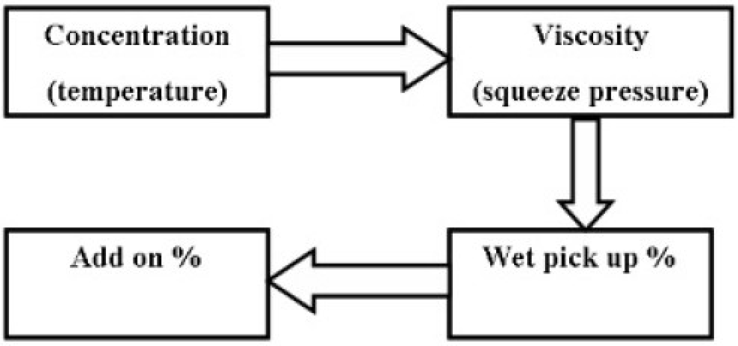
Sizing Diagram

Figure presents the schematic relationship between the concentration of size paste and final add-on% of size on the yarn.



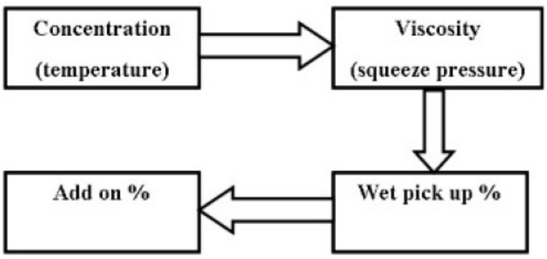
Sizing Diagram

At a given temperature, concentration of size paste determines the viscosity.

For a given yarn, squeeze pressure and sizing speed, viscosity of size paste determines the wet pick-up.

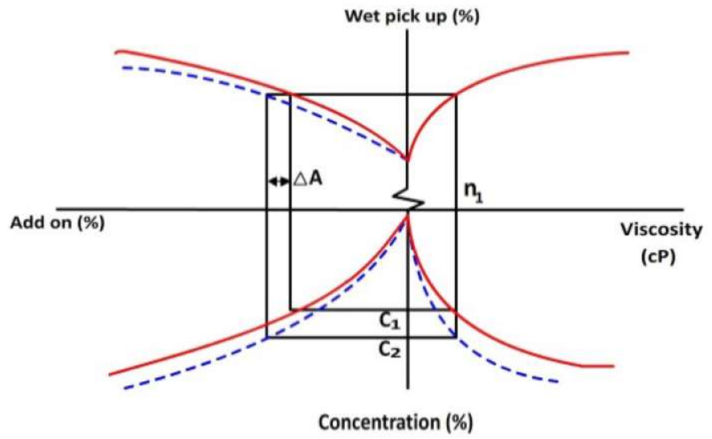
Wet pick-up determines the add-on.

For a given concentration of size paste, higher wet pick-up leads to higher add-on and vice versa.



Sizing Diagram

Figure depicts the relationship among concentration, viscosity, wet pick-up and add-on.



Sizing Diagram

Thin boiling starch requires higher level of concentration, than the normal starch, for the same level of viscosity.

Therefore, even if the wet pick-up is same, add-on will be higher (due to higher concentration) for thin boiling starch.

Besides, for the same level of add-on, wet pick-up will be less for thin boiling starch.

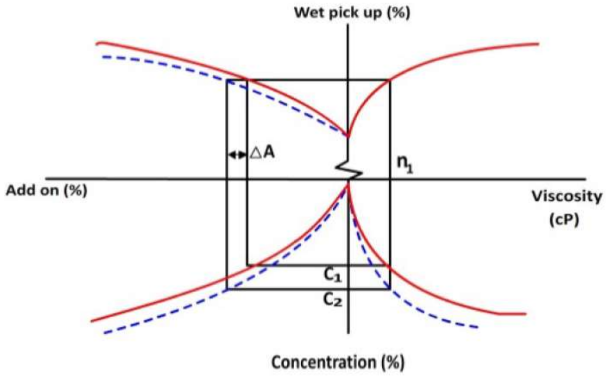
Therefore, water evaporation during drying will be lower for thin boiling starch as compared to normal starch.

This will lead to energy saving in case of sizing with thin boiling starch.

Sizing Diagram

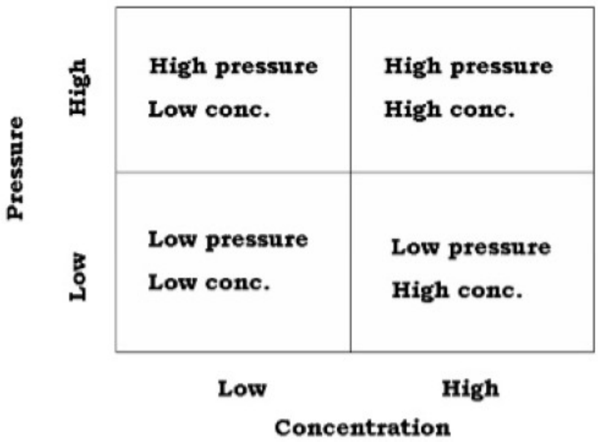
It can be seen that thin boiling starch requires higher concentration (C2) than normal starch (C1) for creating the same level of viscosity (η1).

