# Study on Performance Enhancement of Machine Glycing Dryer in Paper Production Industry

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***Abstract*** **- Paper mill uses baggage and wastepaper as raw materials. The mill manufactures carton board cover paper and pupil note-book cover. It was found that upsets and spills occurred frequently in the old process. The production capacity was found to be 9 ton/day when the mill was running normally.Water balance, material balance and energy balance statistics were prepared for the mill. The water consumption on an overall basis was found to be 376 m$^3$ per tonne of product. The suspended solid (SS) in the wastewater was found to be 431.8 kg/tonne of product. The fibre loss from the paper machines was considerable with the value of 20.8%. The total of SS and SS70 (parameter used to assess the fibre loss of a paper mill) discharged to the Red river was 369.7 kg/tonne and 211.7 kg/tonne respectively. The high concentration of alkaline vapour (0.187 mg/L) in the digester plant was a severe source of air pollution in the mill.**

**Stream segregation with black liquor collection could reduce pollution load. In this plant we suggest the implementation of the additional dryers on the plant. These will helps to remove the moisture content easily and faster manner which results in the improvement of GSM and the strength of the paper board.**

## 1. INTRODUCTION

Paper is becoming an essential commodity of today's society. The pulp and paper industry has been growing with demand of paper. The capita consumption has also been steadily increasing over the world.

The pulp and paper industry is considered as one of the major potential sources of pollution in the environment. There are two segments, pulping and paper making in the manufacturing process. Pulping is the major source of environmental pollution. Black liquor from chemical pulping processes is the most significant and troublesome source of pollution. Effluent from these pulping processes contains chemicals which are known to cause damage to the flora and fauna. Also, a bottom deposit of lignin cellulose material near the point of discharge undergoes slow decomposition that leads to depletion of dissolved oxygen in the receiving body.

The raw materials for pulp production are those containing cellulose fibres. They are divided into two main types: wood and non-wood materials. An environmental problem on a global scale of deforestation is occurring. Therefore, using non-wood fiber material for paper production is encouraging. Although non-wood fibrous raw material based account for only about 5% of the raw material for pulp and paper manufacture today it is one of the major sources of ibrous raw material for many developing countries (GIERTZ, 1993). Agricultural residues are the most important raw materials of non-wood group that were used in agriculture countries. In developing countries, the small scale mills are more popular than large ones.

Small scale mills usually cause high level of environmental pollution because of outdated technologies, poor operational and maintenance practices and others. On the other hand agricultural residues are especially suitable for small scale mills as their raw materials. Pulp and paper production is an important contributor to the economy of many nations. In Vietnam, the industry accounted for 1.8 percent of the output value of the manufacturing sectors.

Despite its increase in production capacity, it has not met the domestic consumption demand. The utilization of sugar cane bagasse as raw material for the pulp and paper industry needs some attention in sugar cane producing countries such as Vienam. It contributes to reducing deforestation as well as using by-product from the sugar industry.

However, small paper mills using sugar cane bagasse as raw material have caused environmental pollution at high levels. Therefore, cleaner production study in the small mill using sugar cane bagasse as raw material for pulp and paper production is useful in terms of economy as well as environmental protection aspect.

An essential step in implementing cleaner production is waste audit as it gives a comprehensive look at production process to facilitate the understanding of material flows and to show pollution sources within the process. A waste audit points out the point's specific area where pollution reduction may be achieved and helps to implement

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maximum resource optimization and improved process performance. This study investigated the current environmental status of a pulp and paper mill in small scale in Vietnam and recommended cleaner production practices for the mill.

## 2. COMPONENTS REQUIRED PULPER

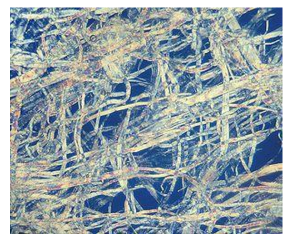
Pulper is used to grinding a paper materials and papers paper woods. It is one of grinding technique waste and paper wood pulps. Most pulp mills use good forest management practices in harvesting trees to ensure that they have a sustainable source of raw materials. One of the major complaints about harvesting wood for pulp mills is that it reduces the biodiversity of the harvested forest.

Pulp tree plantations account for 16 percent of world pulp production, old-growth forests 9 percent, and second- and third- and more generation forests account for the rest. Reforestation is practiced in most areas, so trees are a renewable resource.

The FSC (Forest Stewardship Council), SFI (Sustainable Forestry Initiative), PEFC (Programme for the Endorsement of Forest Certification), and other bodies certify paper made from trees harvested according to guidelines meant to ensure good forestry practices. The number of trees consumed depends on whether mechanical processes or chemical processes are used.There is more amount of organic component has used on eco-friendly easy to manufacturing paper. It has been estimatedthatbasedona mixture of softwoods and hardwoods for 12 metres (40 ft) tall and 15–20 centimetres (6–8 in) in diameter, it would take an average of 24 trees to produce 0.9 tonne (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 tonne (1 ton) of mechanical pulp or newsprint. There are roughly 2 short tons in a cord of wood.

