, we can all play a part in reducing waste and promoting sustainability.

1.2. Paper making resources

Deforestation occurs because trees must be cut down in order to obtain the wood needed to create paper. 42% of all trees that are cut down are consumed by the paper industry globally[5]. To create new paper and paperboard, over 95 million metric tons of cellulose sheets, which are the main component of paper, are collected and recycled each year[1].

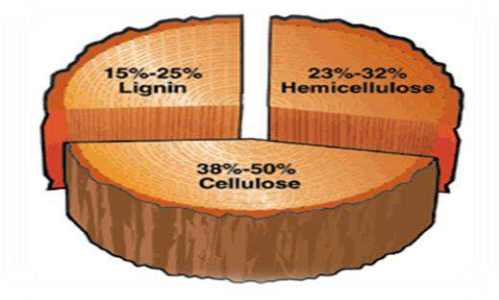

Figure 1.2: composition of wood

There are other components made of wood and other similar raw materials. There are numerous readily available raw cellulose components used in the pulp and paper industry. The conventional source of cellulose, wood, can be replaced with recycled paper and other agricultural waste materials that also contain cellulose. At least in developing nations, the

majority of the world's cellulose is derived from non-wood sources such jute, sisal, bamboo, bagasse, and similar materials. The main source of pulp and raw materials for papermaking is wood. According to its general characteristic composition, cellulose, lignin, and hemicellulose make up the majority of wood. In addition, there are a few different extractives. Table 1 shows that cellulose makes up between 40% and 50% of wood, which agrees with empirical data.

S.NO	COMPONENT	% COMPOSITION
1	Cellulose	40–50%
2	Hemicellulose	25–30
3	Lignin	25–30
4	Extractives	Minor

Table 1.1. *Composition of wood* [6]

The composition of paper varies based on the type of paper and its intended function. Typically, fibers made from cellulose from wood, cotton, or recycled materials are used to make the majority of papers. Papers may also contain fillers, sizing agents, and binders in addition to cellulose fibers.. Here are the main components of paper:

- Cellulose fibers: Cellulose is the main ingredient in paper and it makes up the bulk of the paper composition. Cellulose fibers are processed and refined before they are used to make paper.
- Fillers: Fillers are materials added to the paper to improve its opacity, brightness, and smoothness. Common fillers include clay, talc, calcium carbonate, or titanium dioxide.
- Sizing agents: Sizing agents are compounds that are added to the paper to improve its resistance to penetration by water, ink or other liquids. Common sizing agents include rosin, alum, and starch.
- Binders: Binders are substances that keep the fibers together and give the paper its strength. Binders can be added in the form of latex or synthetic resins, such as polyvinyl acetate or acrylics.
- Additives: Additional components may also be added to paper to achieve specific properties, such as dyes or pigments for coloration, anti-static agents or anti-fungal agents.

The proportions of these components can vary depending on the intended use of the paper. For example, newsprint paper usually contains a higher proportion of mechanical pulp fibers, while

high-end glossy paper may have a higher proportion of chemical pulp fibers to obtain a smoother finish[7].

1.3. Global consumption of paper

The amount of paper consumed worldwide fluctuates according to a number of variables, including population, economic development, technological improvements, and environmental regulations. The Food and Agriculture Organization (FAO)'s most recent estimates, however, show that the production of paper and paperboard worldwide reached 419 million tons in 2019[8].

The greatest paper consumers in terms of regional consumption are Asia and North America, who together account for around 66% of worldwide paper consumption. The top four consumer regions are Latin America, Africa, and Oceania, with Europe coming in third. It is significant to note that the consumption of paper has decreased in many developed nations as a result of the move toward digitalization and growing concern for sustainability. However, as their economies continue to advance and modernize, developing nations' need for paper products is constantly rising.

According to the Confederation of European Paper Industries (CEPI), in 2020 the global paper and board production amounted to approximately 419 million tons. This represents a decline of 0.6% compared to 2019, which is partly attributed to the COVID-19 pandemic[8].

1.3.1. The top 5 paper-producing countries in 2020 were[8]

1. China - 117.3 million tons
2. US - 67.8 million tons
3. Japan - 26.7 million tons
4. Germany - 22.1 million tons
5. Canada - 13.6 million tons

In terms of paper use, data for 2020 is still being collected and analyzed. However, worldwide paper consumption has remained pretty stable over the last decade, ranging between 400 and 420 million tons per year. It is worth noting that there is a growing tendency in the paper sector toward lowering paper use and boosting sustainability. Many manufacturers are using environmentally friendly methods such as recycling materials, minimizing water consumption, and utilizing renewable energy sources. In 2000, 323 296 000 tons of paper and board were produced, with an average consumption of 53.8 kg per person. In 2010, production totaled 393,917,000 metric tons, with an average consumption of 57.7 kg per person. By 2025, annual global paper consumption is expected to have increased by 1.6% to 500 million tons[3].

The desire to further one's education is growing in Pakistan. The number of institutions that grant degrees, such as universities, is growing. There are 16 private universities, 23 state universities, and over 8,000 international students in this region. More over one-third of the population is now enrolled in college. During the same time period, the University of Panjab (the area's largest and most populous higher educational institution) received nearly 5,000 admission files for the 2013/2014 school year. Each folder contains 20 pages of information, 10 of which are needed by law (during the enrolling procedure). In only one academic year, that equates to around 15,000,000 papers, 300 rims, or 750kg for 5,000 students. (based on an average of 30 pages per student)[9]. The demand for paper has increased by 400% over the past 40 years, leading to deforestation, as 35 % of all cut-down trees are used to manufacture paper. The paper industry makes an enormous amount of money. Commercial, administrative, academic, religious, and business activities use much paper. These examples are books, articles, pamphlets, leaflets, posters, and newspapers. It's not just paper and cardboard that you'll find in homes and offices, which are thrown away after use[10].

1.3.2. Recycling of paper is important for several reasons

- Conservation of natural resources: Paper recycling lowers the demand for raw materials, hence reducing the need for natural resources like forests and water. This promotes environmental protection and assures a sustainable future.
- Energy conservation: Compared to creating fresh paper from the ground up, recycling paper uses less energy. Therefore, recycling paper can contribute to energy conservation and a decrease in greenhouse gas emissions.
- Waste reduction: Paper recycling helps to cut the amount of waste that accumulates in landfills. This reduces the demand for new landfills and prevents the accumulation of waste.
- Economic benefits: Paper recycling boosts the local economy and offers job possibilities. Additionally, it helps in reducing the price of handling waste and the price of making new paper..
- Water conservation: Recycling paper uses less water than generating new paper from raw resources. This means that recycling paper can help conserve water resources.
- Environmental benefits: Recycling paper helps to conserve natural resources such as trees, water, and energy. It also reduces the amount of waste that ends up in landfills and reduces greenhouse gas emissions that contribute to climate change.

Overall, recycling paper is a crucial practice that can support sustainable growth and guarantee a better future for future generations. There are a number of businesses in Pakistan that

specialize in turning wastepaper into fresh paper. Here are some examples of companies that offer wastepaper recycling services in Pakistan:

- Century Paper and Board Mills Limited: This company has a wastepaper recycling plant located in Lahore, Pakistan. They collect and recycle wastepaper to produce a variety of paper and board products.
- Mehran Paper Mills: This company has a wastepaper recycling plant located in Hyderabad, Pakistan. They specialize in recycling wastepaper to produce kraft paper and linerboard.
- Packages Limited: This company has a wastepaper recycling plant located in Lahore, Pakistan. They offer wastepaper collection services and recycle the paper to produce packaging products.
- Al Huda Paper Mills Pvt. Ltd.: This company has a wastepaper recycling plant located in Karachi, Pakistan. They specialize in recycling wastepaper to produce writing and printing paper.

These are just a few examples of companies that offer wastepaper recycling services in Pakistan. There may be other companies or recycling facilities in different regions of the country as well.