Now, add-on will be higher for the thin boiling starch (ΔA) even at the same level of wet pick-up (W1).



Sizing Diagram

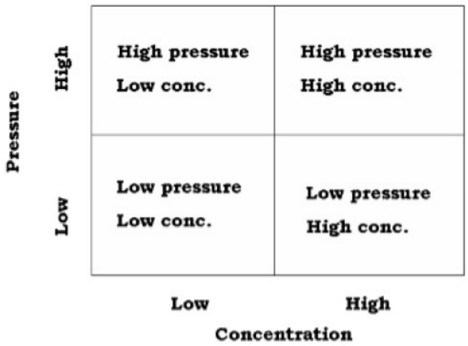
The modern sizing practice recommends the use of high concentration (which results in high viscosity) of size paste and high squeezing pressure



Sizing Diagram

High pressure and high viscosity combination is preferred as high pressure reduces the wet pick-up and high concentration ensures that targeted add-on will be attained with minimum water evaporation.

Low concentration and high pressure will give the minimum wet pick-up.



Sizing Diagram

Example: The targeted add-on is 10 % and oven dry mass of supply warp sheet is 100 kg.

If the concentration is 20% then high pressure can be used to achieve wet pick-up of 50 kg. Then in the drying section 40 kg water will be evaporated to get the target add-on of 10%.

In contrast, if the concentration is 10% then low pressure can be used to achieve wet pick-up of 100 kg. Then in the drying section 90 kg water will be evaporated to get the targeted add-on of 10%.

This obviously requires more energy consumption during drying.

Crowning of Top Roller

High pressure squeezing is used to reduce the load on the drying system.

In modern sizing machine, the squeezing force can go up to the level of 100,000 N.

This force is applied on the two sides of the metallic core of top squeeze roller.

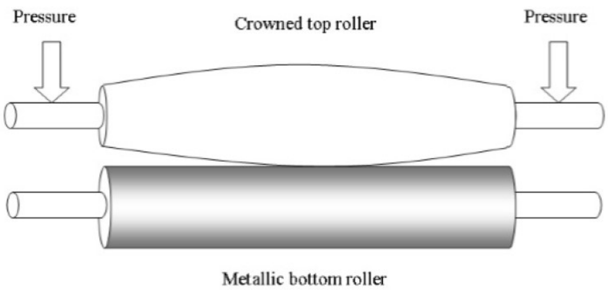
This pressure is good enough to cause bending in the top squeeze roller which may result uneven pressure along the nip line.

Crowning of Top Roller

To overcome this problem, crowned top rollers are used.

The synthetic rubber coated surface of the top squeeze roller is subjected to grinding operation so that the diameter at the sides is lower as compared to that of at the middle

This is compensated by the bending of the top rollers and uniform pressure is obtained along the nip line.



Percent Occupation and Equivalent Yarn Diameter

The relative closeness of the yarns inside the size box is expressed by percentage occupation and equivalent yarn diameter.

100% occupation means that yarns are physically touching each other.

The number of yarns with 100% occupation can be calculated approximately if nominal yarn diameter is known.

Equivalent yarn diameter indicates the space between the two yarns in terms of yarn diameter.

Percent Occupation and Equivalent Yarn Diameter

If equivalent yarn diameter is zero that means that the yarns are touching each other i.e. 100% occupation.

Figure depicts the situation with 100% occupation and with 50% occupation

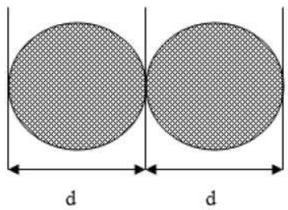


Figure 4.26: Yarn arrangement for 100% occupation

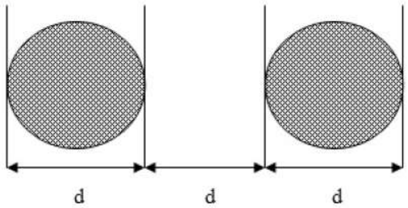


Figure 4.27: Yarn arrangement for 50% occupation

Percent Occupation and Equivalent Yarn Diameter

$$\text{Percent occupation} = \frac{\text{Actual number of yarns in the warp sheet}}{\text{Number of yarns in the warp sheet with 100\% occupation}}$$

The percent occupation and equivalent yarn diameter are related with the following expression.

$$\text{Percent occupation} = \frac{100}{1 + \text{Equivalent yarn diameter}}$$

If the percent occupation is very high then the yarn may not be uniformly coated by the size film. For warp sheet having very large number of yarns, it may be preferable to use two size boxes to keep the percent occupation value within permissible range.

Drying Zone

The wet yarns are dried by evaporating the water from the size paste.

The drying operation is very crucial because

✓ It consumes most of the energy of sizing process

✓Inadequate drying will cause sticking of yarns with one another causing problem in weaving

✓Over-drying will make the size film brittle and therefore they may fall apart by minimum abrasion.

