

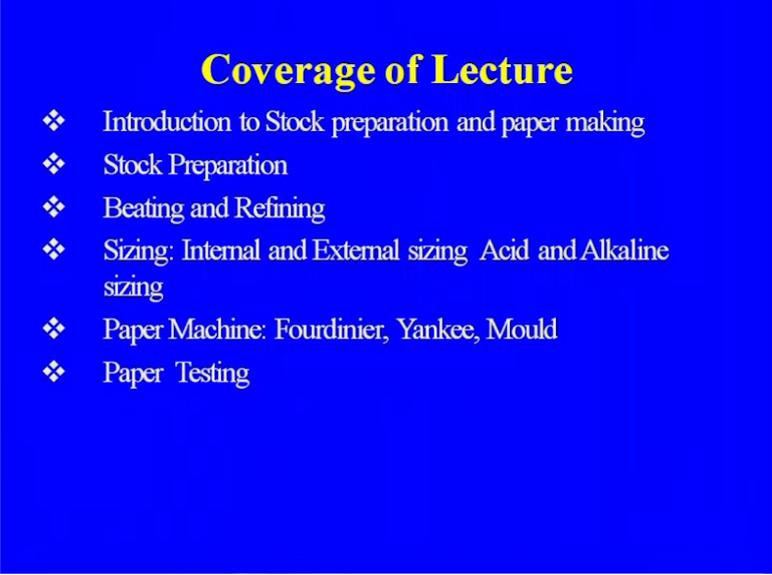
Chemical Technology
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Module - 3
Pulp and Paper
Lecture - 4
Stock Preparation and Paper Making

We are discussing module 3 of the organic chemical technology course. Already, we have discussed about the introduction to pulp and paper making, raw materials for pulp, paper making pulping and bleaching process and the recovery of the chemicals. Now, in the lecture 4 will be discussing about the stock preparation, the paper making because you see it is called the paper making is a art and the stock preparation and paper making is a very important, you can say this is the heart of the any paper industry, and because we are making a large variety of the paper starting from the conventional writing paper or the tissue paper to the abrasive paper, coated paper, insulated paper and the various quality. Already I have discussed the various quality of the various type of the paper which we have we need the currency node, we need the triplex board, duplex board or simply board paper and so the variation carbonless paper all those variety.

So, it is called the paper making is an art. So, the paper making that consists of the 2 parts and that is the stock preparation and the paper making and both are the combine and the because we start whatever the pulp we are getting from the pulping or bleaching that is the craft and bleach pulp, it is not suitable for making the paper, that has to imparted some property. So that the paper sheets we can make, dinning of the water that may be done, adding of the additive, colour, sizing, all those material that is being done and the stock preparation, even the waste paper because the you see the utilization of the waste paper that has increased now a days. And so now we are using huge amount of the waste paper and similarly to the pulp which we are getting that has to be further cleaned for paper making. So, all those process that is taking place in the stock preparation and then the finally after the stock preparation after beating, refining that is going to the paper making.

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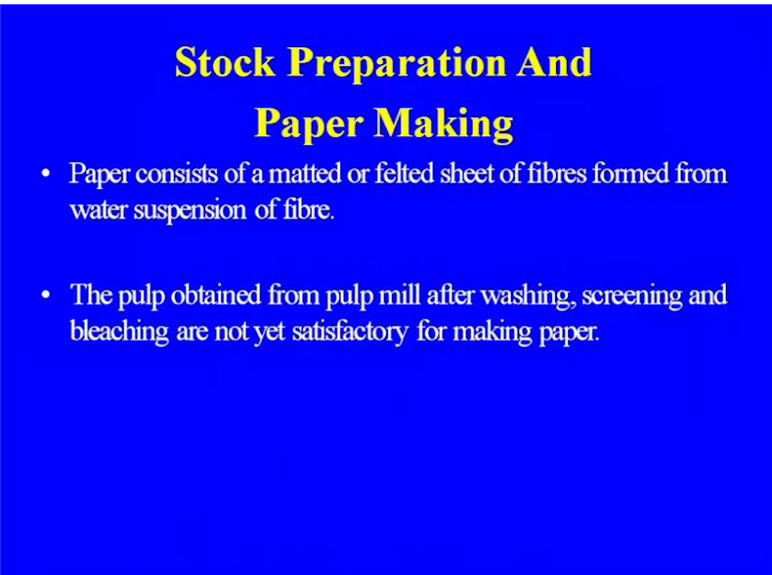


Coverage of Lecture

- ❖ Introduction to Stock preparation and paper making
- ❖ Stock Preparation
- ❖ Beating and Refining
- ❖ Sizing: Internal and External sizing Acid and Alkaline sizing
- ❖ Paper Machine: Fourdrinier, Yankee, Mould
- ❖ Paper Testing

So, this will be the coverage of the lecture introduction to stock preparation and paper making, stock preparation plant. And in the stock preparation there will be beating, refining, sizing. Sizing, again internal and external sizing, acid and alkaline sizing, paper machine we are using because depending upon the quality of the paper we are using different type of the machine Fourdrinier machine, Yankee machine, mould machine, sometimes it may be combination of the Fourdrinier machine and mould.

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**Stock Preparation And
Paper Making**

- Paper consists of a matted or felted sheet of fibres formed from water suspension of fibre.
- The pulp obtained from pulp mill after washing, screening and bleaching are not yet satisfactory for making paper.

Then, finally will be what are the various characteristics of the testing pulp because the quality of the paper it is continuously evaluated and even the consumers have become more cautious and they are having the also own testing lab so that the manufacturer may not manipulate the things and so the depending up on the quality sometimes rejection is also there. Paper consists of the matted or felted sheet of the fibres formed from the water suspension of a fibre. The pulp obtained from pulp mill, as I told you after washing, screening and bleaching are not yet satisfactory for making of the paper.

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Stock Preparation And Paper Making

- Pulp require further processing to develop good fibre bonding and impart several characteristics like surface smoothness, sizing, colour.
- This requires addition of sizing chemicals, colour and additives and other chemicals for foam and pitch control, retention aids etc.

The Pulp require further processing to develop good fibre bonding and impart several characteristics like surface smoothness, sizing, colour, addition of the some of the retention aids, all those things that we are doing in case of the stock preparation and that is very important section in case of the paper making.

This required addition of the sizing chemicals, again as I told you that the sizing may be internal or external sizing, colour and additives because we are manufacturing wide variety of the colour paper also and other chemicals for foam and pitch, that is the controlled that is very important in case of the sometimes the foaming tendency is also there, retention aid that we need for the retention of the some of the chemicals which we are adding, also the wastage of the more fines in the form of the waste water so that has to be avoided and so we are using the retention aid.

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Stock Preparation and Paper Making

- Stock Preparation And Waste Paper Processing
- Paper Making

And this is the about the stock preparation, that is the stock preparation in the waste paper processing and the paper making. These are the 2 important sections in case of the paper making.

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Stock Preparation

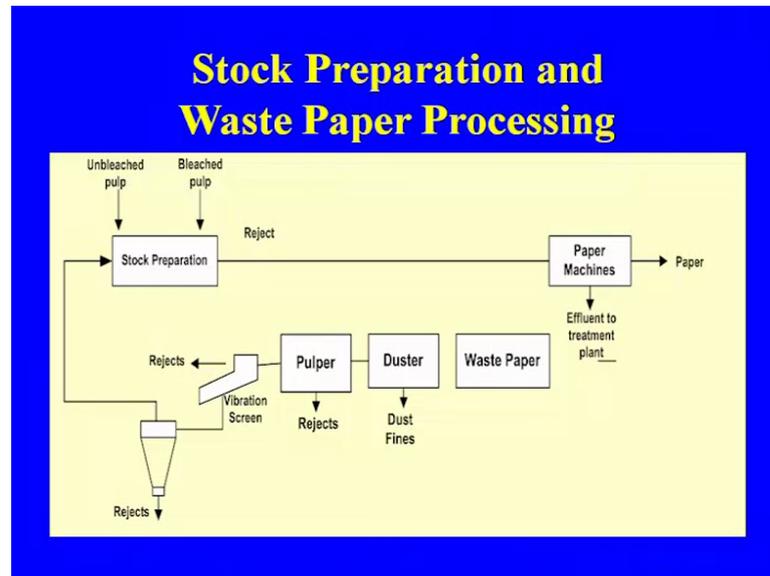
Cellulose fibre must be subjected to mechanical treatment before they can be made in to paper and board.

Beating and refining is done to develop good fibre bonding and high paper strength.