Pulp is a lignocelluloses fibrous material prepared by chemically or mechanically separating cellulose fibers from wood, fiber crops or waste paper. The wood fiber sources required for pulping are "45% sawmill residue, 21% logs and chips, and 34% recycled paper" (Canada, 2014). Many kinds of paper are made from wood with nothing else mixed into them. This includes newspaper, magazines and even toilet paper.
Pulp is one of the most abundant raw materials worldwide.



Structure of the paper pulp

## MANUFACTURE OF WOOD PULP

The timber resources used to make wood pulp are referred to as pulpwood. Wood pulp comes from softwood trees such as spruce, pine, fir, larch, hemlock and hard woods such as eucalyptus aspen and birch. A pulp mill is a manufacturing facility that converts wood chips or other plant fibre source into a thick fiber board which can be shipped to a paper mill for further processing. Pulp can be manufactured using mechanical, semi-chemical or fully chemical methods (kraft and sulfite processes). The finished product may be either bleached or non-bleached, depending on the customer requirements.

Wood and other plant materials used to make pulp contain three main components (apart from water) cellulose fibres (desired for papermaking), lignin (a three-dimensional polymer that binds the cellulose fibres together) and hemicelluloses, (shorter branched carbohydrate polymers). The aim of pulping is to break down the bulk structure of the fibre source, be it chips, stems or other plant parts, into the constituent fibres. Chemical pulping achieves this by degrading the lignin and hemicelluloses into small, water-soluble molecules which can be washed away from the cellulose fibres without depolymerising the cellulose fibres. The various

mechanical pulping methods, such as ground wood (GW) and refiner mechanical (RMP) pulping, physically tear the cellulose fibres one from another. Much of the lignin remains adhering to the fibres. Strength is impaired because the fibres may be cut. There are a number of related hybrid pulping methods that use a combination of chemical and thermal treatment to begin an abbreviated chemical pulping process, followed immediately by a mechanical treatment to separate the fibres. These hybrid methods include thermos mechanical pulping, also known as TMP, and chemical thermosmechanical pulping, also known as CTMP. The chemical and thermal treatments reduce the amount of energy subsequently required by the mechanical treatment, and also reduce the amount of strength loss suffered by the fibres.

PULPING

Pulping is the process by which the bonds within the wood structure are ruptured either mechanically or chemically. Chemical pulps can be produced by either alkaline (i.e., sulphate or kraft) or acidic (i.e., sulphite) processes. The highest proportion of pulp is produced by the sulphate method, followed by mechanical (including semi-chemical, thermomechanical and mechanical) and sulphite methods. Pulping processes differ in the yield and quality of the product, and for chemical methods, in the chemicals used and the proportion that can be recovered for reuse.

CLEANER

It is the one of cleaning process about after pulping processes of the paper. it can produced clean and refined pulp for out to hopper and head box should

be maintain that much level pulp for clean about stones, iron and plastic material through washing by this plant to out and pure pulp is produced by that wire path system.

THUMCHESTER

Chemical pulp is produced by combining wood chips and chemicals in large vessels known as digesters where heat and the chemicals break down the lignin, which binds the cellulose fibres together, without seriously degrading the cellulose fibres. Chemical pulp is used for materials that need to be stronger or combined with mechanical pulps to give product different characteristics.concentrated and conveyed to storage. Historically, the most common bleaching sequence used to produce market-grade bleached Kraft pulp is based on the five-stage CEDED process for definition of symbols. The first two stages of bleaching complete the delignification process and are considered extensions of pulping.

Because of environmental concerns about chlorinated organics in pulp mill effluents, many mills substitute chlorine dioxide ($ClO_2$) for a portion of the chlorine ($Cl_2$) used in the first bleaching stage ($C_DEDED$) and use oxygen ($O_2$) pre-treatment during the first caustic extraction ($C_DE_ODED$).

The kraft process is the dominant chemical pulping method, with the sulfite process being second. Historically soda pulping was the first successful chemical pulping method.

BLEACHING

Bleaching is a multi-stage process that refines and brightens raw pulp. The objective is to dissolve (chemical pulps) or modify (mechanical pulps) the brown-coloured lignin that was not removed during pulping, while maintaining the integrity of the pulp fibres. A mill produces customized pulp by varying the order, concentration and reaction time of the bleaching agents. Each bleaching stage is defined by its bleaching agent, pH (acidity), temperature and duration. After each bleaching stage, the pulp may be washed with caustic to remove spent bleaching chemicals and dissolved lignin before it progresses to the next stage.