1.4. Recycling Wastepaper in the World

A substantial portion of the paper industry involves recycling old paper to create new ones. What is taking place here can be called "paper recycling". The need for recycled paper has increased dramatically as a result of depleting natural resources and a lack of raw materials. Paper recycling rates average 58% on a global level. Recycling paper waste today accounts for up to 75% of the total paper waste in some more industrialized nations. These developed countries might increase their national paper recycling rates and raise the average paper recycling rate globally by expanding their waste recycling infrastructure. While Europe has the highest paper recycling rate worldwide, Asia, Latin America, and Africa all have some of the lowest. North America is just the third best in the world[10]. Paper is the most recycled material in Europe due to its easy biodegradability and recyclable nature. Cellulose fibers can be recycled up to seven times. Recycling paper waste that can be reused is so necessary. Due to a lack of raw materials, recycling paper is becoming more and more popular in the paper and paperboard business. Recycled paper serves as the main source of raw materials for paper mills in both industrialized and developing nations. Recycling paper helps protect limited resources like forests and water while also sharply lowering production costs. When a piece of paper is recycled, a variety of resources are conserved, including trees, water, oil, power, and landfill

space. Paper scraps can be recycled into various products, including newspapers, napkins, office and printing paper, envelopes, cardboard boxes, wrapping paper, egg packaging, wallpaper, and thermal insulation wool[11].

1.5. Types of waste paper

wastepaper is classified as either pre-consumer or post-consumer garbage. Paper shavings and scraps produced during the manufacture of paper are referred to as pre-consumer waste. Old newspapers or printer paper are examples of post-consumer trash, which is paper that has been used by customers before being thrown. Post-consumer waste is the most frequently recycled kind of wastepaper since it has already been used by consumers.

CHAPTER 02

LITERATURE REVIEW

2.1Review of some publishers

Repulping is a critical step in paper recycling, and the quality of the repulping process directly affects the quality of the recycled paper product. A study by Bhardwaj et al. (2018) investigated the effect of various parameters such as pH, temperature, and pulping time on the repulping process of mixed office wastepaper. The study found that increasing the temperature and pH improved the repulping process and reduced the time required to achieve complete pulping[12].

Sustainable development is universally recognized as a pressing concern for humanity. Success or failure in this endeavor will depend significantly on how we manage our environmental resources. Recycling paper is a green and sustainable practice that helps reduce trash and maximizes the use of renewable materials. In the same way that recycling reduces the demand for virgin timber, using PW as a feedstock also helps forest resources. Paper manufacturing uses 42% of all harvested wood (not counting firewood), making it an important part of the recycling debate[4]. Recycling paper is a popular practice that serves important purposes in various cultural contexts. More and more people are becoming aware of the importance of shifting waste management to waste. due to environmental concerns, climate change, and the efficient use of natural resources. One significant aspect of the paper business is recycling scrap paper into new paper goods. The practice is commonly referred to as "paper recycling." As natural resources are depleted and raw materials become scarcer, the recycled paper market grows exponentially. More than 7% to 8% yearly growth in demand for recycled paper has been reported in emerging nations over the past several years[13].

After comparing recycled paper to newly obtained hardwood pulp, Ferguson (2000) concluded that recycled paper was a viable alternative to hardwood pulp and could be used to manufacture printing papers. Among the many uses for the paper they used were for writing, coloring, and personal hygiene[14]. About 35% of annual tree harvesting, or about 160,000 km2 of the forest, is attributed to paper manufacture. Due to their renewability, only nine percent of the trees used to create paper come from old-growth forests. However, many trees are still used to produce paper, harming the natural world. You can recycle old newspapers and magazines to use in this situation. Paper recycling is the process by which used paper is converted into new paper products. The benefits it provides are numerous and important: This reduces the risk of PW

infiltrating homes and producing methane gas during the decomposition process. To reduce tree cutting, finding a suitable substitute is of paramount importance. Paper recycling rates are on the rise as a result of eco-friendly and money-saving policies. Throughout Europe, recycling has increased by about 20% over the past decade, reaching over 72% in 2012[15]. Countries like India and China are providing aid to paper recyclers to reduce the depletion of natural resources and increase recycling rates. These days, paper is produced more often from recycled materials than new trees. A shift in consumer preferences toward recycled pulp from virgin pulp will aid in protecting the environment[16].

CHAPTER 03

PLANT LAYOUT

A plant layout defines the structure of the location, machinery, and other equipment used to manufacture the product. This facility's layout represents the overall configuration of the equipment, tools, stockroom, material handling equipment, and service areas. It describes the overall layout of the premises, machinery, and other equipment used to make the product.

3.1Objective of plant layout

Layout is designed to develop a manufacturing system that efficiently meets quantity and quality requirements. A productive plant layout may lead to reaching the following goals:

- To satisfy the quality and capacity requirements in the most cost- effective way possible.
- The elimination of idle time will enhance the utilization of manpower resources.
- The quality and efficiency of the operation will be improved.
- Use floor space efficiently and affordably to reduce transportation costs and time.
- The removal of bottlenecks by balancing plant capabilities.
- Reduce machine interruption to a minimum.
- Lower risks and increase worker safety.
- Avoid frequent changes in layout, which may result in an increase in manufacturing costs.

3.1.1. Component in process flow diagram

- Shredder
- Soaking tub
- Digester
- Mold (Frame)
- Mechanical presser
- Dryer

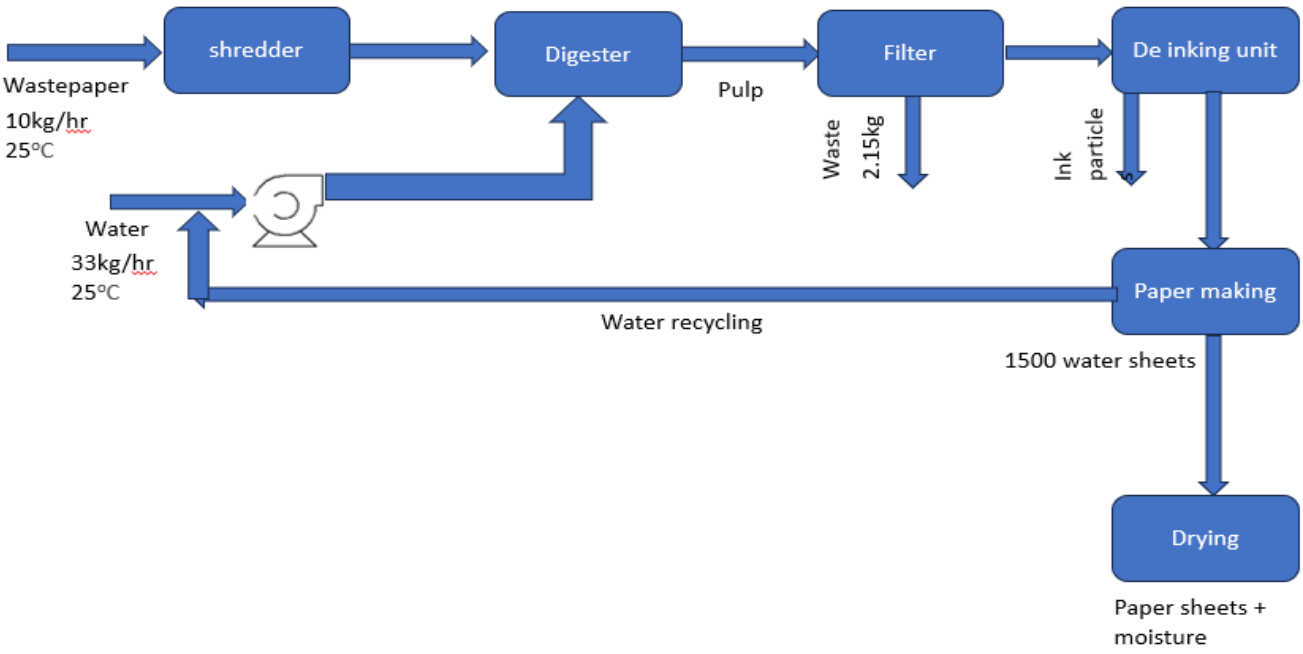

Figure3.1: Process flow diagram of wastepaper recycling

3.2. Plant Location

Industrial venture success mainly depends on the geographical location of the plant. For selecting plant location, care is needed. Although the plant does not need any environmental conditions, The human safety comes first so if there is any mishap happens during the production of biodiesel the plant is away from the populated area.

3.3. Raw materials availability

Raw materials for producing fresh paper from wastepaper is wastepaper and water. All these 2 raw materials are available in market and in our institute. Educational institutes being the main producer of the wastepaper also packaging materials etc.

3.4. Climate

The climate conditions required for paper production is nor too hot nor too cold. As in extreme atmospheric conditions there's increase within the cost of the plant. An ambient climate condition is important due to its chemical and physical nature.