Cellulose fibre which we are getting after the bleaching or the pulp must be subjected to mechanical treatment before they can be made in to paper and board. So, the process which we are using for the mechanical treatment of the pulp is the beating and refining. Beating and refining is done to develop good fibre bonding and the high paper strength.

If the proper beating and refining is not there then, the fibre strength or the paper strength that will go down and the proper paper making will be not there, so that is very important.

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This is the process we are using in case of the stock preparation and the bleach, in case of the craft pulp or bleach pulp that is going to the stock preparation where, the beating, refining then the, centri cleaning and finally, after the centri cleaning in-between it may be the if the requirement of the sizing is there, size paper if you are making tissue paper then un-size paper, all those thing that is being done in case of the stock preparation.

And finally after addition of all those chemicals, additives, fillers because sometimes in case of the many of the quality paper we need the fillers also because that reduces the cost, also they are helping in the beater fibre bonding and improving the quality just like if you are using the talcum or the titanium dioxide, all those things that is being used so, even coating is also done. So, the coating part finally it is been after making of the paper.

But, bleach pulp that is going to be stock preparation, centri cleaning that will be held the rejects will be removed and then the finally, the pulp that will go to the machine and the waste water that will go to the free treatment plant and then, the paper, final paper that will report the cutting, duelling all those process are there. This is about the I was telling because now the many of the mills are only this, this diagram the flow processes will be there, there will be no recovery, there will be no pulping and so they will be processing,

they are processing only waste paper and the number of mills are now the liner, they are having a very high capacity plant based on the waste paper as high as 400 tons per day or even more.

So, this is the waste paper that is going to duster for the removal of the dust because the waste paper, that will again the quality of the waste paper that will depend the what type of the paper we are collecting the waste paper, office paper or the from the packaging paper, that may not get major problem but, if you are having the roots sweeping from where the, from the municipal weight we are collecting paper so, definitely that will have lot of the impurities sorting is very important sometimes even the coated papers are also there, some of the plastic materials are also there. All this things that we are doing in the sorting that is being done.

The dusting that duster the dust removal then fines removal that is there then, it is going to the pulper and from the pulper it is going to the vibrating screen, centricleaning here, the centricleaning with the series of the 3, 4 stages are there and finally, after that is going to the stock preparation and where again the same activity which we are doing in case of the paper, the pulp original pulp they are doing and then, after that stock preparation that is going to the paper machine.

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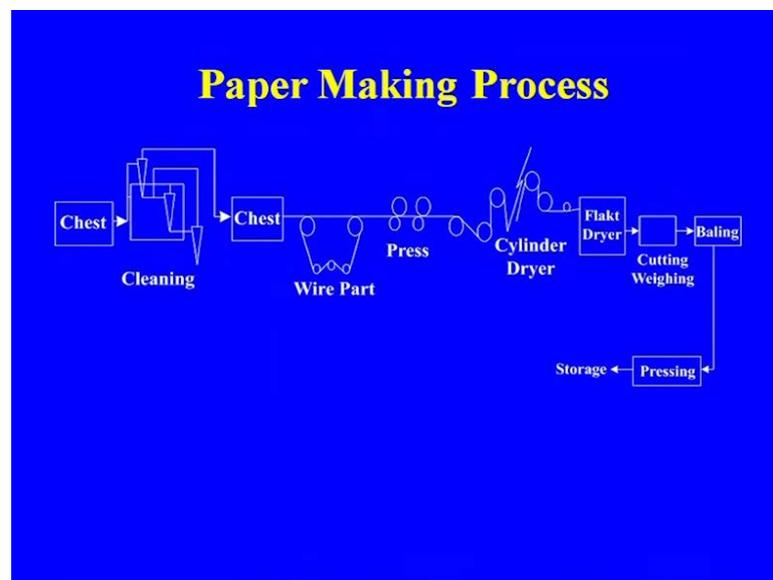
Paper Making

- Conversion of pulp from stock preparation into a sheet of paper/board using Fourdrinier Machine or Mould machine.

Paper making that was the part of the stock preparation and after the stock preparation the paper making that consists of the conversion of the pulp from stock preparation into a

sheet of paper board because the depending up on the quality of the paper we may need the furnace which we are using as a pulp, different furnace that may be required depending up on the quality of the paper or different type of the machine that we are using, we may use the mould machine for tissue paper, another paper you may have the Yankee machine or it may be the writing paper may have only the and the paper that may be machine finish or manish machine glaze depending up on the requirement. So, we are using the Fourdrinier machine, mould machine and normally these are the some of the machine that we are using there.

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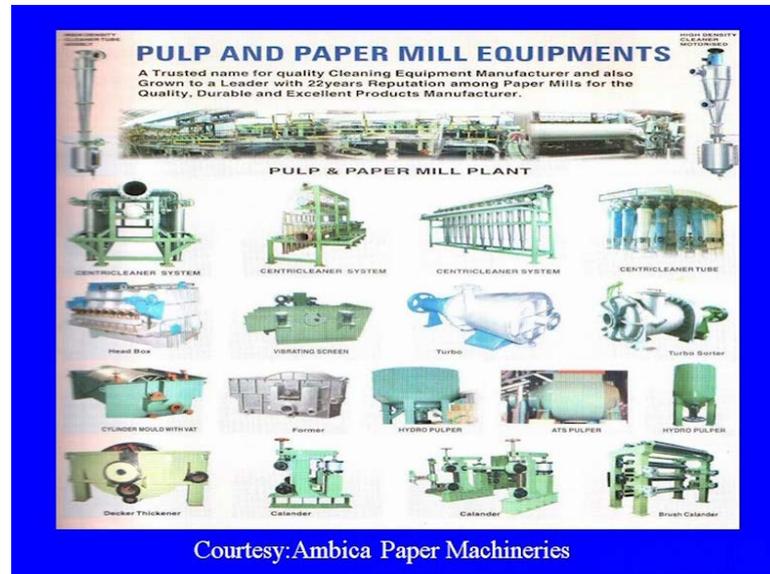


This is the actually the process which we are using the in case of the paper. I will go in detail about the paper making process but, this is the machine chest that we are having. This from this is not actually a machine chest form this chest the pulp which we are getting from this that is going to final cleaning that we are using this centricleaner and after the centricleaner the pulp is going to the machine chest and from the machine chest because here, the consistency of the pulp is around 99 percent your water is there, 1 percent less than 1 percentage very dilute pulp means the consistency it may be 99.4, 99.5 water that is going to the machine.

And then, this is the wire part of the machine and wire part of the machine section group table so all these things are that may be there wire part and after the wire part it will go to the cylindrical dryer where, the dryer we are using the steam for drying of the paper and

finally, it will be the cutting, weighing, baling, depending upon the type of the paper. So, this is the brief in about the paper making process.

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This is if you are see this is a Fourdiner machine and these are the some of the equipments and some that is being used in the pulp and paper equipments, this is the centricleaning, this is also the centric clear cleaners we call it but, it is nothing it is a cyclones. Series of cyclones are there then, we are having the machine chest we are having, this is the refiner part, in case of this we are also having the disc refiner also machine chest. All these equipments are there, these are the just various equipments that we are using in case of the paper making.

Now, let us come to the stock preparation. Beating and refining: This result in increase of the beating and refining improves the bursting and strength, folding endurance, smoothness, formation and other strength properties of the paper which is very important. The process involves cutting of the fibres however, it can also be made to do considerable fibrillation in case of the bars or on the rotor and the casing are wide, that is, wide angle refiners. Even in case of the beating refiner, we are also using the disc refiner because the conventionally is the beating and the conical refiner. Now, in many of the mills they have also having the disc refiner.

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Beating and Refining

- Increase of beating and refining improves bursting strength, folding endurance, smoothness, formation and other strength properties.
- The process involves cutting of fibres, however, it can also be made to do considerable fibrillation in case of bars on the rotor and casing are wide, i.e., wide angle refiner.

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Stock Preparation

There are three main types of Beating/Refining equipments,

- i. Beaters
- ii. Conical Refiners
- iii. Disc Refiners

Three types of the refining equipments we are using. One is the beaters, conical refiner and the third is disc refiner, because in case of the disc refiner more uniformity is there and the high capacity disc refiners are available and even in case of the because we have started using the hardwood pulp and so, it is disc refiner they are giving better refining property to the pulp.

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Stock Preparation

“Beating” and “Refining” are the operation of mechanically treating the pulp fibres.

Refining usually refers to fibre separation and cutting; whereas Beating action may include the above two effects and also fibrillation or bruising effect of the fibre.