After the last stage, the pulp is pumped through a series of screens and cleaners to remove any contaminants such as dirt or plastic. It is then

| CONSISTENCY* (%) | TEMPERATURE (°C) | TIME (H) |
|---|---|---|
| 3 | 20–60 | 0.5–1.5 |
| 10–12 | <80 | 1–2 |
| 10–12 | 60–75 | 2–5 |
| 10–12 | 30–50 | 0.5–3 |
| 25–33 | 90–130 | 0.3–1 |
| 12 | 35–80 | 4 |
| 35–55 | 20–40 | <0.1 |

Bleaching agents and their conditions of use

The current trend in Europe and North America is towards complete substitution with $ClO_2$ (e.g., DEDED) or elimination of both $Cl_2$ and $ClO_2$. Where $ClO_2$ is used, sulphur dioxide ($SO_2$) is added during the final washing stage as an "antichlor" to stop the

$ClO_2$ reaction and to control the pH. Newly developed chlorine-free bleaching sequences (e.g., OAZQP, OQPZP, where Q = chelation) use enzymes, $O_2$, ozone ($O_3$), hydrogen peroxide ($H_2O_2$), per acids and chelating agents such as ethylene diamante tetrameric acid (EDTA).

Totally chlorine-free bleaching had been adopted at eight mills worldwide by 1993. Because these newer methods eliminate the acidic bleaching steps, acid washing is a necessary addition to the initial stages of Kraft bleaching to allow removal of metals bound to the cellulose.

Sulphite pulps are generally easier to bleach than kraft pulps because of their lower lignin content. Short bleaching sequences (e.g., CEH, DCEHD, P, HP, EPOP) can be used for most paper grades. For dissolving-grade sulphite pulps used in the production of rayon, cellophane and so on, both hemicellulose and lignin are removed, requiring more complex bleaching sequences (e.g., $C_1C_2$ECHDA). The final acid wash is both for metal control and antichlor purposes. The effluent load for dissolving-grade sulphite pulps is much greater because so much of the raw wood is consumed (typical yield 50%) and more water is used. Chelating agents are added before bleaching to neutralize any metal ions, thereby preventing the formation of coloured salts or the decomposition of $H_2O_2$. The effectiveness of mechanical pulp bleaching depends on the species of wood. Hardwoods (e.g., poplar and cottonwood) and softwoods (e.g., spruce and balsam) that are low in lignin and extractives can be bleached to a higher brightness level than the more resinous pine and cedar.

COLOURING THE PAPER

To colouring the paper the basic colours like white, red, colour pigments are added

TURBO

It is reprocesses by the pulping paper at fine particles so that easy to process of the product in easy to machining after that operation. There is using for crazing pulp at machine there is having a three blades for grinding the element at fine particles for that part of work


Turbo

HEAD BOX

A second head box may be added to a conventional fourdrinier to put a different fibre blend on top of a base layer. A secondary head box is normally located at a point where the base sheet is completely drained. This is not considered a separate ply because the water action does a good job of intermixing the fibres of the top and bottom layer. Secondary head boxes are common on linerboard.

Head box

VARIATIONS OF FOUR DRAINER FORMING SECTION

The forming section type is usually based on the grade of paper or paperboard being produced; however, many older machines use a less than optimum design. Older machines can be upgraded to include more appropriate forming sections. A modification to the basic fourdrinier table by adding a second wire on top of the drainage table is known as a top wire former. The bottom and top wires converge and some drainage is up through the top wire. A top wire improves formation and also gives more drainage, which is useful for machines that have been sped up. The Twin Wire Machine or Gap former uses two vertical wires in the forming section, thereby increasing the de-watering rate of the fibre slurry while also giving uniform two sidedness. There are also machines with entire Fourdrinier sections mounted above a traditional Fourdrinier. This allows making multi-layer paper with special characteristics. These are called top Fourdriniers and they make multi-ply paper or paperboard. Commonly this is used for making a top layer of bleached fibre to go over an unbleached layer. Another type forming section is the cylinder mould machine using a mesh-covered rotating cylinder partially immersed in a tank of fibre slurry in the wet end to form a paper web, giving a more random distribution of the cellulose fibres. Cylinder machines can form a sheet at higher consistency, which gives a more three dimensional fibre orientation than lower consistencies, resulting in higher calliper (thickness) and more stiffness in the machine direction (MD). High MD stiffness is useful in food packaging like cereal boxes and other boxes like dry laundry detergent.

Tissue machines typically form the paper web between a wire and a special fabric (felt) as they wrap around a forming roll. The web is pressed from the felt directly onto a large diameter dryer called a Yankee. The paper sticks to the Yankee dryer and is peeled off with a scraping blade called a doctor. Tissue machines operate at speeds of up to 2000 m/min.