3.5. Storage of paper

When it comes to storing papers, you want to ensure they remain in good condition and are easily accessible. Utilize paper trays or bins specifically designed to hold and organize papers. These containers keep the papers neatly stacked and readily available for use. Transparent

plastic containers with lids can be used to store and protect blank papers. They allow you to see the contents while keeping the papers safe from dust or moisture.

3.6. Transportation Facility

Transporting blank paper typically doesn't require any special transportation facilities. Blank paper, such as loose sheets or notebooks, can be easily transported using standard methods, depending on the quantity and size. It’s important to ensure that the paper is adequately protected during transportation to prevent any damage or creasing. Consider using padded envelopes, bubble wrap, or additional cushioning materials to provide extra protection if needed.

3.7. Water supply

Water supply is a crucial component in the papermaking process. It is used for various purposes, including preparing the pulp, diluting chemicals, rinsing fibers, and controlling moisture content and washing equipment after use. Paper mills typically use freshwater from reliable sources such as rivers, lakes, wells, or municipal water supplies. Treated water can be reused and recycled. Specific place should be founded for washing of equipment's after use and for safety purpose.

3.8. Labor supply

Working in a plant requires trained labor so it must be managed carefully. Always wear the appropriate PPE as required by job tasks and the specific work area. Operating machinery in the paper industry, ensure you receive proper training on equipment operation and follow all safety protocols. Any mishap leads to accidents; therefore, workers should be trained for such circumstances, and manual operations like temperature and pressure should be checked constantly to keep them under control.

3.9. Other requirements

Emergency notification system or alarms should be setup at different sites within the plant for any emergency situations. For emergency conditions all employees should be given respirators and trained them for use of respirators in emergency situations.

CHAPTER 04

PROCESS DESCRIPTION

Recycling wastepaper has various advantages, including the conservation of natural resources, the reduction of trash transported to landfills, the reduction of energy consumption, and the reduction of environmental effect. It is critical to the development of a more sustainable and circular economy, in which resources are reused and waste is reduced, resulting in a greener and more environmentally responsible world. There are steps which are involve in recycling of wastepaper.

4.1Sorting

Successful recycling demands clean recovered paper, thus we must maintain paper free of impurities such as food, plastic, metal, and other debris, which make recycling difficult. Workers or automated equipment recognize and sort different types of paper, such as newspapers, cardboard, office paper, periodicals, and mixed paper. Sorting ensures that each type of paper may be recycled efficiently and that high-quality recycled products are produced.

4.2. Collection and transportation

After sorting, the paper is collected and transferred to a recycling center. Paper waste is collected from a variety of sources, including residences, offices, schools, and commercial businesses. The wasted paper is then collected and delivered to a recycling center. Efficient and well-organized collecting methods are required to avoid contamination and ensure that collected wastepaper arrives at the recycling facility in good condition. Transporting wastepaper to a recycling plant may necessitate the use of trucks, trailers, or other specialized equipment.

4.3. Storage

The wastepaper is temporarily stored before being further processed after being sorted and transferred to the recycling facility. To prevent the paper from being exposed to moisture, dust, and other contaminants that can reduce its quality or slow the recycling process, proper storage facilities are required. Large bales are often used to store paper, making it simpler to transport and use.

4.4. Shredding

The wastepaper is mechanically shredded into little bits once it has been sorted and stored.

The surface area of the paper is increased by shredding, making it easier to handle throughout the next processing steps. This reduces the repulping procedure time.

Figure 4.4: shredded papers

4.5. Repulping

The shredded paper is then repulped. This is done by mixing the shredded paper with water and it is fed into digester to create a slurry called pulp. The mixture is agitated to break down the paper fibers into individual cellulose fibers, resulting in a homogeneous pulp mixture.

Figure 4.5: Repulp of waste paper

4.6. Screening

Screening pulp is an important phase in the papermaking process that comes after repulping. The pulp is run through various types of screens during screening to remove any remaining

impurities, big fibers, or undesired particles, ensuring that the pulp has the appropriate quality and consistency for the production of high-quality recycled paper.

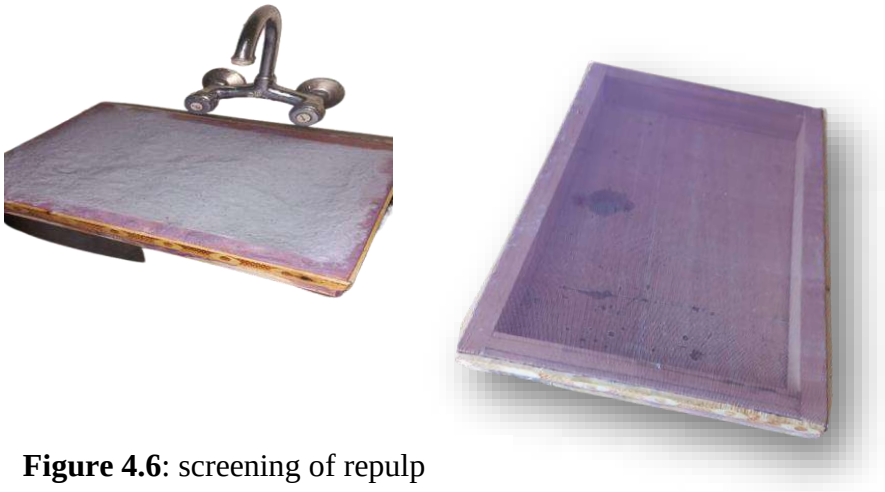

Figure 4.6: screening of repulp

4.7. Deinking

Deinking is a process used to remove ink and other contaminants from the recycled paper pulp. During flotation deinking pulp is fed into a large vat called a flotation cell, where air and surfactants are injected into the pulp. The surfactants cause ink and stickies to loosen from the pulp and stick to the air bubbles as they float to the top of the mixture. The inky air bubbles create foam which is removed from the top, leaving the clean pulp behind. Deinking is particularly important for producing high-quality recycled paper, especially for applications where a clean white appearance is required.

4.8. Papermaking

After the deinking process, the clean pulp is ready for papermaking. The deinked and watery pulp mixture is poured into a mold. The bottom of the mold is made of a screen on the screen,

Figure 4.8: paper making

water starts to drain from the pulp, and the recycled fibers quickly begin to bond together to form a watery sheet.

4.9. Drying

The sheet is quickly squeezed out more water by a series of felt-covered press rollers. This procedure aids in drying the sheet of material, which now resembles paper, as it travels over a series of heated metal rollers. In the production of paper, drying has two purposes. The first thing it does is remove any water that is still in the web but cannot be eliminated by pressing. Second, it makes fibers adhere to one another.

4.10. Water recycling

Almost every step of the pulp and paper manufacturing process requires the use of water, whether the facility is processing wood chips, creating fiber slurries, or cleaning the equipment and rollers. Despite significant advancements over the years, the paper and cellulose industries are now required to cut their water use due to increased pressure on freshwater supplies, increased requests for water conservation, and stricter regulations. W recycle the wastewater use in our plant by the following method in order to minimize the wastewater drainage.

The water that drains during the paper producing and screening process is recirculated to avoid water drainage into the environment from the sheet-forming zone, which is rich in fiber fines and filler. This water is mixed with the fresh water for soaking and for use in digester because it has large quantity of fibers in it.

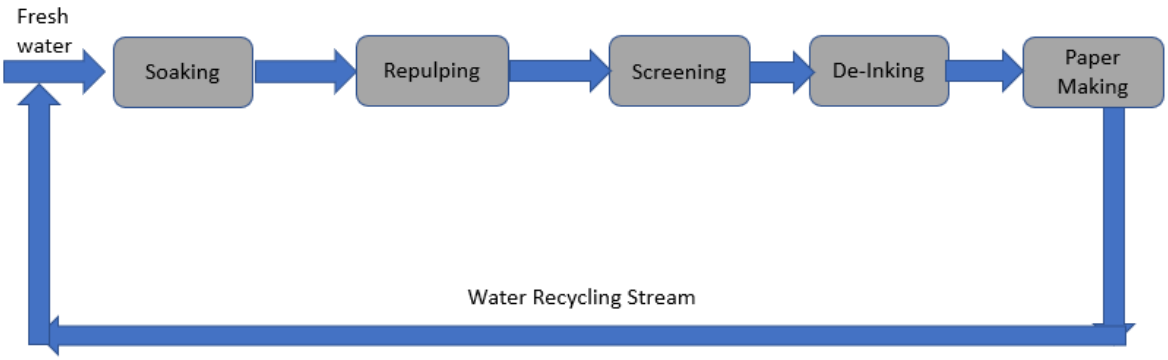

Figure 4.10:process flow diagram of water recycling

CHAPTER 05

MATERIAL BALANCE

5.1 Mass balance on digester

Raw materials = wastepaper + Water

Basis 10kg wastepaper/hr

Here we use 10kg of wastepaper and 33liters of water for making pulp:

The density of wastepaper is 800kg/m^3 and the density of water is 1kg/L.