Beating and refining are the operation of mechanically treating the pulp fibres refining because the slightly difference in these 2 but, the purpose is same, because before coming of the refiner it was the only the beater that was the older howled beater that was the name given and the beater and then, it came the refining and then, the disc refiner, conical refiner you can say. They usually refer to the fibre separation and cutting.

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Stock Preparation

Beating/Refining of pulp is measured by “Freeness”.

A “free pulp” drains readily, whereas “slow pulp” drains its water slowly.

Freeness can also be defined as the water holding capacity of fibre.

Whereas, the beating action may include the above 2 effects: fibrillation or the bruising. Sometimes it also helping the beaters we are using for addition of the various fillers or retention aid or the colour that is also the operation that is been carried out the beating.

The beating and refining of the pulp is made measured by freeness. Free pulp means where that the freeness that is very important characteristics while the making of the paper. Free pulp means drains readily because the water as I told you the pulp at the consistency of about the 99 percent means the 1 percent pulp is there, 1 percent not, not 99.5 percent water depth may be there.

So, the water has to be removed from the pulp during the paper making. So, the slow pulp is there so, the slow drainage will be there, we may need the longer wire part and even the proper running of the machine that will be there. So, the free pulp drains readily. Freeness can also be defined as the water holding capacity of the fibre.

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Stock Preparation

Beating/Refining of pulp is measured by “Freeness”.

A “free pulp” drains readily, whereas “slow pulp” drains its water slowly.

Freeness can also be defined as the water holding capacity of fibre.

Steps involved in the stock preparation of the refining beating of the pulp stock through beaters or refiners, blending the refined stock in case more than 1 pulp furnace because as I told you that we are making different type of different quality of the paper so, sometimes we are using the cotton linter pulp also or aspen pulp in case of specially the board where, the high folding into endurance that is required. So, sometimes the hardwood softwood part pulp is there or good quality of pulp is there, high strength pulp is there so, the blending the refining in case of the more than 1 pulp furnace we have.

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Stock Preparation

Steps involve in Stock preparation

- Refining/Beating of pulp stock through Beaters/Refiners
- Blending the refined stock in case more than one pulp furnish.
- Addition of chemicals to make suitable for the desired product of papers and board.
- Transferring prepared stock of pulp to machine chest.

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Stock Preparation

Steps involve in Stock preparation

- Refining/Beating of pulp stock through Beaters/Refiners
- Blending the refined stock in case more than one pulp furnish.
- Addition of chemicals to make suitable for the desired product of papers and board.
- Transferring prepared stock of pulp to machine chest.

Addition of the chemicals to make suitable for the desired product of the paper and board, transferring the prepared stock of the pulp to the machine chest and after the machine chest it will go to the machine and a then, the paper making process that will start.

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Beaters

- Beating includes fibre separation, cutting and fibrillation or brushing effect. However, the action of the beater is primarily of rubbing or crushing nature.
- The operation of beater is carried out at 5-6% consistency.

Beating as I told you the beating includes the fibre separation, cutting and fibrillation or brushing effect. However, the action of the beater is primarily of the rubbing or the crushing nature. The operation of the beater here, we are maintaining about 5 to 6 percent consistency means the 5 to 6 percent of the (()).

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Beaters

The circulating power requirement is high. It can be used for mixing and blending the chemicals.

Beaters are important even for making special grade papers.

The circulating power requirement is high in case and that is the reason why it was the beater to refiner or disc refiner is there. Beater are important even for making special grade papers where, the blending of the various furnace that is required or the sometimes

we need the colour paper so, in 1 beater we can have the, make the, add the various colouring material also. So, that helps in the making the special grade of the papers.

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Conical Refiners

- Beaters have been replaced with refiner which has advantage of low space requirement and less energy consumption over the conventional old beaters.
- Refiners can be used on continuous basis where fibres flow parallel to the bars of the rotor and stator.
- Refining refers to fibre separation and cutting, conical refiners and disc refiner.

Beaters have been replaced with refiners as I told you that has become more energy saving device and which has advantages of the low space requirement because the space required in case of the beater is very large, in case of the refiner it is the space requirement is less it is less, it is energy consumption over the conventional old beater.

Refiners can be used on continuous basis where, fibre flows parallel. Here, actually the beaters batch process, refiners are the continuous process. So, in case of the refiner can be used on continuous basis where, fibres flow parallel to the bars of the rotor and stator and the refining process that takes place. Refining refers to the fibre separation because what is happening the pulp will have to make suitable for the will have to improve the dense property. So, that is the cutting, conical refiners and disc refiner that we are using for this operation for the refining.

So, disc refiner is, I told you the refiner consists of rotating disc we are having the 2 disc grooves bar on either side positioned between 2 stationary discs with grooves on the inner side. The stock is admitted through 2 inlets and it passes outward through the pipe. Disc refiner has higher power economy and requires 20 to 25 percent less power with very less space requirements than the conical. So, it is more economical than the refiner also and the capacity. This is the advantages in case of the disc refiner.

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Disc Refiners

- Disc refiner consists of rotating discs with grooves/bars on either side positioned between two stationary discs with grooves on the inner side.
- The stock is admitted through two inlets and it passes outward through a pipe.
- Disc refiner has higher power economy and requires 20-25% less power with very less space requirement than the conical refiners.

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Disc Refiners

- Disc are available with variety of patterns of configuration resulting in Different actions like fibrillation.
- Short fibres pulp can be used to achieve better strength properties.
- These refiners can operated at 3-5% consistency and also at 30-40% consistency. Changing of disc is easier with simple maintenance.

So, disc refiners are available with variety of the patterns of the configuration resulting in different actions like fibrillation. Short fibre pulp can be used to achieve better strength property. Sometimes, as I told you, in case of the news print, the short fibres also preferred and so, we are using the line series of mechanical pulp. Disc refiners can also operated at the 3 to 5 percent consistency and also at 30 to 40 percent consistency. So, this is how the variation is there. In case of the beaters we have operating at 5 to 6 percent consistency. Changing of disc is easier with the simple maintenances in case of

these. These are some of the advantages in case of the disc refiner and all the new mills they are having disc refiner and the beaters you will find only in the old mills.

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Blending and Mixing of Chemicals

- Stock preparation section involves blending and mixing of rosin, alum, loading material (talcum powder, calcium carbonate, titanium dioxide), dyes, whitening agent, starch, gum, sodium silicate, wax emulsion mixing chest.
- Refined pulp stock of required quantity is taken and chemicals are added according to grade of paper and board.

Blending and mixing of the chemicals that is very important in case of the stock preparation. Stock preparation section that involved blending and mixing of rosin, rosin and alum that is the sizing material although they are now, this is called the acids sizing. Now, we are going to for the alkaline or the your neutral sizing loading material, talcum powder, calcium carbonate, titanium oxide. All those material that we are using as a loading material as a filler in the paper especially, in the as you take the case of the writing paper where, you can go as high as 12 to 14 percent filler that is the so, the cost depending up on the quality of the paper whether it we are using the talcum powder or the calcium carbonate. So, dyes, whitening agent, starch gum, sodium silicate, wax emulsion, all these things that is being added in the mixing chest.

Refined pulp stock of required quantities is taken and chemicals are added according to grade of the paper and the board because as you see the requirement of the chemicals, processing of the pulp that will depend totally what type of the paper you are interested to make. So, depending up on the type of the paper you are making you will have to go for the various processing stages in case of the stock emission. Even, sometimes if you are suppose the waste paper is more so, definitely the refining action that less requirement will be there, that will be not at the sever condition that we are trying in case

of hardwood pulp so, the waste paper that may even the requirement of the power that will be less. So, that is the how the a things are different depending upon the raw material, depending upon the furnace that will required, suppose if you are having the cotton linter pulp or the hosiery cuttings then, that will that may require longer refining or the beating time because the one thing is there fibre length is high and so, the they need more time for the making the paper suitable for after that that will be mixed with the pulp.

So, refine pulp stock of required quantity is taken and chemicals are added according to the grade of the paper which I told you.

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Sizing

- Paper making fibre have strong tendency to interact with water due to hydrophilic nature of cellulosic fibre.
- Sizing process imparts resistance to water penetration. Sizing makes the fibre surface water repellent by using chemical additive.

Sizing because the paper making fibres have strong tendency to interact with the water due to the hydrophilic nature of cellulosic fibre. And so, remember that our time we use to have the writing paper and the ink that was being used so, feathering of ink that was very common phenomena when the ink was being used although, we are now using the ball pens ball pens so the that problem is not there but, during the and so, the blotting paper that was being the unsize paper but, if you want a resistance to water penetration then, sizing is done.