REFINING PROCESS

Between chemical and mechanical pulps there are semi-chemical pulps that use a mild chemical treatment followed by refining. Semi-chemical pulp is often used for corrugating medium.

From the unrefined stock chest stock is again pumped, with consistency control, through a refiner. Refining is an operation whereby the pulp slurry passes between a pair of discs, one of which is stationary and the other rotating at speeds of typically 1,000 or 1,200 RPM for 50 and 60 Hz AC, respectively. The discs have raised bars on their faces and pass each other with narrow clearance.

FILTERING ELEMENT

The raw materials are different paper pulps. The pulp may be from softwood, hardwood, fiber crops, and mineral fibres. For high quality filters, dissolving pulp and mercerised pulp are used. Most filter papers are made on small paper machines.

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For laboratory filters the machines may be as small as 50 cm width. The paper is often creped to improve porosity. The filter papers may also be treated with reagents or impregnation to get the right properties. Filter paper comes in various porosities and grades depending on the applications it is meant for. The important parameters are wet strength, porosity, particle retention, flowrate, compatibility, efficiency and capacity. There are two mechanisms of filtration with paper; volume and surface. By volume filtration the particles are caught in the bulk of the filter paper. By surface filtration the particles are caught on the paper surface. Filter paper is mostly used because even a small piece of filter paper will absorb a significant volume of liquid.

WIRE PATH

It is uniformly forming over the pulp at GSM (Grams per square meter) current level to out in the pulp for paper making machine. It has concluded to correct thickness of the paper produced in that system of wire path.

.Wire path

WIRE PATH LINE

Conventional roll presses are configured with one of the press rolls is in a fixed position, with a mating roll being loaded against this fixed roll. The felts run through the nips of the press rolls and continue around a felt run, normally consisting of several felt rolls. During the dwell time in the nip, the moisture from the sheet is transferred to the press felt. When the press felt exits the nip and continues around, a vacuum box known as an Hula Box applies vacuum (normally -60 kPa) to the press felt to remove the moisture so that when the felt returns to the nip on the next cycle, it does not add moisture to the sheet. Some grades of paper use suction pick up rolls that use vacuum to transfer the sheet from the couch to a lead in felt on the first press or between press sections. Pickup roll presses normally have a vacuum box that has two vacuum zones (low vacuum and high vacuum). These rolls have a large number of drilled holes in the cover to allow the vacuum to pass from the stationary vacuum box through the rotating roll covering.

The low vacuum zone picks up the sheet and transfers, while the high vacuum zone attempts to remove moisture. Unfortunately, at high enough speed centrifugal force flings out vacuumed water, making this less effective for dewatering. Pickup presses also have standard felt runs with Uhle boxes. However, pickup press design is quite different, as air movement is important for the pickup and dewatering facets of its role. Crown Controlled Rolls (also known as CC Rolls) are usually the mating roll in a press arrangement. They have hydraulic cylinders in the press rolls that ensure that the roll does not bow. The cylinders connect to a shoe or multiple shoes to keep the crown on the roll flat, to counteract the natural "bend" in the roll shape due to applying load to the edges. Extended Nip Presses (or ENP) are a relatively modern alternative to conventional roll presses. The top roll is usually a standard roll, while the bottom roll is actually a large CC roll with an extended shoe curved to the shape of the top roll, surrounded by a rotating rubber belt rather than a

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standard roll cover. The goal of the ENP is to extend the dwell time of the sheet between the two rolls thereby maximising the de-watering. Compared to a standard roll press that achieves up to 35% solids after pressing, an ENP brings this up to 45% and higher—delivering significant steam savings or speed increases. ENPs densify the sheet, thus increasing tensile strength and some other physical properties.

PRESSES

Tissue machines typically form the paper web between a wire and a special fabric (felt) as they wrap around a forming roll. The web is pressed from the felt directly onto a large diameter dryer called a yankee. The paper sticks to the yankee dryer and is peeled off with a scraping blade called a doctor. Tissue machines operate at speeds of up to 2000 m/min. The second section of the paper machine is the press section, which removes much of the remaining water via a system of nips formed by rolls pressing against each other aided by press felts that support the sheet and absorb the pressed water. The paper web consistency leaving the press section can be above 40%.

Presses

BABY PRESS

Simple press rolls can be rolls with grooved or blind drilled surface. More advanced press rolls are suction rolls. These are rolls with perforated shell and cover. The shell made of metal material such as bronze stainless steel is covered with rubber or a synthetic material. Both shell and cover are drilled throughout the surface. A stationary suction box is fitted in the core of the suction roll to support the shell being pressed. End face mechanical seals are used for the interface between the inside surface of the shell and the suction box.