Mass of the wastepaper = 10kg

Volume of wastepaper = 10kg /800 kg/m^3 =0.0125m^3

Mass of water = 33 kg

Volume of water = 33 L /1000 = 0.033 m^3

Mass of input = Mass of output

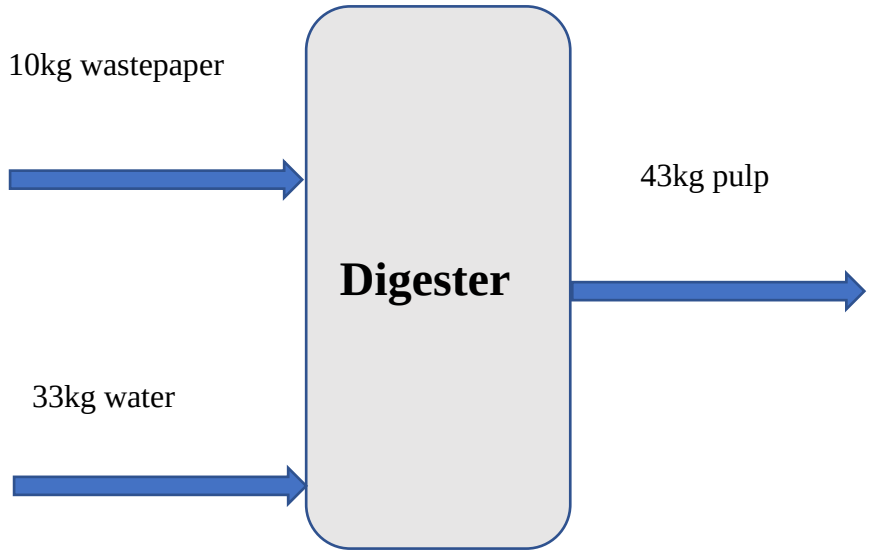

Figure5.1: mass flow of digester

When the wastepaper and water are mixed to form pulp, the total mass and volume will be:

Total mass = mass of wastepaper + mass of water

= 10kg +33kg = 43kg

Total volume = volume of wastepaper + volume of water

= 0.0125 m^3 + 0.033m^3 = 0.0455m^3

So, the mass balance equation can be written as:

The mass of pulp is produced 43kg from 10kg of wastepaper and 33liters of water.

5.2. Mass balance on the screen

Here we pass 43kg of pulp from screen.

Initial mass of pulp = 43 kg

Percentage of mass removed = 5%

Mass removed = Initial mass × Percentage of mass removed

Mass removed = 43 kg × 0.05 = 2.15 kg

Mass in – mass out = accumulation

43kg - 40.85kg =2.15kg

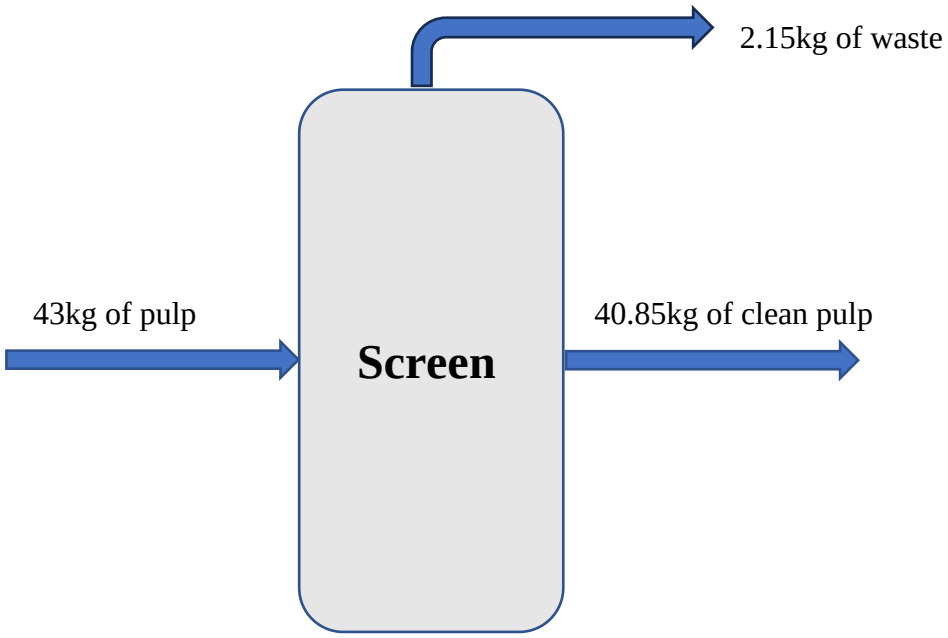

Figure5.2: mass flow of screen

5.3. Material balance for mold

The clean pulp is then poured into a mold. Water starts to drain from the pulp, and the recycled fibers quickly begin to bond together to form a watery sheet.