So, sizing process imparts resistance to water penetration. Sizing makes the fibre surface water repellent by using chemical additives that we are using, that sizing alum and rosin or it may be other AKD that may be there or the neutral sizing material that may be used.

So, then because you see the in case of the you take the case of the tissue paper, there the sizing is not required there, the moisture absorbance is more important. So, in case of the tissue paper toilet tissue paper we do not need the sizing but, in other grade of the paper definitely the sizing that is very important. Even the sizing chemical that will also differ from qualitative quality of the paper.

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Sizing

- In unsized paper, liquid tends to spread out on the surface of paper and the process is called “feathering”.
- Various sizing agents like rosin, paraffin waxes, wax derivatives, wax emulsions and synthetic sizing agents like alkyl ketene dimer(AKD) and Alkenyl Succinic anhydride (ASA) are being used to make paper reasonably hydrophobic.

In unsized paper, liquid tends to the spread out on the surface of the paper and the process is called the “feathering” which I told you when using the ink that way, that was a major problem with the because sometimes the if the sizing was not proper, feathering of the ink that was a common problem.

So, various sizing agents like rosin, paraffin waxes, wax derivatives, wax emulsions and synthetic sizing chemicals like alkyl ketene dimer that is AKD and alkenyl succinic anhydride (ASA) are being used to make and so that is the what you call the AKD sizing or ASA sizing. So, this is one of the new developments in case of the sizing that is being used and that is to make the paper is reasonable hydrophobic because that is the requirement in case of the most of the grade of the paper except the tissue paper.

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Requirement of Good Internal Size

- The size must be readily available and chemically stable.
- It must be possible to add in a form that ensures good and even distribution across the papermaking fibres.
- The size must be retained in the wet end.

Requirement of good internal size, the size must be readily available and chemically stable. This is the one of the very important property.

It must be possible to add in a form that ensure good and even distribution across the paper making process. The size must be retained in the wet end of the paper because if it is lost then, definitely the paper quality that is going to be effected. So, the retention of the sizing material is also a very important.

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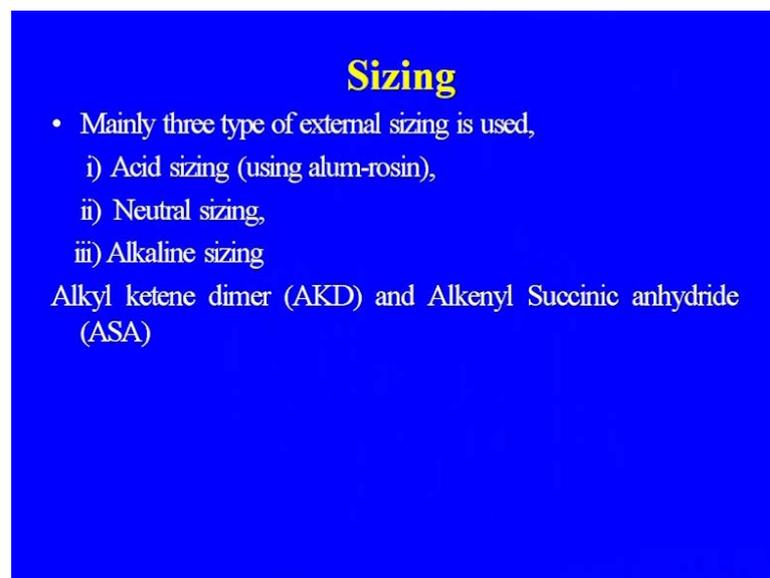
Sizing

- Sizing may be internal sizing or surface sizing or external sizing.
- In internal sizing, the sizing chemicals are added and mixed in pulp whereas in external sizing the sizing chemical applied on the surface of paper.

The molecules must orient themselves so that the hydrophobic end is away from the fibre. The size must be sufficiently hydrophobic so that the sizing achieved in cost effective manner. The size must not cause unacceptable problem in paper and board manufacture. These are the some of the requirement of a good sizing. So, again as I told the sizing that may be internal sizing or the surface sizing what we called or the external sizing.

So, both type of the depending up on the requirement that we are having this process. In internal sizing the sizing chemicals are added and mix in the pulp whereas, in the external sizing the sizing chemical applied on the surface of the paper only. So, this is the how the difference in the case of the internal sizing and the external sizing is there.

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Sizing

- Mainly three type of external sizing is used,
 - i) Acid sizing (using alum-rosin),
 - ii) Neutral sizing,
 - iii) Alkaline sizing

Alkyl ketene dimer (AKD) and Alkenyl Succinic anhydride (ASA)

So, in case of the sizing mainly 3 type of external sizing used: Acid sizing, neutral sizing or alkaline sizing. This is AKD and ASA which I was telling that has become now, there this shift in from acid sizing to alkaline sizing. And lot of work that has been done even for the planet labour they have the data are available and the advantage of the alkaline sizing over the conventional sizing acid sizing that has been well reported.

Some of the weaknesses of the acids sizing are- Ageing effect in paper, restriction of the calcium carbonate use because you see a loading that is also very important to reduce the cost, the corrosion in the machine, reduced brightness of the paper and the high sizing cost. Sometimes the brightness of paper that is because after keeping sometime the they

are the brightness is reduced so that is not required so, the brightness should be retained for longer time and the high sizing cost in case of the alum and rosin. These are the some of the disc advantage and at the same time lot of the corrosion problem is also because we are having the low pH and because the low pH and the alum. So, the problem of the corrosion is there. And these are the some of the reason why acid sizing into alkaline sizing that is been.

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Acid Sizing

- Some of the weaknesses of acid sizing are- Ageing effect in paper, restriction of calcium carbonate use, corrosion in machines, reduce brightness of paper, high sizing cost

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Acid, Neutral and Alkaline Sizing

- Acid sizing (alum-rosin) is most adopted sizing process in the paper industry since long because it is cheap, reliable and reasonably effective.

However, there has been interest in a alkaline and neutral sizing

So, for the acid sizing is still that is very common. So, acid sizing is most adopted sizing process in the paper industry since long because it is cheap, reliable and reasonable effective. However, there has been interest in the alkaline and neutral sizing in the recent year and now, the means they have shifted from your alum-rosin sizing to the AKD or ASA sizing.

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Acid, Neutral and Alkaline Sizing

- From the conventional acidic system with Alum-rosin sizing, the paper industry has changed to neutral sizing using (dispersed rosin sizes) and alkaline sizing with synthetic sizing chemicals like alkyl ketene dimer (AKD) and Alkenyl Succinic anhydride (ASA)
- The driving force for this change is process advantage, product improvement and environmental considerations.

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Advantages of AKD sizing

- ❖ Increase equipment life due to less corrosion at higher pH
- ❖ Increase in brightness and optical properties
- ❖ Increase in permanency of paper
- ❖ Increase in machine clothing life due to less choking
- ❖ Gain in machine runability due to better drainage
- ❖ Good smooth feeling on paper surface
- ❖ Reduction in fluff

So, from the conventional acidic system with alum-rosin sizing, the paper industry has changed to neutral sizing, dispersed rosin sizing and alkaline sizing with synthetic sizing

chemicals like alkyl ketene dimer and the alkenyl succinic anhydride. The driving force for this change is the process advantage, product improvement and the environmental consideration. These are the some of the advantages why now everybody is talking about the AKD or ASA sizing.

Advantages of the AKD sizing, these are the some of the advantage- In the increase equipment life due to less corrosion at higher pH, increase in brightness and optical properties, increase in the permanency of paper, increase in the machine clothing life due to less choking, gain in the machine runability because that is very important in case of the machine operation due to better drainage. If the drainage is poor then, the running of the machine that will be affected and of the sheet which we are getting that and that will not of the proper strength. good smooth feeling on the paper surface, reduction in the fluff.

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Loading

- Loading means, the incorporation of inorganic materials into fibrous web to improve the quality.
- The principal fillers used are clay, talcum powder, Calcium Carbonate, Titanium dioxide, Zinc Sulphide, Calcium Sulphate.

Now, come to loading because loading means the incorporation of the inorganic material into fibrous web to improve the quality. The principal fillers used are clay, talcum powder, calcium carbonate, titanium oxide, zinc sulphide, calcium sulphate. But, the brightness of these fillers are very important otherwise, that will result in the brightness of the pulp of duller side of the so, always there is problem in some of the quality of these fillers are not good.