For the smooth rolls, they are typically made of granite rolls. The granite rolls can be up to 30-foot (9.1 m) long and 6 feet (1.8 m) in diameter.

JUMBO PRESS

Pressing is the most efficient method of de-watering the sheet as only mechanical action is required. Press felts historically were made from wool. However, today they are nearly 100% synthetic.

They are made up of a polyamide woven fabric with thick batt applied in a specific design to maximise water absorption. Presses can be single or double felted. A single felted press has a felt on one side and a smooth roll on the other. A double felted press has both sides of the sheet in contact with a press felt.

Single felted nips are useful when mated against a smooth roll (usually in the top position), which adds a two-sidedness—making the top side appear smoother than the bottom. Double felted nips impart roughness on both sides of the sheet. Double felted presses are desirable for the first press section of heavy paperboard.

3. DRYERS

DRYER

Dryers are used to efficiently process large quantities of bulk materials that need reduced moisture levels. Depending on the amount and the makeup of material

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needing to be dried, industrial dryers come in many different models constructed specifically for the type and quantity of material to be processed.

Dryer

TYPES OF DRYERS

The most common types of industrial dryers are fluidized bed dryers, rotary dryers, rolling bed dryers,conduction dryers, convection dryers, pharmaceutical dryers, suspension/paste dryers, and dispersion dryers.

Various factors are considered in determining the correct type of dryer for any given application, including the material to be dried, drying process requirements, production requirements, final product quality requirements and available facility space.

| STEAM TEMPERATURE ( $^{O}C$ ) | SPEED OF DRYER (RPM) | MOISTURE REMOVED (%) | OUTPUT PAPER ( GSM ) |
|---|---|---|---|
| 180 | 40 | 98 | 3.8-4.0 |
| 190 | 45 | 97 | 3.5-3.7 |
| 200 | 45 | 96.8 | 3.5-3.6 |
| 210 | 50 | 96 | 3.4-3.2 |
| 220 | 55 | 95 | 3.3-3.1 |
| 260 | 75 | 91.5 | 2.5-2.2 |
| 270 | 80 | 90 | 2.0-1.8 |

Dryer Performance

DRY STRENGTH RESINS

Dry strength resins increase the internal bond strength and tensile strength of paper by increasing bonding sites on fibres or by providing stronger bonds. These include:

- Cationic starch - has a greater affinity, being positively charged to negatively charged fibres under standard papermaking conditions. Typical additions in the wet-end of 0.5 - 1.5%.
- Amphoteric starches - are frequently used in multi-component furnishes and are effective over a higher pH range. Starch also is used to improve drainage and retention.
- Synthetic aids - like low molecular weight polyacrylamides increase the strength of the fiber-fiber bond when added at 0.2 - 0.5% dry basis on fiber. These can be cationic or anionic in nature.
- CMC - carboxymethyl cellulose can be used alone or in conjunction with another dry strength aid. CMC increases the negative sites on the fiber which makes it more receptive to cationic starch in later additions. CMC is added in the pulp at levels that are 0.3 - 0.5% per dry basis on fiber.

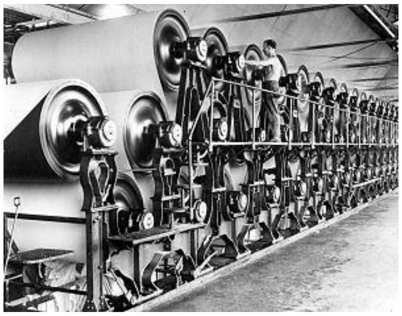
THE PRINCIPLE OF DRYING

The moisture content of the paper entering the

| | | | |
|---|---|---|---|
| 230 | 55 | 94 | 3.0-2.9 |
| 240 | 60 | 93 | 2.8-2.5 |
| 250 | 70 | 92 | 2.6-2.5 |

dryer depends on the efficiency of the presses. This moisture content can be as low as 60% or as high as 75% depending on the product. After the dryer the moisture content varies between 2% and 10%.

It is important however not to dry below the normal equilibrium moisture content which is commonly 8 - 9% but can range from 5 - 10%. These figures illustrate the important contribution of the dryer to the energy consumption of the process.



Principle of Drying

Drying is dependent on a number of factors which influence the rate at which water can be removed from the bulk of the paper.

Temperature - When a surface is wet there is an interchange of water molecules between the surface and the adjacent air.

Vacuum pressure - Increasing the temperature increases the vapour pressure of the water in the liquid phase and reduces the pour pressure of the water in the vapour phase thus increasing the differential and hence the drying rate.

Air pressure - The water content rate of interchange varies with in the difference between the molecular vapour pressure of the liquid phase and that in the vapour phase.