Mass in = 40.85kg

Mass out =25kg water + 1500 pages of paper

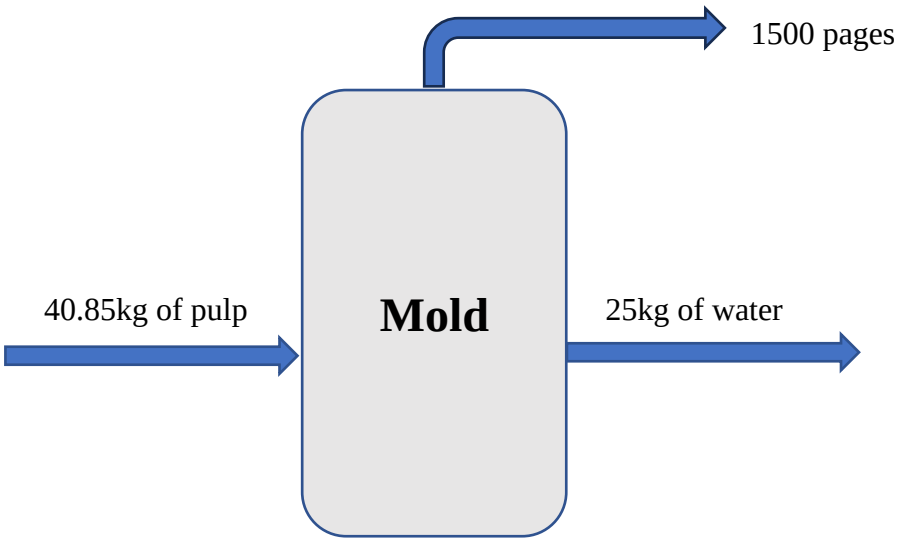

Figure5.3: mass balance on mold

CHAPTER 06

ENERGY BALANCE

6.1 Energy balance on digester

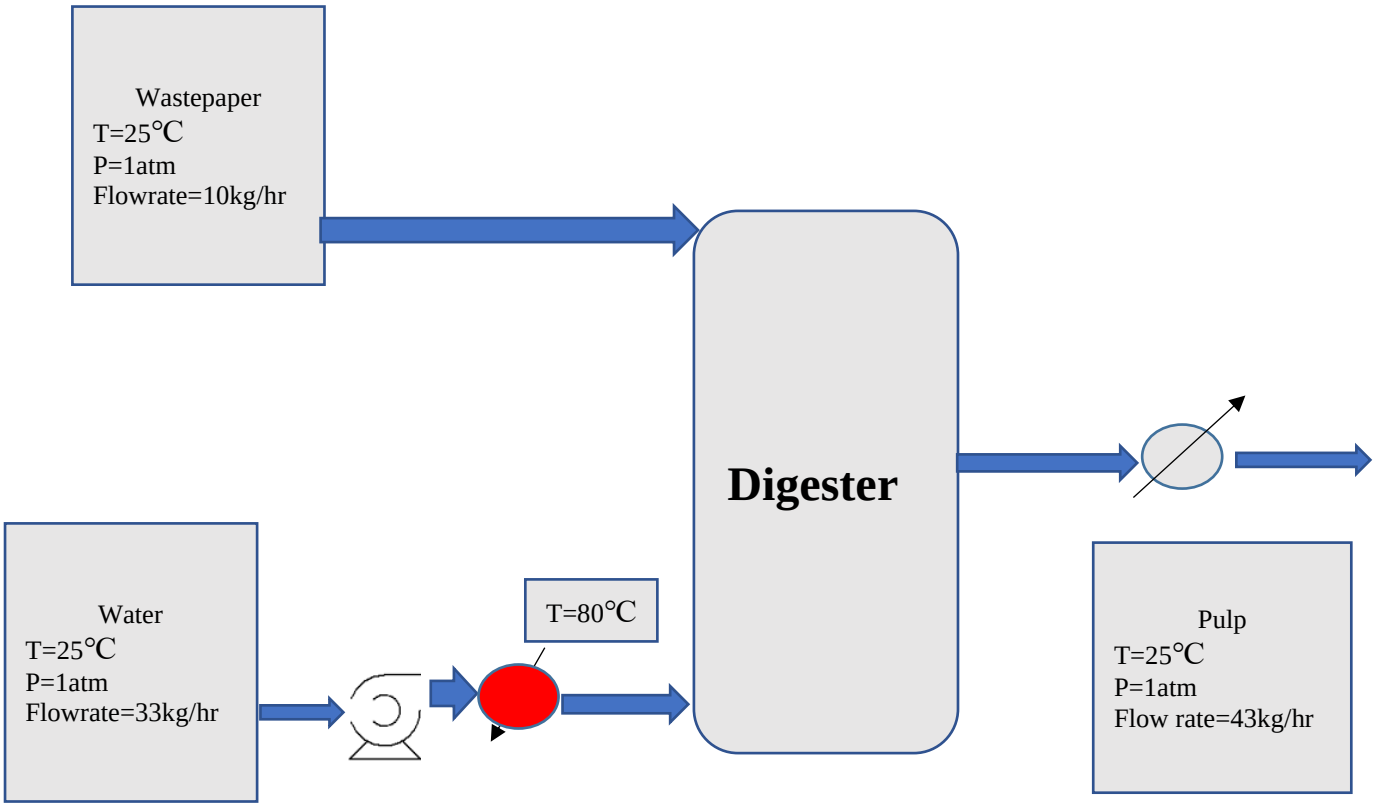

Figure 6.1: Energy flow on Digester

Using: $Q = m C_p \Delta T$ **on heater**

Mass flowrate of water = m = 33 kg/hr

C_p = 4.18kJ/kg ℃

Q = 33 kg/h (4.18 kJ/kg ℃) (80-25) ℃

Q = 7586 kJ/hr.

Using: $Q = m C_p \Delta T$ **on cooler**

Mass flowrate of water = m = 43kg/hr

C_p = 2.5kJ/kg ℃

Q_2 = 43 kg/h (2.5 kJ/kg ℃) (80-25) ℃

Q_2 =5912kJ/hr

Using: Q = Pt on the water **pump for electrical energy**

Pump power = 0.5 hp = 0.5 x 746 watts = 373watts

Operation time = 20 minutes x 60 seconds = 1200s

Q = Pt

Q=373x1200

Q=447600 watt second or 0.124 kilowatt-hours

Using: Q = Pt on the **electric motor in the digester for electrical energy**

Pump power = 2hp = 2 x 746 watts = 1492watts

Operation time = 1.5hour x 3600 seconds = 5400s

Q = Pt

Q=1492x5400

Q=8056800 watt second or 2.238kilowatt-hours

Energy balance on dryer

Using: Q = m C_p ΔT

M=40.85kg

Cp=2.5kj/kg℃

Q=40.85 x 2.5 x (80-25)

Q=5616.88kj/hr

CHAPTER 07

EQUIPMENT DESIGNING

7.1Design of conversion Digester

The function of the reactor is to convert wastepaper and water into pulp.

7.1.1. Selection of packing

Stainless Steel is selected as the construction material for the vessel because of its high durability, low cost, and high corrosion resistance.

Steps:

Volume is calculated with the help of.

- Rate of reaction
- Residence time
- Then power consumed is calculated,
- Mechanical design
- Thickness of Shell

Procedure

- Collect all the kinetics and thermodynamic data on the desired reaction.
- Collect physical data required for the design.
- Identify the predominant reaction controlling mechanism.
- Choose a suitable reactor type.
- Make an initial selection of reactor conditions to give the desired conversion and
- yield.
- Size the reactor.
- Select suitable material for construction.
- Make a preliminary design for the reactor.

7.2. Container Volume Calculation

Container Volume (V) = Wastepaper Weight + Water Volume

V = 2 kg + 6 .6L = 8.6L

7.3. Time required for repulping

Total Wastepaper weight = 10 kg

Repulping rate = 0.13kg/min

Time required for 10kg = 77minutes

7.4. Designing of Screen

The wastepaper pulp screening system plays a crucial role in the papermaking process by removing unwanted contaminants, fibers, and particles from the pulp mixture. The design of an efficient and effective screening system is essential to ensure the production of high-quality paper products.

7.4.1. Screening System Components

Infeed Hopper: The system begins with an infeed hopper that receives the wastepaper pulp mixture, directing it into the screening process.

Screening Surface: The heart of the system, the screening surface, consists of a series of fine mesh panels or plates with varying mesh sizes. These screens remove larger contaminants, fibers, and particles from the pulp.

Pulp Outlet: The screened pulp passes through the mesh openings and exits the screening system, ready for further processing in the papermaking process.

Operation

1. Material Feeding: Wastepaper pulp is fed into the infeed hopper, where it is evenly distributed onto the vibratory feeder.
2. Screening Process: The pulp travels over the vibrating surface, and contaminants are separated based on their size. Smaller particles pass through the mesh openings, while larger contaminants are retained on the surface.
3. Pulp Collection: The screened pulp passes through the mesh openings and is collected for further processing. The contaminants that are retained on the screening surface are removed and discarded.

7.5. Material Flow Rate (Q)

The material flow rate is the amount of wastepaper pulp passing through the screening system per unit of time. It can be calculated using the following equation:

$Q=A \times v$

Where:

Q is the material flow rate (volume/time).

A is the effective screening area (area).

v is the velocity of pulp movement

$A=0.13m^2$

V=1kg/1minute

$Q=0.13m^3$ /minute

7.6. Retention Efficiency

The retention efficiency describes the ability of the screening system to retain specific contaminants based on their size. It can be calculated using the following equation:

$RE= M_{retained} /M_{initial} \times 100$

Where:

$M_{retained}$ is the mass of specific contaminants retained on the mesh.

$M_{initial}$ is the initial mass of those specific contaminants in the wastepaper pulp.

RE= 2.15 / 43 x 100

RE = 5%

CHAPTER 08

HEALTH, SAFETY AND ENVIRONMENT

8.1Exposure methods

Exposure can occur by:

- Breathing
- Eating or drinking
- Skin contact
- Eye contact

8.2. Effects of wastepaper pulp on health

Its effect depends on the concentration that the worker has been exposed to and for how much time they have been there.

8.2.1. Short-term Effects

- Respiratory Irritation: Handling dry and dusty wastepaper pulp can cause rapid respiratory irritation, resulting in symptoms such as coughing, sneezing, and shortness of breath. These effects are more obvious when people are exposed to high levels of airborne dust particles[17].
- Skin Irritation: Contact with wastepaper pulp, especially if it contains chemicals or irritants, may cause skin irritation, redness, or rashes in some individuals.
- Allergic Reactions: People who already have allergies or sensitivities to components contained in wastepaper pulp (such as dust mites, molds, or chemicals) may have allergic reactions, resulting in symptoms such as sneezing, itching, or watery eyes.

8.2.2. Mid-term Effects

- Chronic Respiratory Issues: Repeated or prolonged exposure to high levels of dust and airborne contaminants from wastepaper pulp can contribute to the development of chronic respiratory conditions, such as chronic bronchitis or occupational asthma[18].
- Dermatitis: Contact with discarded paper pulp or its chemical constituents can cause chronic skin irritation and the development of dermatitis, a chronic skin disorder characterized by redness, inflammation, and itching.
- Occupational Hazards: Workers in the paper recycling or manufacturing industry who regularly handle wastepaper pulp may face mid-term health risks related to their

occupation. Proper safety protocols and protective equipment are crucial to minimize these risks.