(Refer Slide Time: 29:23)

Loading

- Advantage of filler
 - i) High degree of whiteness/brightness
(80- 98°pv)
 - ii) High index of refraction (1.5 - 2.7)
 - iii) Small particle size (0.3 to 10 micron)
 - iv) Low solubility in water.
 - v) High specific gravity than cellulose
(2.60 – 4.50)

So, the advantages of the filler are the high degree of the whiteness, brightness because if you see the titanium dioxide or even the calcium carbonate precipitated calcium carbonate although they are having the high brightness, high index of refraction, small particle size, size is very small, low solubility in the water, high specific gravity than the cellulose. Colouring because as we know we are making the now, the actually the colour paper for the poster and other thing that has decreased but, poster paper, colour poster paper, match box still that is being used. So, colour and even for the various quality of other grade paper we need the colouring.

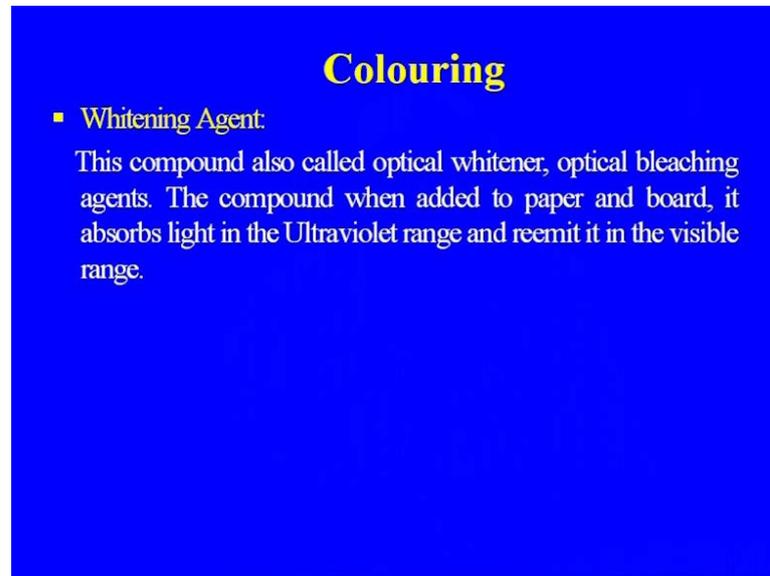
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Colouring

- Dyes, and Colours are added to manufacture coloured paper.
- There are three types of dyes normally used :
 - i) Acid dyes,
 - ii) Basic dyes and,
 - iii) Direct dyes.

So, dyes and colours are added to manufacture coloured paper. There are 3 types of the dyes normally we are using in the case of the paper. That is, the acid dyes, basic dyes and the direct dyes.

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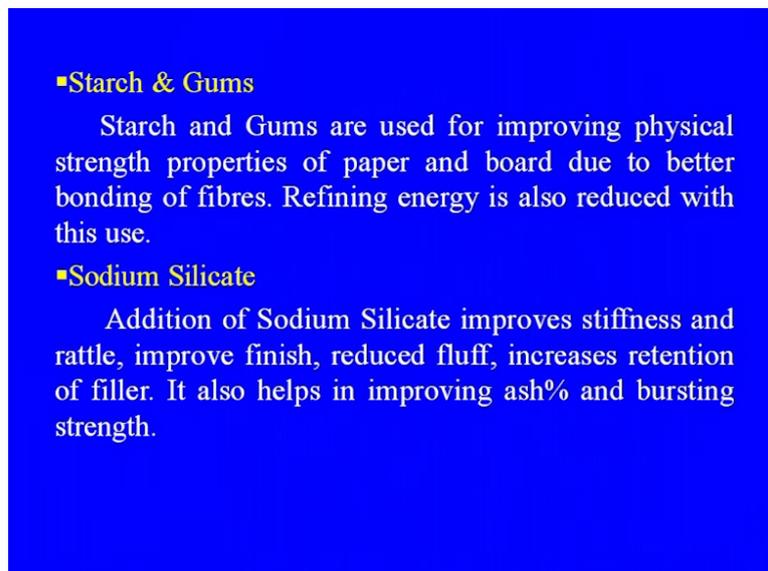


Colouring

- **Whitening Agent:**
This compound also called optical whitener, optical bleaching agents. The compound when added to paper and board, it absorbs light in the Ultraviolet range and reemit it in the visible range.

Whitening agent also that we are using this compound also called the optical whitener, optical bleaching agent. The compound when added to the paper and board, it absorbs light in the ultraviolet range and it in the visible range and so, that is the sometimes the whitening agent is also added.

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- **Starch & Gums**
Starch and Gums are used for improving physical strength properties of paper and board due to better bonding of fibres. Refining energy is also reduced with this use.
- **Sodium Silicate**
Addition of Sodium Silicate improves stiffness and rattle, improve finish, reduced fluff, increases retention of filler. It also helps in improving ash% and bursting strength.

Starch and gums are used for improving the physical strength properties of the paper and board due to the better bonding of the fibres because the better refining of the bonding of the paper is very important. Refining energy is also reduced with this use. Sodium silicate that also we are using sometimes in the addition of the sodium silicate improves the stiffness, improve furnish, reduce the fluff, increases the retention of the filler, it also help improving the ash percentage and bursting strength.

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Wax Emulsion:

Wax emulsion is used with Rosin size for reducing Rosin consumption per tonne of paper and it is cheaper than Rosin. As partial substitute of Rosin.

(Refer Slide Time: 31:58)

Paper Making

- The pulp from stock preparation section after beating/ refining and entricleaning enters to the manifold and then to head box.
- The function of the head box is to receive cleaned pulp stock at the consistency of 0.2-0.8% and distribute it uniformly across the width of wire at constant head.
- Rectifier roll/Evener on rolls are used to provide necessary agitation and even out distribution of fibres.

Sometimes, wax emulsion is also used with the rosin size for reducing the rosin consumption per tonne of the paper because it is cheaper than the rosining as partial substitute of the rosin sometimes some mills are using. Now, let us come this was the part of the stock preparation and after getting the different furnished of the pulp and then, the now it is ready. After furnish reduce, the fluff increases the retention of the filler, it also helps improving the ash percentage and bursting strength.

So, what are the steps involved in case of the paper making. The pulp from the stock preparation section after beating and refining and cnetricleaning enters to the manifold and then, to the head box that is the head box that is the starting point of the paper machine. The function of the head box is to receive cleaned pulp stock at the consistency of 0.2 to 0.8 percent means, the rest is water. So, you can imagine the how dilute pulps that we are distributing and the drainage of the water that is very important.

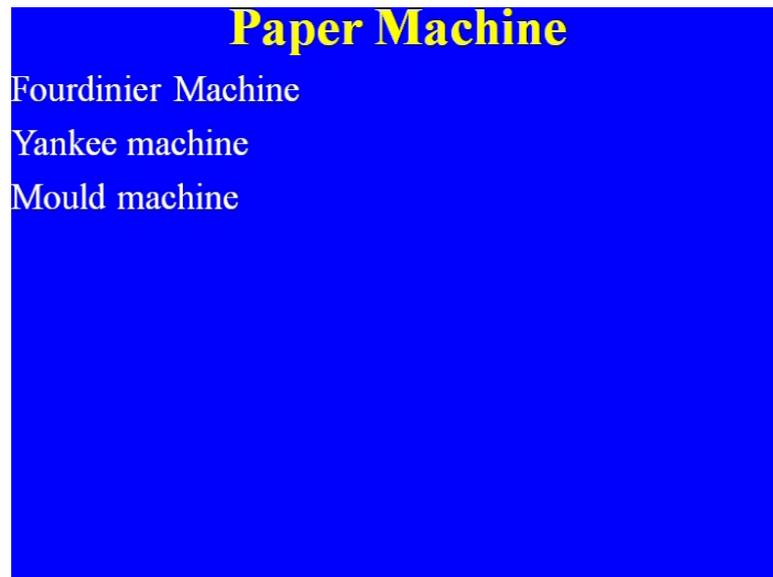
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Paper Making

- The pulp from stock preparation section after beating/ refining and cnetricleaing enters to the manifold and then to head box.
- The function of the head box is to receive cleaned pulp stock at the consistency of 0.2-0.8% and distribute it uniformly across the width of wire at constant head.
- Rectifier roll/Evenner on rolls are used to provide necessary agitation and even out distribution of fibres.