Humidity - The dryer the air the lower is the molecular vapour pressure of water within it, thus the greater it’s potential to absorb water molecules.

Velocity - As the molecular vapour pressure of water in the air increases the air becomes saturated, if this air stays in contact with the paper the drying process would stop because no further water could move from the paper to the air. Provided this saturated air is moved away from the surface of the paper and is replaced with drier air the drying process will continue. By having a high air velocity the air in contact with the paper never becomes saturated.

DRYING BY CYLINDERS

This is the pulp formation which will become the paper, contacts the first drying cylinder, heating begins by conduction from the hot cylinder. Heat is then transferred by conduction into the body of the web. As a result, the whole sheet temperature rises rapidly to around 60 - 90"C. This causes an increase in evaporation from the exposed surface of the sheet and a "capillary" movement of water within the web to replace the water lost from the surface. Eventually and usually quite early in the drying section, the temperature of the hottest part of the web will reach vaporisation point. This will be the region in contact with the hot surface of a drying cylinder.

The vapour so created will be forced under its own pressure, through the web towards the exposed surface. Some vapour will be condensed on the way. Thus increasing heat transfer and promoting natural evaporation at the exposed surface. For an MG or Yankee cylinder, which is a large single cylinder up to about 7 or 5.5 metres in diameter used to produce a polished side to paper or for tissue drying, an equilibrium state is reached where moisture is vaporising at the cylinder surface against the web and also evaporating at the exposed surface. As water in the vapour state is removed, capillary action draws in more water to replace it. Thus in the web, water is drawn towards the surface to replace water lost by natural vaporisation and at the same time drawn towards the drying cylinder to replace water lost by evaporation.

Tests have shown that the vaporization loss is greater than the surface evaporation loss.

It is generally accepted that this reduction occurs as a result of growing resistance to the movement of water within the web. Drying thus falls conveniently into two regimes, the constant rate drying region and the falling rate drying region. The transition from one to another depends on many circumstances but is normally in the region of 30 - 40% moisture, by weight.

DRYING WITH A FELT

The purpose of using a felt in the drying section is to increase the evaporation. On heavy grades in particular, a felt maintains adequate contact between the web and the cylinder.

Drying using a felt on cylinders has the advantage that resistance to heal transfer is much reduced. However, as the felt covers the outer surface of the paper, which drastically affects the conditions for removal of vapour and evaporation, the net result may not be so beneficial.

Drying with a felt can be considered in four phases, the first of which is of short duration when only the paper touches the cylinder surface. This is the start of heating the web.

In the second phase, heating up of the web is very rapid due to the reduction in heat transfer coefficient by the felt, but evaporated moisture and vapour must penetrate the felt. This may occur in two ways, by direct mass transfer of liquid driven by the contact pressure or by diffusion of vapour, with subsequent partial condensation where the felt temperature is lower.

Some vapour may diffuse right through the felt. Phase three, which occurs when the felt separates from the web, will be characterised by rapid evaporation from the surface of the web and the felt. This will be accompanied by a rapid fall in temperature of the inner felt surface. Evaporation will continue from the paper in contact with the cylinder but at a ‘lower rate due to reduction of the heat transfer coefficient.

During phase four, the open draw, more vapour is released from the paper surface as it leaves the cylinder leading to cooling as with the felt. In the falling rate drying region, external factors such as air velocity and cylinder temperature are not critical since the amount of moisture is much less. Removal rates can only be enhanced by raising sheet surface temperature.

OPERATION OF THE DRYING SECTION

The predominant drying system on a paper machine is still the conventional cylinder section, because no better system has yet been developed to replace it.

Improved run ability of the web has been the most significant development over the past few years. This has principally been achieved by the adoption of single felt drying techniques as well as sheet flutter control measures and improved drying fabrics.

Even though some problems remain, it is likely that progress will continue in these directions. The use of cold bottom cylinders, along with single felt drying is becoming common. Alternatively, vacuum rolls can replace ineffective bottom cylinders.

All these measures improve run ability further and also provide for the control of Cross Directional (CD) sheet shrinkage. If required two sided drying can be achieved by alternating drying sections.

Other improvements in the dryer section include:

- Improved steam and condensate systems
- Spoiler bars

- High dew point hoods
- Improved pocket ventilation systems
- Silent drives
- Improved CD moisture control
- Improved heat recovery systems
- Computer control of steam and condensate systems and ventilation

For drying coated or surface sized paper, air foil, gas fired or electric infrared - IR is often used in addition to conventional cylinder drying. These technologies are also being used for CD moisture profile control for which other techniques such as dielectric and electromagnetic heating are also being evaluated.

CONDENSATE REMOVAL

When used as a heating medium, the highest rates of heat transfer are achieved when steam condenses thus releasing its latent heat.