8.2.3. Long-term Effects

- Respiratory Diseases: Long-term exposure to wastepaper pulp dust and pollutants might raise the chance of developing chronic respiratory disorders such as chronic obstructive pulmonary disease (COPD). Individuals working in the sector or living near paper recycling plants are particularly vulnerable to this risk.
- Carcinogenic Risks: Some chemicals present in wastepaper pulp, such as certain dyes or ink components, have the potential to be carcinogenic. Long-term exposure to these substances may increase the risk of developing certain types of cancer.
- Environmental Impact: Although there is no direct connection between this point and human health, it is still important to take the environment's long-term effects of wastepaper pulp into account. The quality of the air, water, and soil can all be negatively impacted by improper disposal or processing of wastepaper, which can then indirectly influence human health[19].

8.2.4. Measurements to take after exposure to wastepaper pulp

After exposure to wastepaper pulp, there are several measurements or actions individuals can take to assess potential health risks and protect themselves:

8.3. Respiratory Monitoring

- Monitor Breathing: Pay attention to any changes in your breathing or respiratory symptoms, such as coughing, wheezing, shortness of breath, or chest tightness. If you experience persistent or worsening respiratory issues, seek medical advice promptly.
- Spirometry Test: If you suspect significant exposure to dust or contaminants from wastepaper pulp, consider undergoing a spirometry test. This test measures lung function and can help identify any impairments or changes in lung capacity.

8.3.1. Skin Examination

- Inspect Skin: After handling wastepaper pulp or products made from recycled paper, check your skin for any signs of irritation, redness, or rashes. If you notice any unusual reactions, avoid further contact and wash the affected area thoroughly[20].

8.3.2. Seek Medical Advice

- Consult a Healthcare Professional: If you experience any concerning symptoms or have been exposed to wastepaper pulp in an industrial setting or under conditions that may have posed health risks, consult a healthcare professional. They can evaluate your symptoms, provide appropriate medical advice, and conduct necessary tests if required.

Additionally, to prevent potential health issues after exposure to wastepaper pulp, take the following precautions:

8.3.3. Practice Good Hygiene

- Wash Hands: Always wash your hands thoroughly with soap and water after handling wastepaper pulp or products. This helps to minimize the risk of ingesting any harmful substances or irritants present on your hands.

8.4. Use Personal Protective Equipment (PPE)

- Wear Gloves: When handling wastepaper pulp, especially in industrial settings, use protective gloves to prevent skin contact and potential irritation.
- Use Masks: If working in dusty environments or with wastepaper pulp in a dry form, consider wearing a mask to avoid inhaling airborne particles.

8.5. Ensure Adequate Ventilation

In industrial settings or confined spaces, ensure proper ventilation to minimize the concentration of airborne dust and contaminants.

CHAPTER 09

HAZOPAND OPERABILITY STUDY

9.1 HAZOP Introduction:

Imperial Chemical Industries (UK) first proposed HAZOP (hazard and operability analysis) as a method of operability problem solutions in 1966[21]. Later, its uses in danger identification and assessment were investigated, and as a result, the technique was updated to easily handle this element. Any industry (refinery, chemical, petrochemical, metallurgical, pharmaceuticals, etc.) and stage of operation can use the HAZOP study technique. HAZOP is described as research carried out by a group of specialists from various fields to find and evaluate hazards utilizing brainstorming sessions on operational parameter deviations from typical/standard conditions[22].

These deviations are generated by using standard guide words. Normally the team consisting of 6-8 expert members of different disciplines will sit together to identify and assess the hazards associated with each and every process/plant component by analyzing the behavior of process/plant component under deviation from the normal operation[23].

There are three main steps of HAZOP study:

- Identification of abnormal behavior of the unit under different abnormal inputs/outputs.
- qualitative assessment of the abnormal behavior as it propagates to other units.
- basic recommendation to mitigate this abnormality.

9.2. HAZOP study process:

1. form a HAZOP team.
2. Identify the elements of system.
3. Consider variations in operating system.
4. Identify the failure and hazard points.

9.3. Factors affecting the effectiveness and efficiency of HAZOP:

HAZOP study has 10 key problem areas such as:

1. lack of experience of team members and leader
2. inappropriate team selection
3. incorrect scope of study
4. repetitious work
5. inadequate/inaccurate information
6. management shortcoming

7. poor loss prevention practice
8. shortage of technical information
9. lack of interest
10. the ultimate limitation (human error, wrong
11. documentation etc.).

Some definitions that are helpful or used in HAZOP study:

9.3.1. Study nodes:

The collection or location of process lines, equipment which will examine together in systematic HAZOP methodology, in which the process parameters are investigated for deviation.

9.3.2. Design Intention:

The design intention is defined as how the plant is expected to operate, it's the description of the intent of the node. It can either be descriptive or diagrammatic, e.g., line diagrams, flow sheeting, P&IDs.

9.3.3. Parameter:

The parameter is defined as or applied to guidewords to create a deviation e.g., none, more, less, reverse, etc.

9.3.4. Guidewords:

These words are used to guide the team and members into thinking of situations that introduce hazards e.g., temperature, flow, pressure.

Some guide words are shown in the table below that are used in HAZOP.

Guide words	**Meaning**
None	Negation intention
Less	Quantitative decrease
More	Quantitative increase
As well as	Qualitative increase
Reverse	Logical opposite
Part of	Qualitative decrease

Table9.1: *Guide words and their meanings*[23]

9.4. Success or failure of HAZOP

There are some factors which depend on HAZOP:

- The technical skills insight the team.
- The accuracy of the drawings and other data that are used as a basis of study.
- The ability of the team to use the approach as an aid to their imagination in visualizing deviations, causes, and consequences.
- Ability of the team to concentrate on the hazard which is identified.

9.5. HAZOP on Digester

A digester is a container used in the papermaking business to turn raw materials like wastepaper into pulp. Chemicals, heat, and pressure are used in the process to break down the cellulose fibers in the wastepaper. Although digesters are necessary for the creation of pulp, the severe temperatures, and chemicals they require make them potentially dangerous. Potential risks connected to digesters that are used to turn wastepaper into pulp include:

- High Pressure and Temperature: The digestive process usually takes place under intense pressure and temperature. If not adequately managed and monitored, this combination can increase the danger of equipment failure, leakage, or explosions.
- Chemical Risks: A variety of chemicals are used by digestive systems, including strong alkalis (such as sodium hydroxide) and sulfurous substances (such as sodium sulfide). These substances have the potential to be poisonous, caustic, and harmful to human health. Chemical burns or respiratory risks might emerge from spills or discharges.
- Corrosive Environment: If equipment and pipelines are not securely secured, the extremely corrosive chemical environment inside the digester could cause damage.
- Steam and Hot Water: The digester is heated using steam and hot water. The handling and transportation of these hot substances puts personnel at risk for burns and scalds.
- Mechanical Risks: If there is insufficient guarding or safety measures in place, the mechanical functioning of the digester, such as mixing and stirring the pulp, might put workers at danger.
- flames and Explosions: If there are sources of ignition, the presence of high temperatures, chemicals, and combustible materials might result in the possibility of flames or explosions.
- Hydrogen Sulfide (H2S) Formation: The pulping process can result in the production of poisonous hydrogen sulfide gas, which puts workers' health at risk.
- Steam Blowdowns: Steam blowdowns, which release high-pressure steam that may be harmful to people during maintenance or emergencies, are a possibility.

9.6. HAZOP on Press Machine drying for paper:

Drying paper with a presser machine can be risky and perhaps harmful. It is not advised to use a presser machine to dry paper for several reasons:

1. Extreme heat: Presser machines frequently employ heat to swiftly dry materials. Exposing extremely flammable paper to high temperatures might make it more likely to catch fire or burn.
2. Paper degradation: Paper can degrade and lose quality when exposed to high temperatures and pressure. The paper's fibers may deteriorate, producing a weaker and more fragile final product.
3. Fire risk: Paper is extremely flammable, as was already explained. A fire risk can arise from using a presser machine to dry paper, particularly if the equipment breaks down or if the paper comes into touch with heat sources.
4. Mechanical Risk: Presser machines apply pressure to materials, which presents a mechanical risk. Such a machine can be damaged by running paper through it, and if the paper jams or becomes caught, the operator may be put in danger while attempting to free it.
5. Health risks: If the paper contains any chemicals or coatings, using a presser machine to dry it may produce toxic fumes or particles.