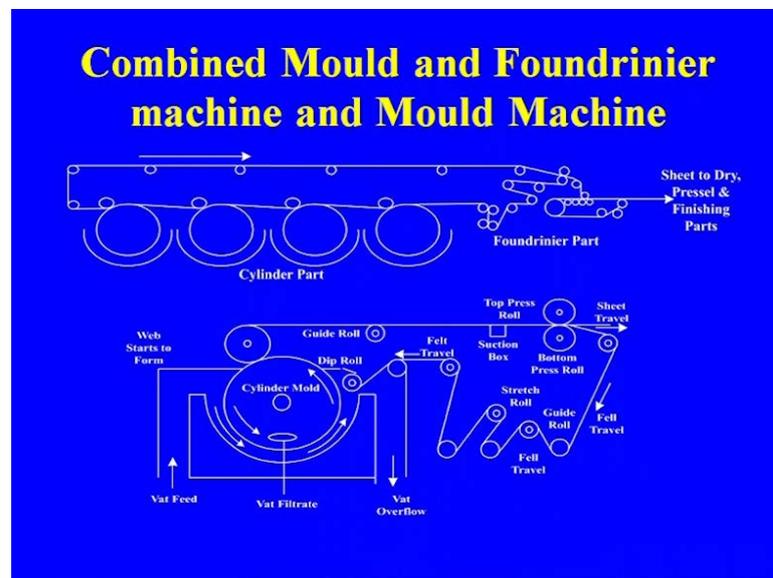
And this from the head box it is distributed uniformly across the width of the wire part of the machine at constant head. So, this is very important.

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We are using the 3 types of the machine normally foundrinier machine, Yankee machine and the mould machine.

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This is the typical mould machine when normally we are going to make the number of moulds that may be more. So, what we are doing in case of the mould machine normally that is being used when we are using the duplex board or triplex board and the different type of the pulp furnish that we are using for the liner side, filler side or the sometime the

triplex board inside the filler board is there and the outside are the white board is there, white paper is there. So, that is the triplex board that we are having.

And sometimes it is also combined in the cylindrical mould to the Fourdrinier part. So, sometimes they combine machines also. This is the type of another machine that we are having that is the Fourdrinier sometimes the or also called the Yankee machine. So, the head box in case of the paper making that may be the open head box or pressure rise head box, from head box pulp flows to the paper machine. In paper making 2 types of the paper machines are commonly used as I told the MF means machine finish or machine glaze because you might have seen in some of the paper more glaze is there, without doing any coating the more glaze. So, in that case the MG cylinders they are having so, the paper glaze paper we are getting and the roughness is not there.

And the second type of the machine which we are using that is the mould machine for making of the duplex board, triplex board or the board because at the different layer that is combining and then, we are getting the 2 layers, 3 layers of the board. Sometimes, even the single board because we know the high gram weight board just like file board you take the case then, we need the higher gram weight at that time some mould machine that can be used or even the Fourdrinier machine also we are using for making of the file board paper. So, already I discussed about the MF machine finish and machine glaze that is the Yankee or combined machine that may be there.

(Refer Slide Time: 35:25).

Fourdrinier Machine

- It may be MF machine or MG Machine (Yankee or combined machine).
- Fourdrinier machine are characterized at the wet end by a head box which delivers stock to a moving woven-wire part belt supported by table rolls suction boxes.

Fourdrinier machine are characterized at the wet end by a head box which delivers stock to a moving woven wire part belt supported by table rolls suction boxes etcetera.

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These are actually the various section in case of the Fourdrinier machine that is, the head box from where the pulp is distributed over the wire part then, the wire part where the major drainage of the water that is taking place and the table roll these are also helping with the supporting of the wire, suction couch where the backbone suction couch is also there which is removing the major water which is not being removed on the wire part that is being removed in the section part then, the dandy roll is also there, press rolls remaining position of the water removing in the press rolls where the simple pressing is there and after the press roll there may be the number of press rolls also. After the press roll the paper that is been transfer to dryer where, the dryer we are using the steam for drying in the paper and depending up on the type of the paper, raw material variation in the speed of the machine that may be there because now, we are having the high speed machine also there very high speed machine.

Earlier it use to be lower speed of the machine but, now we are having the higher speed of the machine also. So, dryer part that has to be adjusted accordingly depending up on the speed of the machine, at the same time of the drainage of the pulp that is the stock preparation part that is why it is playing important role. Because the furnished pulp which we are getting fro paper making it should be the good drainage so that the

maximum removal of the water is at the wire part. And then, the MF, MG cylinders are there. Then finally, the reeling, cutting all those activities are there in case of the, that is the finishing house, that also called the first part is the stock preparation, paper making and the finishing house and where the packaging of the or the rolls of the paper different type of the requirement depending up on the requirement that is there, just like if you take the case of the xerox paper, bond paper sizing sometimes, at the finishers end or the consumer end also the some of the activity that is being done.

(Refer Slide Time: 38:14)

Fourdrinier Wire Part

- The wire part consists of endless wire to support the weak web and drain out water.
- When stock enters on the wire the consistency of stock remains 0.5-0.6%, i.e., 99.5 g water and 0.5 g pulp in 100 g of pulp stock.
- Such a huge amount of water is removed on the wire part, press section and dryer section. About 97% water is removed on the wire part, 1.5% on the Press Section and about 1.0% by the dryer part.

Now, come to the some detail of the fourdrinie Fourdrinier r wire machine because that is very important. The wire part consists of the endless wire to support the weak web because the weak web means the pulp which we are getting and drain out the water because this is maximizer to the maximum removal is taking place at the wire part and the amount of the water that is available because we are feeding the pulp at 0.5 to 0.6 percent consistency through the machine chest. So, the drainage of the rest remaining of and I told you that earlier also that in case of the paper making we are using huge amount of the water. We start with the dry raw material chips are the hardwood or any material and then, we are adding at 10 different points water removing it sometimes, it is 1 percent consistency, some it is 10 percent consistency sometimes, it is the even the centricleaners also. We need the lower consistency for this better cleaning efficiency.

(Refer Slide Time: 38:14)

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- Such a huge amount of water is removed on the wire part, press section and dryer section. About 97% water is removed on the wire part, 1.5% on the Press Section and about 1.0% by the dryer part.

So, this is how the water that is the maximum water that is, the pulp water 0.5 to 0.6 percent consistency means 99.5 gram water and 0.5 gram of pulp in 100 gram pulp. So, that is the definition of the consistency. This is a very common term we are using in case of the pulp and paper making that is we called as the consistency. So, 0.5 to 0.6 percent of consistency pulp will be going to the wire part.

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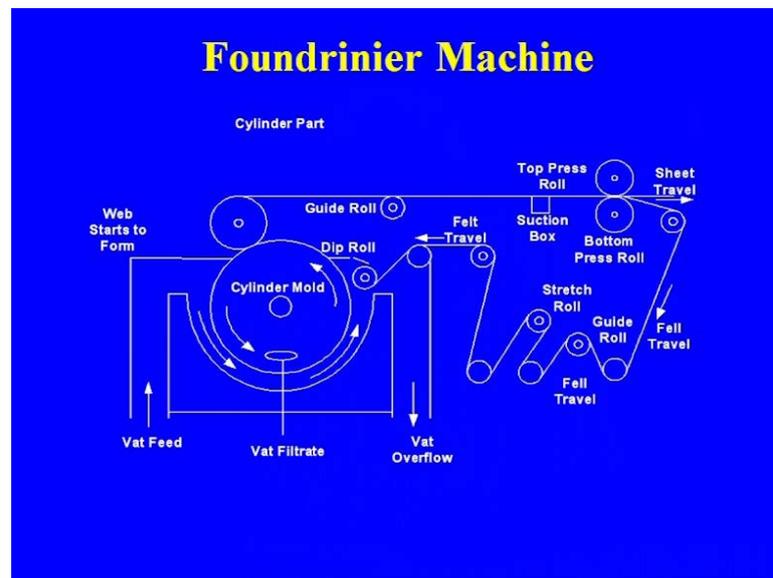
Jcourtesy: MC IMPEX LLC-USA

Such a huge amount of the water is removed on the wire part press section and the dryer section about 97 percent of the water is removed on the wire part 1.5 percent on the press

section and about 1.0 percent by the dryer. So, this is this will actually the again this percentage do not exactly that there may be variation in but, maximum removal has to be on the wire part of the machine.

This is a typical machine which I was telling and then, you are seeing this is the wire part. This is the wire part where, the pulp is at a low consistency 0.5 percent consistency, it is a evenly distributed and these are the supports, various rules are there on which the wire part is supported and after this is suction couch is there where, the remove we are applying vacuum for removal of the remaining water which is not because here you see the drainage property of the pulp that is very important that is why the beating and refining they are very important part and the smooth smoothness of the paper which we are making on the wire part. So, after this it is being transferred to the dryer part, these are the dryer cylinder number of the dryer cylinders will be there where, the paper is being dried using the steam.