If steam contains condensate then the total heat content per kg of mass flow is reduced, thus ideally, when used for heating, steam should be dry and at the saturation temperature. In practice this is rarely possible since heat losses in the distribution paper work will lead to some condensate being present. This condensate can be removed either by separation or by expanding the steam to a lower pressure, sometimes using a super heater to limit the amount of superheat.

Condensate 'Rimming' a cylinder will inhibit heat transfer, since oscillation in the condensate layer is suppressed to the extent that a laminar layer is formed, which is resistant to heat transfer. This can be restored by the use of dryer bars which break up the condensate film by recreating a turbulent layer.

Two types of siphon are available to remove condensate from a rotating cylinder, the rotating siphon or the stationary siphon. The rotating siphon is fixed to a point inside the cylinder and rotates with the cylinder, whereas the stationary siphon is fixed to a point outside the cylinder and does not rotate.

Both types of siphon have their advantages which can be summarised as follows:

ROTATING SIPHON

- Better mechanical stability
- Fixed siphon clearance generally means a thinner condensate layer in rimming condition leading to better heat transfer.
- Better evacuations of a cascading cylinder
- Large quantities of low pressure steam are generated

STATIONARY SIPHON

- Lower differential pressures
- Reduced How rate of blow through steam
- Smaller thermo compressor required
- Lower pressures required for motive steam
- Better flood recovery

Although there are still machines that use traps for condensate removal, most modern machines use a blow through steam system. The blow through steam serves several purposes.

- Reduces the density of the steam/condensate mixture which allows operation at lower differential pressures
- Entrains and evacuates any non-condensable gas in the cylinder

The blow through steam rate is generally around 15 - 20% by mass fraction of the condensate flow. Higher flow rates could be used but can lead to erosion of pipe components etc- Also, excessive blow through will finish up in the condenser with a consequent increase in operating costs.

Whilst the actual balance between differential pressure and blow through rate must be based on a particular machine and the design of the steam system, blow through rate is a function of differential pressure.

Excessive blow through would therefore require a high differential pressure, which on a machine cascade would limit operating pressures and hence drying rates.

MACHINE GLYCING

The dryer section of the paper machine, as its name suggests, dries the paper by way of a series of internally steam-heated cylinders that evaporate the moisture. Steam pressures may range up to 160 psig. Steam enters the end of the dryer head (cylinder cap) through a steam joint and condensate exits through a siphon that goes from the internal shell to a centre pipe.

From the centre pipe the condensate exits through a joint on the dryer head. Wide machines require multiple siphons. In fast machines centrifugal force holds the condensate layer still against the shell and turbulence generating bars are typically used to agitate the condensate layer and improve heat transfer.

The sheet is usually held against the dryers by long felt loops on the top and bottom of each dryer section. The felts greatly improve heat transfer.

Dryer felts are made of coarse thread and have a very open weave that is almost see through, It is common to have the first bottom dryer section un felted to dump broke on the basement floor during sheet breaks or when threading the sheet.

Machine glycing

Paper dryers are typically arranged in groups called sections so that they can be run at a progressively slightly slower speed to compensate for sheet shrinkage as the paper dries. The gaps between sections are called draws. The drying sections are usually enclosed to conserve heat. Heated air is usually supplied to the pockets where the sheet breaks contact with the driers. This increases the rate of drying. The pocket ventilating tubes have slots along their entire length that face into the pocket. The dryer hoods are usually exhausted with a series of roof mounted hood exhausts fans down the dryer section.

SURFACE FINISHING

Surface Finishing

Although similar in principle to making pulp sheets, paper making is considerably more complex. Some mills use a variety of different pulps to optimize paper quality (e.g., a mix of hardwood, softwood, kraft, sulphite, mechanical or recycled pulps). Depending on the type of pulp used, a series of steps is necessary prior

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to forming the paper sheet. Generally, dried market pulp is rehydrated, while high consistency pulp from storage is diluted. Pulp fibres may be beaten to increase the fibre-bonding area and thereby improve paper sheet strength.

ROLL BACK

Pocket Ventilation

Pocket ventilation is desirable to prevent the formation of stagnant pockets of air within parts of the dryer. These can become saturated and slow the overall drying effect.

There are two basic methods of pocket ventilation.

- Blow Ducts (boxes)
- Blow Rolls

The former are the cheaper but the latter are possibly more effective and allow the use of denser fabrics and an air flow, even when an open fabric becomes denser with use.