To address these hazards and ensure the safety of the workers and the surrounding environment, several safety measures should be implemented:

Protective Gear: Workers should put on the proper personal protective equipment (PPE), which includes gloves, respirators, heat-resistant clothes, and goggles.

Training and Procedures: Ensure that staff members are properly trained to operate the digester safely and in accordance with SOPs.

Emergency Response Plans: Create and test emergency response strategies for situations like chemical spills, fires, or equipment malfunctions.

Corrosion Management: Conduct routine inspections and upkeep on equipment to avoid corrosion problems.

Ventilation and Gas Monitoring: Implement gas monitoring systems and provide appropriate ventilation to limit exposure to harmful gases like hydrogen sulfide.

Isolation and Lockout/Tagout: During maintenance tasks, implement isolation measures and lockout/tagout protocols.

Fire Protection Systems: To reduce the chance of a fire, install fire detection and suppression systems.

CHAPTER 10

COST ESTIMATION

10.1 Introduction:

Cost estimating is a crucial project activity since it serves as the basis for creating and controlling the project budget. Cost estimation is the process of estimating the quantity, cost, and price of all the materials and equipment required to complete a project. Since cost estimating includes generating guesses about spending rather than adding up actual expenses, there is some degree of uncertainty involved. Forecasting is challenging since equipment costs are fluctuating over time. Before the project actually begins, before the project's beginning, the costs are first estimated.

- It indicates whether or not the proposal is financially viable: To determine whether the plant is feasible, a precise cost estimate is essential. An organization benefits when a project is completed on time and under budget.
- It helps an organization to stay on schedule: Project estimation is important to complete the project on time and efforts are not wasted. Estimated targets set in the beginning give benefit to achieve the result and safeguard the expectation of the client.

10.2. Factors in cost estimation

Cost estimates outline each task required to finish the project. While estimating, there are several factors to consider, with the market situation having the greatest impact. Cost estimation considers every little detail, including labor, training, material costs, etc. It became challenging to accurately estimate each cost and adjust the project. It is preferable to separate the costs into direct and indirect costs in the beginning before estimation is completed with accurate prices and the customer has accepted that project and work begin.

10.2.1. Direct cost:

A direct cost is an expense that is specifically incurred or paid for a project in project management. Direct expenses are identified right away since they are directly related to every stage of an activity in a project.

Direct cost includes:

- Fees for workers participating in the project that have been contracted.
- Any raw materials used throughout project activities.
- Expenses for travel.
- Supplies and resources are required in Project.

- Rent on equipment or office space, including the headquarters of a corporation.

10.2.2.Indirect cost:

In project management, all implicit costs associated with a project are referred to as indirect costs. Overhead costs and burden costs are common names for indirect costs. The terms factory overhead, manufacturing burden, indirect production costs, and labor load are frequently used to describe indirect or burden costs. Support costs that aren't directly connected to a project's operations are known as indirect expenses. Examples of indirect costs include administrative and other project-related expenses.

- Consultation on financing
- Rent on equipment or office space, including the headquarters of a corporation.
- Development and research
- Operating costs, such as power utilities
- Administrative salaries and benefits financial fees accrued for budget preparation and accounting.
- Publicizing project requirements and recruiting manpower.

10.3. Major reasons for inaccurate cost estimation

- Farsighted prediction.
- Shortage of expertise.
- Lack of requirement.
- Exchange Rates.
- Splitting one task in multiple people.
- Expecting that resources will work with 100% efficiency.

10.4. Different percentage of fixed capital investment

Direct cost	% Of equipment cost
Equipment installation	25%
Piping	10%
Control system	8%
Building for specific equipment	15%
Land	2%
Electrical component	5%
Yard Improvement	25%
Service Facilities	10%

Table 10.1: *Percentage of direct cost investment.*

Indirect cost	% Of equipment cost
Designing engineering supervision	10%
Contractor fee	7%
Construction Expenses	8%
Contingence	12%

10.6. Equipment cost in US dollars.

Materials	Prices in PKR
Shredder	1700000
Water tanks	100000
Digester	1900000
Water pumps	350000
Screens	1000000
Heater	2000000
dryer	450000
TOTAL	4170000

Table 10.2: *Equipment cost estimation.*

Direct and indirect cost estimation

Direct cost	% Of equipment cost	Total cost (PKR)	Amount (PKR)
Equipment installation	25%	4170000	1042500
Piping	10%	4170000	417000
Control system	8%	4170000	333630

Building for specific equipment	15%	4170000	625500
Land	2%	4170000	83400
Electrical component	10%	4170000	417000
Yard Improvement	20%	4170000	834000
Service Facilities	10%	4170000	417000
	Total direct cost		4170030

Table 10.3*: Direct and indirect cost estimation.*

Indirect cost	**% Of equipment cost**	**Total cost ($)**	**Amount ($)**
Designing engineering supervision	10%	4170000	417000
Contractor fee	7%	4170000	2919000
Construction Expenses	8%	4170000	3336000
Contingency	12%	4170000	500400
	Total indirect cost		**7672800**

Table 10.4: *Indirect cost estimation*

Fixed total capital cost = Direct cost + Indirect cost

Fixed total capital cost = 4170030 + **7**672800

Fixed total capital cost = 11842830

Working capital = 0.15 * Total fixed capital cost

Working capital = 1776424.5

Overall cost = Equipment + Direct cost + Indirect cost

Overall cost = 4170000 + 4170030+762800

Overall cost = 16012830 PKR

We produce 3.5 rims of paper per hour and operate the plant for 12 hr 42 rims will be produce the price of one rim is 1500.

Daily produced rims price =1500 x 42 = 63000 per day

Monthly Produce rims price = 1890000 per month

Expenses per month = Electricity + workers + Raw Material + Other Utilities

Monthly Expenses = 250000 + 250000 + 50000 + 300000 = 1300000

Profit = 1890000 – 1300000

Profit = 590000

Profit =590000 per month

Time to recover the investment

Time = Investment / Monthly Earnings

Time =16012830/590000

Time =27.14 months

CHAPTER 11

ASPEN HYSYS SIMULATION

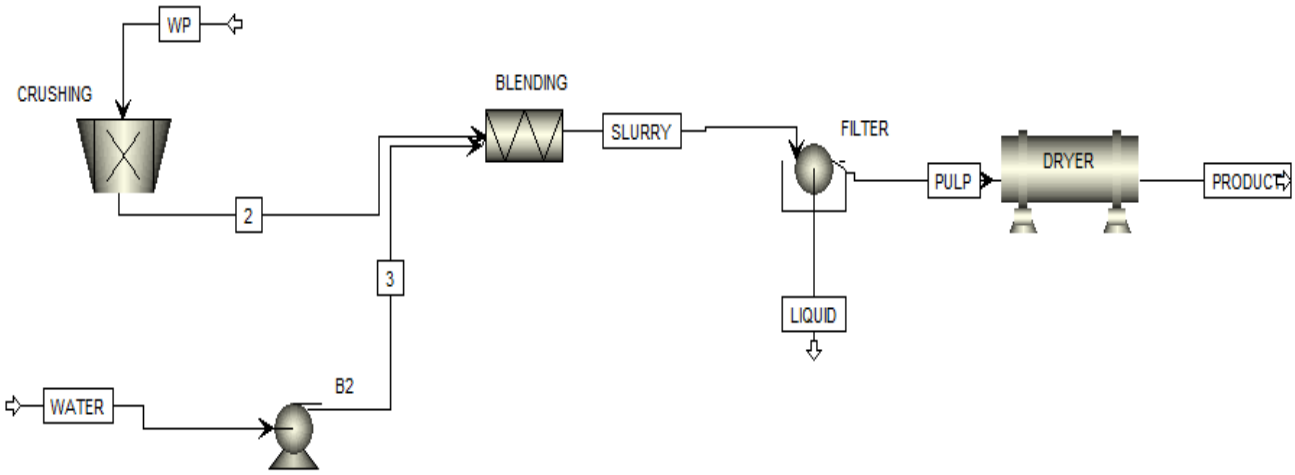

Figure 11.1: simulation diagram of recycling of waste paper

11.1 Process simulation

We systematically modelled the entire recycling process to learn more about its effectiveness, cost, and environmental impact in our waste paper recycling simulation. The simulation was conducted using simulation software Aspin plus V11, and it involved a detailed representation of the various stages of waste paper recycling. The simulation started when various kinds of waste paper were put in. To produce a consistent pulp mixture, the paper was sorted, shredded, and processed through pulpers, screens, and filters.