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So, the steam consumption that is also very important and so the and this whole machine running of the wire, running of the press part, running of the tire that is synchronized continuously and the machine they are operating at a very high speed machines are there because now the earlier used to be 200 ton machine or the single even, I remember in the Orion paper we used to have the 7 machine for producing only 200 tons now, you will have the many of the machines are producing 400, 500 or even upto 1000 ton capacity

machines are there single machines where you are producing that high amount of the paper. So, this is the how the because you will have to increase the speed also. This is the Fourdrinier machine which I told you earlier that the combined Fourdrinier and the mould machines are there.

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Fourdrinier Wire Part

- Dandy roll and shake are used to improve the sheet formation. Shake helps in improving evenness of fibre orientation, which improves physical properties, drainage of free stock (less beater stock) is retarded by shake, particularly in forming zone which improves formation.

This already I have discussed about the Fourdrinier machine but, these are the some of the other parts of the Fourdrinier machine. Dandy rolls and shake are used to improve the sheet formation because the removal of the water on the wire part that is very important. Shake helps in improving the evenness of the fibre because the power has to be distributed on the wire part which improves the physical property, drainage of the free stock is a retarded by shake, particularly in the forming zone which improves the formation because you cannot afford to lose the fibre. Also, that is also very important.

Dandy roll is also used for water marking. You must have the water mark it also smoothens the top surface of the paper, it helps in taking froth bubbles. It also makes a sheet more dense and compact, which is the requirement of a good paper.

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Fourdrinier Wire Part

- Dandy roll is also used for water marking, it also smoothens the top surface of paper, it helps in breaking froth bubbles. It also makes a sheet more dense and compact.

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Table Rolls

Table rolls serve two purposes; firstly to support wire and to create vacuum at outgoing nip, this tends to pull water from the web. Water is also removed by surface tension. Water is removed by gravity flow and micro vacuum.

This is the table rolls which is so, due that the while the wire part we are having the number of table rolls which is supporting the wire part. So, firstly to support the wire part and to create vacuum at outgoing nip, this tends to pull water from the web. Water is also removed by surface tension. Water is removed by gravity flow and the micro. These are the some of the actually the separation that is taken place because of this surface tension, it may be the gravity flow or the micro vacuum.

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Suction Boxes

Water which cannot be removed by Table rolls is removed by mild vacuum through series of Suction boxes (3-7 nos.). These boxes are connected with a vacuum pump. The suction boxes remove a good part of the remaining water, at the same time, compact the sheet.

Suction boxes because there we are applying the vacuum for removal of the remaining water because 100 percent removal that may not be possible. So, we need this vacuum for removal of the remaining water in case of this. So, suction boxes numbers that again may vary, these boxes are connected with a vacuum pump. The suction boxes remove a good part of the remaining water, at the same time compact the sheet.

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Suction couch roll

- About 2-3% water is removed by suction couch, where high vacuum is applied (12 – 15" Hg).
- A lump breaker roll is normally used to make the sheet more compact. When web leaves the couch roll, it carries about 18-2 dryness.

Suction couch about 2 to 3 percent of water is removed by suction couch where, high vacuum is applied. A lump breaker roll is normally used to make the sheet more compact. When web leaves the couch roll, it carries about 1.8 to 2 dryness that is there.

The next step is the press part. The next step is to remove the moisture from the web by mechanical means by process of pressing the web that is the formation of the sheet which we are getting after distribution of wire part that we call it the web process of pressing the web without affecting the quality of the paper and board. So, the now earlier we used to have the wooden spare parts of putting the paper now, we are having the synthetic felts because this felts which we are using for supporting that is very important then, lot of the development that has taken place in that because the quality of the that is also affecting the smoothness of the paper.

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Press Part

- Three types of presses are normally used: Plain Press, Suction Press and Reverse Press In plain press, water is removed by mechanical pressing and suction vacuum.
- Other modern presses are grooved press, unipress, trinip press etc.
- The felts are used for carrier of water between stonite and Rubber rolls. As the paper web leaves the press section, it carries about 35-40% solids

Three types of the process are normally used: plain press, suction press and reverse press. Other modern presses are grooved press, unipress, trinip press. So, these are the some of the developments that has taken place in the case of the press part. I was telling about the felts, are used for carrier of the water is between stonite and rubber rolls. As the paper web leaves the press section, it carries about 35 to 40 percent of the solid. So, rest of the moisture that is being removed in the dryer part. So, that is also giving the support.

Now, come to the dryer part of the machine because that is the very important and continuous because the wire part transfers of the wire part to the press part and press part to the dryer part that is the continuous operation is there. So, the continuous running of the any blockage that will affect the whole running of the machine and lot of the losses are incurred when the breakage of the paper is there due to some or other reason.

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Dryer Part

- Web leaving the Press section, contains 35-40% solids. The remaining water from the web is removed by steam dryer.
- In drying, the sheet is passed round the cylinders and held in intimate contact with the heated surface by means of dryer felts.

So, web leaving the press section contains 35 to 40 percent solid. The remaining water from the web is removed by steam dryer. In drying the sheet is passed round the cylinders and held in intimate contact with the heated surface by means of dryer felts. Here, also in case of the dryer we are using the felts for supporting the paper where, by use of the steam we are drying the moisture is removed and finally, the paper is ready for the use.

The number of cylinders and its arrangement in various sections is determined by the following factors which I told you the basis weight of the sheet because we called it the basis weight, means the weight of the 1 square meter of the paper. So, gram weight of the paper sometimes, the very common word gram weight of the paper, weight of the water to be evaporated, speed of the machine, pressure of the steam in various section, any fluctuation in the quality of the steam that will also affect these. So, these are the some of the parameters which affect and the requirement in case of the good running of the good working of the dryer.

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Dryer Part

- The number of cylinders and its arrangement in various sections is determined by the following factors basis weight of sheet, weight of the water to be evaporated, speed of the machine, pressure of steam in various sections.
- The dryer sections are divided in 4-5 groups, depending on size of machine.

The dryer section are divided in 4-5 groups depending upon the size of the machine because the dryer part is less in case of the Yankee but, in case of the Fourdrinier machine or the board machine that dryer part that may be longer dryer part that may be required.

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Dryer Part

The number of cylinders and its arrangement in various sections is determined by the following factors

- Basis weight of sheet
- Weight of the water to be evaporated
- Speed of the machine
- Pressure of steam in various sections.

So, this a remaining portion as I told you in the dryer part that we are remembering. In the conventional method of drying the sheet is pass around the cylinder and held in the intimate contact with heated surface and the number of the cylinders which I told you

these are the factors- the basis weight of the sheet, weight of the water to be evaporated, speed of the machine and pressure of the steam in the various sections.

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The Yankee Cylinder

- The Yankee Cylinder is a large drying cylinder generally of 12-18 ft diameter.
- It has a very high polished surface, against which the sheet is pressed by one or more press rolls. The drying cylinder is generally unclothed.
- The Yankee Cylinder was developed to impart a high smooth finish to one side of sheet. Hence the term “Machine glazed” or MG Paper applied to paper.

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Calendaring

- After the sheet is dried, it is passed through a stack of heavy metal rolls, where it is calenderised under high pressure.
- The purpose of calendaring is to smooth down the felt and wire marks, to remove cockle and to level off lumpy formation and to make sheet of uniform caliper.

Now, come to another development that the some of the machine they are having. The Yankee cylinder which is called this is a large drying cylinder generally 12 to 18 feet, large diameter is there and it is the single dryer part is there. It has the very high polished surface also against which the sheet is pressed by one or more press the drying cylinder is generally unclothed. The Yankee cylinder was developed to impart a high smooth

finish to one side of the sheet hence the term machine glazed or MG paper applied to the paper.

Calendaring, sometimes this calendaring that is very important, after the sheet dried it is passed through a stack of heavy metal rolls, where it is calendared under high pressure, calendaring effect due the calendaring effect the smoothness is there. The purpose of the calendaring is to smooth down the felt and wire parts and to remove the cockle and to level off the lumpy formation and to make the sheet of uniform calliper because that is very important in case of these.

So, that is smoothens the surface of the paper. Finally, the paper which is made that is going to the reeling section, a final paper and board having umm because some inherent moisture will be always there and the paper but, lower moisture always cannot remove 100 percent this is the requirement sometimes the you find the moisture in the paper you see the moisture obviously, always there sometimes, even the xeroxing machine you will be finding there the sometimes problem is there and the normally they say that this is the waste paper and because of that the problem is there so, the final paper some moisture will be there.

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Reeling

The final paper and board having moisture of 4 - 6 % is reeled on pope reeler. The empty shell on which paper and board of reeled rests on the drum and driven round by virtue of the surface friction between them. The full roll of paper or board is removed by crane for rewinder / cutter.