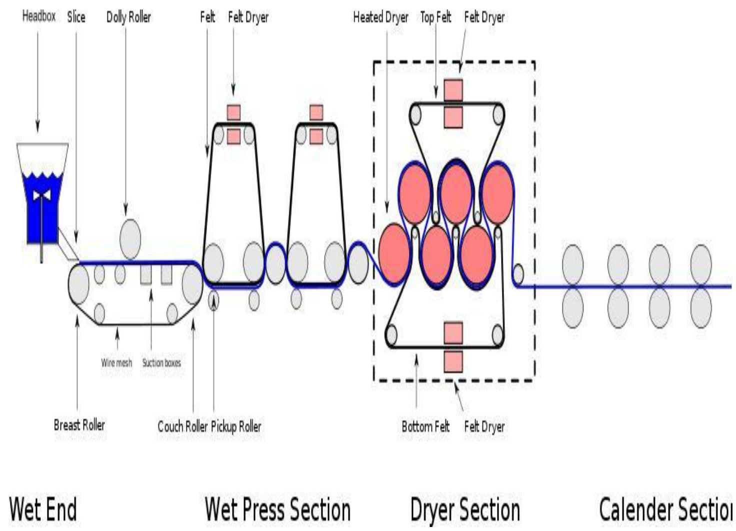
CALENDAR SECTION

A calendar consists of two or more rolls, where pressure is applied to the passing paper.


Roll back calendaring section

Calendars are used to make the paper surface extra smooth and glossy. It also gives it a more uniform thickness. The pressure applied to the web by the rollers determines the finish of the paper.

After calendaring, the web has a moisture content of about 6% (depending upon furnish (or) finishing of a product). It is wound onto a roll called a tambour or reel, and stored for final cutting and shipping. The roll hardness should be checked, obtained and adjusted accordingly to insure that the roll hardness is within the acceptable range for the product.




Working of dryer plant

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## 5. MATERIALS USED

RAW MATERIAL

The fibrous raw materials can be classified as follows:

Wood

• Softwood (spruce, pine, fir, hemlock etc.)

• Hardwood (birch, eucalyptus, mixed tropical hardwoods etc.)

Non-wood

• Agricultural and other residues such as straw from cereals, rice and sorghum as well as sugar cane bagasse

• Naturally grown plants such as bamboo, reeds, papyrus, esparto and other grasses

• Crops primary grown for their fibres content such as juite, hemp, kenaft,

ramie, flax (bast or stem fibres); abaca or Manila hemp, sisal (leaf fibres); cotton (seed hair) Of these, bagasse, reed, bamboo, cereal (wheat, rye) and rice straw are the most important non-wood fiber raw materials for paper making.

NON-WOOD RAW MATERIALS

The chemical composition does not differ much between different types of non wood fiber and the lignin content is largely the same as that of hardwood. The cellulose content and the fibres length vary relatively little between the wood based and non-wood based raw materials.

Chemical characteristics and fiber dimension of different raw materials including hardwood (common raw material for large mills) and non-wood (raw material for small mills).

Non-wood fibres are easy to be delignified by chemical pulping. It is noted that non-wood fiber are delignified much faster than wood. This can be explained by the reason of the more open structure of the fiber tissue. (UNEP,1986) GIERTZ (1993) reported that the most widely used pulping method for non-wood raw materials are the soda and the sulphate processes. These processes have a relatively short cooking cycle either applied in continuous or in a batch system. This means the digester volume can be rather small. Bagasse fairly resembles hardwood in chemical composition and this is reflected in the yield which is largely the same as that of hardwood but not in cooking time. Generally speaking, further processing in the fibre production line such as screening, bleaching and drying is largely the same for the non-wood fibres as for wood.

ADVANTAGES OF NON-WOOD PULP

Non-wood raw materials are cheap.

Non-wood fibres are delignified much faster than wood. The material is satisfactorily delignified and the pulp obtained is of high quality and can be easily bleached to an acceptable brightness.

The cooking time of non-wood raw material is shorter than that of the hardwood.

Therefore the bagasse cooking time is very short with low alkali requirements and results in a pulp with low yield.

DISADVANTAGES OF NON-WOOD PULPING

Preparation of fibrous raw material

The problem lies in the preparation of fibrous raw material including collection, transportation, and storage. These are bulky material.

One important thing to note is its seasonal delivery. They might deteriorate during storage. The dust loads in the handling, storage and cleaning of bagasse, bamboo and straw is high.

## 6.CONCLUSION

Dryers are used to efficiently process large quantities of bulk materials that needs reduced moisture levels. Depending on the amount and the makeup of material needing to be dried, industrial dryers come in many different models constructed specifically for the type and quantity of material to be processed. Already 3 dryers are placed but that is insufficient for removing the moisture, it can remove only 80% of moisture only. It will create the strength damage and lack of output efficiency. So we can suggest 4 additional dryer needed on the wire path way, which can improves the drying of 90% and above. By this the strength of the paper and the efficiency has been improved. Through this improved productivity and cost reduction is arrived.

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