Based on actual data and industry standards, important process parameters, including processing times, temperatures, chemical use, and water consumption, were included into the simulation. In various scenarios, these variables were changed to examine the influence they had on the effectiveness and quality of recycling.

The simulation outcomes were then validated against real-world data and observations from our waste paper recycling facility. We observed a high level of consistency between the simulation results and actual outcomes, which added credibility to the accuracy of our model.

11.2. Simulation material stream detail

	Units	2	3	SLURRY	PULP
Description					
From		CRUSHING	B2	BLENDING	FILTER
To		BLENDING	BLENDING	FILTER	DRYER
Stream Class		MIXCIPSD	MIXCIPSD	MIXCIPSD	MIXCIPSD
Maximum Relative Error					
Cost Flow	$/hr				
− Total Stream					
Temperature	C	25	25.0316	25.0291	25.0291
Pressure	bar	1.01325	2	1.01325	1
Molar Vapor Fraction		0	0	0	0
Molar Liquid Fraction		0	1	0.970589	0.251914

	Units	2	3	SLURRY	PULP
Mass Density	kg/cum	1543.97	994.683	1084.39	1516.62
Enthalpy Flow	Gcal/hr	1.03339e-19	-0.124985	-0.124985	-0.00124977
Average MW		180.158	18.0153	22.784	139.312
+ Mole Flows	**kmol/hr**	**0.0555069**	**1.83178**	**1.88729**	**0.0727146**
+ Mole Fractions					
+ Mass Flows	**kg/hr**	**10**	**33**	**43**	**10.13**
+ Mass Fractions					
Volume Flow	cum/hr	0.00647681	0.0331764	0.0396535	0.00667935

Figure 11.2: Simulation material stream detail of wastepaper into new products

CHAPTER 12

INSTRUMENTATION AND PROCESS CONTROL

Instrumentation and control refers to the evaluation, measurement, and management of industrial process variables using hardware and software tools for process control, such as temperature, pressure, flow, and level sensors, analyzers, and actuators that are both electrical and mechanical. The control can be operated manually, somewhat automatically, or automatically.

12.1 Concept of Measurement in Automation Applications

Measurement is the process of removing signals that indicate parameters or variables from physical and chemical systems or processes. An automated system's performance can never outperform the corresponding measuring tools. A human being is a simple illustration. The output of a measuring device is compared to an arbitrary reference point of appropriate magnitudes, which is typically taken to be constant. Transducer or Sensor is a general term for sensing device.

12.2. Temperature Measurement and Control

Heat exchangers, reactors, etc. use temperature measurement to regulate the temperature of the output and inlet streams. To make it easier to bring the measurement to a centralized place, thermocouples are used for the majority of temperature measurements in the industry. Bi-metallic or filled system thermometers are utilized for local readings at the equipment to a lesser extent. Usually, resistance thermometers are employed for high measurement accuracy. When used locally, all of these meters have thermo-wells attached. This offers defense against the environment and other natural elements. Typically, feedback controllers are utilized in the control loops that regulate the regulated variables. Feed forward controllers make up only just 10% of all controllers.

12.3. Pressure Measurement and Control

Pressure is a useful indicator of the state and composition of a substance, like temperature. These two metrics used together serve as the main tools for assessing industrial materials. Pressure measuring devices are provided with pumps, compressors, and other processing equipment related to pressure changes in the process material. As a result, measuring pressure can indicate an increase or decrease in energy.

Industry uses clastic clement devices, either directly connected for local use or transmitted to a centralized point, for most pressure readings. Burden tubes, diaphragms, and bellows gauges are the most often used industrial pressure elements[24].

12.4. Flow Measurement and Control

To manage the flow of liquid, flow indicator controllers are used. All manually defined streams must also have a flow indicator or a simple way to take sporadic sample measurements. The feed and product stream are metered for accounting purposes. Additionally, utilities to both separate and grouped pieces of equipment are metered.

The majority of low measures in the sector use variable head devices. Variable area and the numerous available varieties are used to a lesser amount when unique metering situations develop.

12.5. Control Schemes

12.5.1. Objectives

In Conversion control any of the following may be the goals to achieve

- Constant Pressure inside the reactor
- Constant Temperature inside the reactor
- Constant Level
- High Quality of Product

12.5.2. Reactor Variables

- Uncontrolled Variables
- Manipulated Variables
- Controlled Variables

12.5.3. Uncontrolled variables

The variables, which cannot be controlled by controller, are called uncontrolled variables. These include.

- Temperature of feed etc.

12.5.4. Manipulated variables:

The independent manipulated inputs are variables, which are adjusted to control the chemical reaction. Any one or any combination of the following may be the manipulated variables.

- Flow rate of cooling tower Flow rate of feed
- Flow rate of product stream

12.5.5. Controlled Variables:

Any process variable that is selected to be maintained by a control system is called a controlled variable. Following are the controlled variables.

- Inside Reactor Temperature
- Inside Reactor Pressure
- Level of Reacting Mixture in Reactor

12.6. Process control on Digester

There is a method of controlling temperature, pressure, flow and level controller. From figure it observed that temperature and flow transmitters are connected at outlet of the Digester to sense the temperature and flow rate at the outlet of the digester in order to check the temperature and maintain that desire flow rate and control the outlet flow of the digester with the help of valve. Level transmitter is connected to sense and transmit the data in order to control the level inside reactor. Pressure sensor at the inlet of water stream sense the pressure to control it with the valve from the beginning.

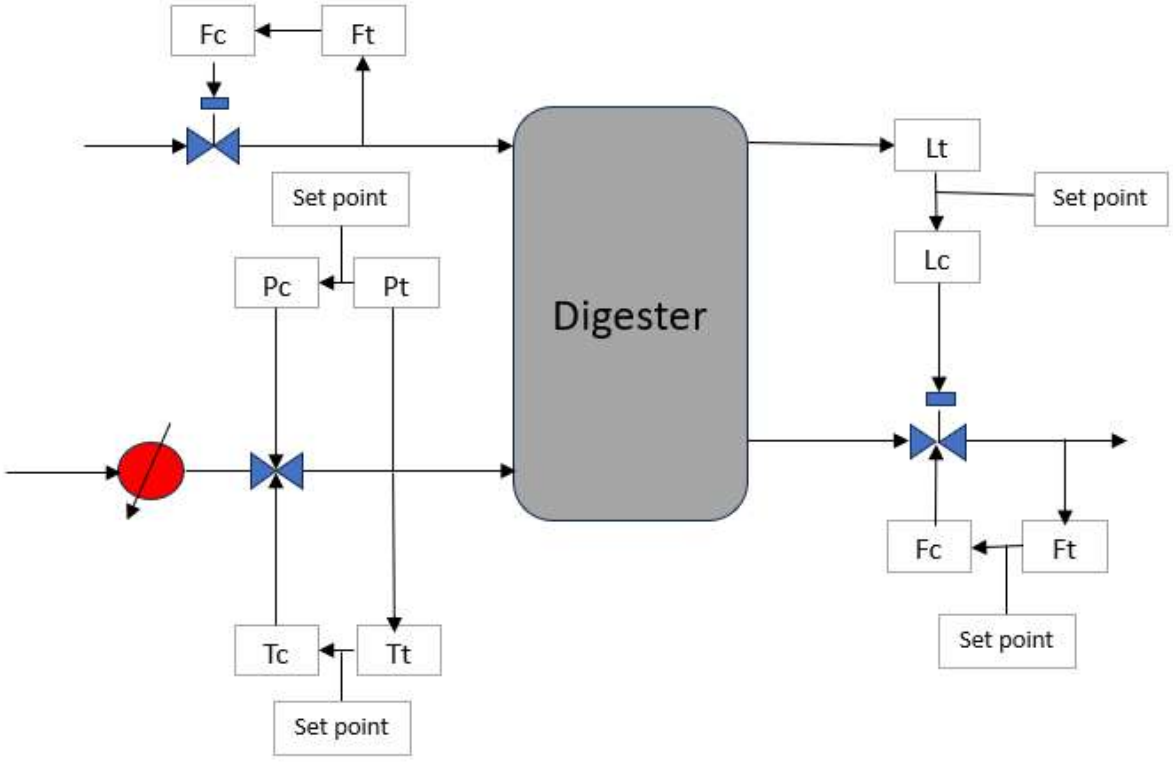

Fig 12.1 process control of digester

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