The empty shell on which the paper and board of reeled sheets rests on the drum and driven by the virtue of the surface friction between the full roll of the paper or board is removed by crane or rewinder because the one roll huge amount of the that is rewinded

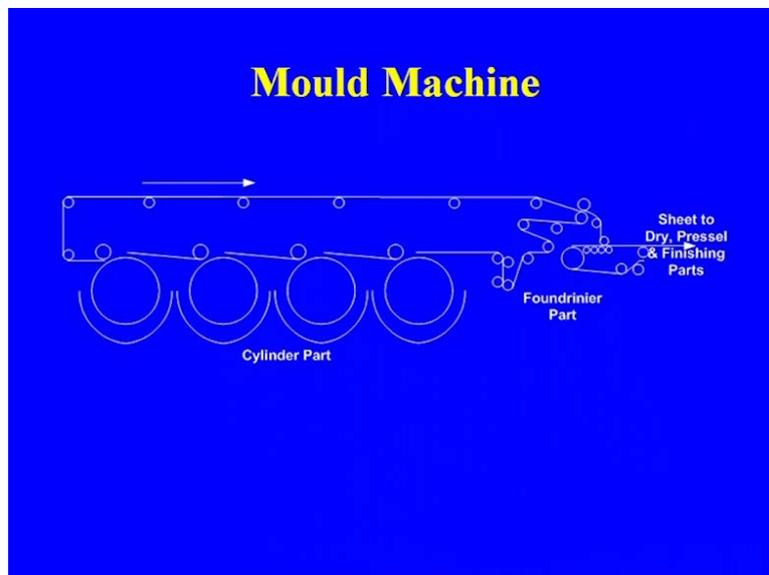
so, that has to be removed by crane. This is another development in case of when we are using making the triplex or duplex board.

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Cylinder Mould Machine

- Cylinder Mould Machine differs from Fourdrinier machine by replacing Fourdrinier wire part by cylinder mould part.
- Cylinder machine make use of cylinder structure which supports the forming wire mesh.
- Stock is supplied to the outside of the rolls. This is used for making paper board.

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So, the cylindrical mould machines we are using here. Cylindrical mould machine differs from the Fourdrinier machine by replacing the Fourdrinier wire part by a cylindrical mould and the mould that is being used and where the mesh formation is there. Cylindrical machine made use of the cylindrical structure which supports the

forming wire mesh. Stock is supplied to the outside of the rolls this is used for making paper board.

So, this is a typical board so, web here actually this is the pulp slurry is there and this will be the transfer of the pulp sheet, that is the web paper that is on the felt and continuously because if you want to increase the in 2 mould that will be different type of the pulp here. So, 2 layers of the pulp that will be made because one layer here again I can another layer that may be so, it may be 4 to 6 cylinders that may be there and finally, the board or the paper that that will go for the drying purpose. So, uniflow cylinders that may be there, counter flow cylinders that may be there so, both the type of the mould cylinder that we are using.

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Cylinder Mould Machine

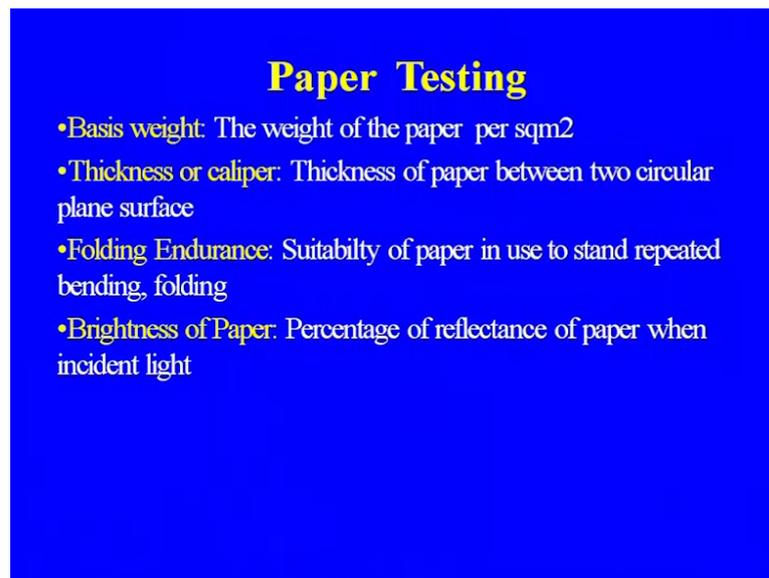
- In the mould machine, the stock is picked up on a wire covered cylinder mould and then transferred to a felt which carries it to the next cylinder mould.
- This process is repeated until a multiply board of several ply's is obtained.
- From cylinder mould, the board passes to the same stages as that of Fourdrinier machine, i.e., Press section, Dryer section, Calendar and Reeler etc.

In mould machine, the stock is picked up on the wire covered cylinder mould and then transferred to a felt which carries to the as I told you the on the felt on the wire mould machine the felt that is continuously taking the web part of the pulp and that is transferred from one cylinder to another cylinder.

This process is repeated until a multiplied multiply board of the several ply's is obtained that is what needed duplex board triplex board. From the cylinder mould the board passes to the same stages as that of the Fourdrinier machine that the press section, dryer section and the calendar section and the reeler section. These are the let us come to the final part of the because as I told you the earlier that the paper making is a art. Quality of

the paper that is totally depending upon the calibre of the people who are there, smooth running of the machine, quality of the paper so some of the test which are very important for the day to day variation day to day because the quality that is being strictly monitored by the consumers also because normally the paper to the stock holders is going to they are controlling these parameters.

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Paper Testing

- **Basis weight:** The weight of the paper per sqm²
- **Thickness or caliper:** Thickness of paper between two circular plane surface
- **Folding Endurance:** Suitability of paper in use to stand repeated bending, folding
- **Brightness of Paper:** Percentage of reflectance of paper when incident light

Because sometimes suppose, you take the first basic weight. The weight of the paper per square meter if the variation the weight is there their requirement is 60GSM, if the uniformity of the GSM is not there definitely, the total weight tonnage in terms of the weight they will be losing and so, this is the what why the basis weight the gram and the normally writing paper that is around 50 to 60 GSM, tissue paper that is below 30, board paper that may be 300, 400 GSM. Thickness or calliper that is the thickness of the paper between two circular plane surface that we are measuring and thickness that is very important.

Folding endurance that is required for the board because that the suitability of the paper in use to stand repeated bending or the folding because suppose the board is there and if you are folding it, it should not crack that is the basic requirement in case of the many packaging.

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Paper Testing

- **Basis weight:** The weight of the paper per sqm²
- **Thickness or caliper:** Thickness of paper between two circular plane surface
- **Folding Endurance:** Suitability of paper in use to stand repeated bending, folding
- **Brightness of Paper:** Percentage of reflectance of paper when incident light

Brightness of the paper- percentage of the reflectance of the paper when incident light is following, brightness of the paper as I told you earlier while bleaching there has been lot of the Improvement in the bleaching because now, our requirement of the bright high brightness paper is there.

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Paper Testing

Bursting strength: It is used as measure of resistance to rupture

Tensile strength: it is measure in terms of force per unit width requirement to break specimen and the percentage elongation at break

Breaking length: it is strength to weight ratio indicating length of strip of paper to cause strip to break under its own weight

Bursting strength it is used to measure the resistance to rupture. Tensile strength it is measure in terms of the force per unit width requirement to break specimen and percentage elongation at the break this is from the tensile because all we are having the

different machine for measuring different property. Breaking length- it is the strength to weight ratio indicating length of the strip of the paper to cause strip to break under its own weight. So, these are the some of the properties they are very important in case of the board or the white paper.

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Paper Testing

Breaking length: It is strength to weight ratio indicating length of strip of paper to cause strip to break under its own weight

Tear Factor: this is the ratio of tearing strength to basis weight

Cobb Test (for packingmatter): The test is useful in determining the the ability of packing paper to protect the contents of the package from dampness

Breaking length it is strength to weight ratio indicating the length of the strip of the paper. Tear strength- this is the ratio of the tearing strength to basis. Cobb test for packing materials, the test is useful to determine the ability of the packing material to protect the contents of the package from the damage. So, these are the some of the properties required for the testing and the closely it is being monitored in the paper mill itself and at the consumer end also because the all the big dealers they are continuously monitoring the quality of the paper, any variation in the quality that is going to affect the end users of the paper. So, this was the brief about the paper making process, how the paper from the pulp from the chips to conversion of the forest raw materials starch, the bagasse, the final paper making.