Drying Zone

Drying is done by passing the warp sheet over large number of drying cylinders, coated with Teflon (poly tetra fluro-ethylene), arranged in sequential manner.

The number of drying cylinders can vary from 2 to 30 depending on the amount of water to be evaporated in unit time.

In general, higher speed of sizing would require more number of drying cylinders.

Drying Zone

The following expressions are useful for calculating the mass of water to be evaporated during drying.

$$\text{Mass (kg) of water to be evaporated per unit oven dry mass (kg) of yarn} = \left(\frac{\text{Add on \%}}{\text{Concentration \%}}\right) - \left(\frac{\text{Add on \%}}{100}\right)$$

The first part of the expression yields wet pick-up.

If the mass of dry size is subtracted from the wet pick-up then the amount of water to be evaporated can be obtained.

The above equation presumes that there is no residual moisture in the sized yarn after drying.

Drying Zone

But, for the running machine it is more important to calculate the mass of water to be evaporated in unit time (minute).

This will be depending on the following factors.

✓Sizing machine speed

✓Total number of yarns

✓Linear density of yarns (tex)

✓Add-on %

✓Concentration %

Drying Zone

The mass of yarn passing through the machine per minute can be expressed as follows:

$$= \frac{\text{Sizing machine speed (m/min)} \times \text{Total number of yarns} \times \text{tex}}{1000 \times 1000} \text{ kg}$$

The mass of paste picked up by the warp sheet per minute will be

$$= \left(\frac{\text{Sizing machine speed (m/min)} \times \text{Total number of yarns} \times \text{tex}}{1000 \times 1000} \times \text{wet pick up} \right) \text{kg}$$

$$= \left(\frac{\text{Sizing machine speed (m/min)} \times \text{Total number of yarns} \times \text{tex}}{1000 \times 1000} \times \frac{\text{add on \%}}{\text{concentration \%}} \right) \text{kg}$$

The mass of water to be evaporated per minute will be

$$= \frac{\text{Sizing machine speed (m/min)} \times \text{Total number of yarns} \times \text{tex}}{1000 \times 1000} \times \frac{\text{add on \%}}{\text{concentration \%}} \times \left(1 - \frac{\text{Concentration \%}}{100} \right) \text{kg}$$

Drying Zone

For the same level of size add-on, more water has to be evaporated if the size paste concentration is low.

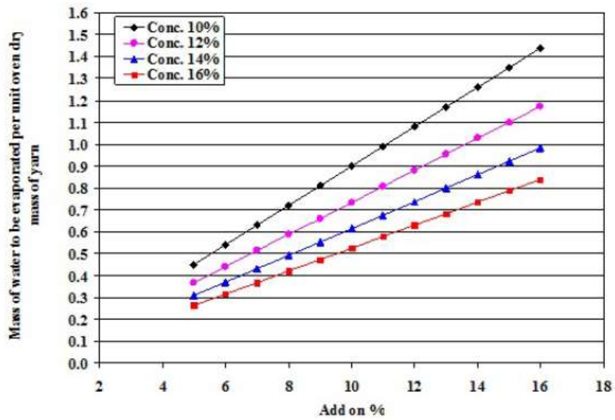


Figure 4.28: Effect of add-on% and concentration % on the amount of water evaporation

Methods of Drying

The methods of drying in sizing process can broadly be divided in two categories.

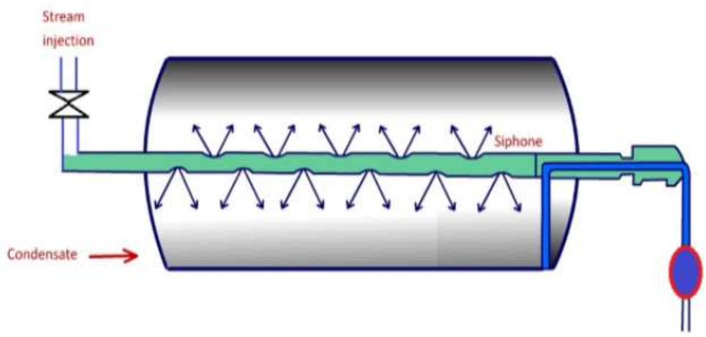
✓Conduction method

✓Convection method

Methods of Drying: Conduction method

Warp sheet is passed over a metallic cylinder which is heated by using superheated steam.

High efficiency, but only one side of the warp sheet is exposed to the heated cylinder at a time.

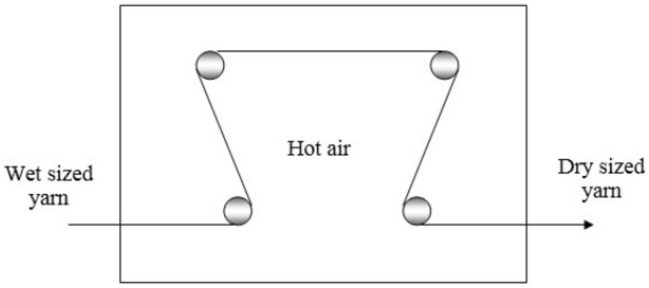


Methods of Drying: Convection method

Hot air is circulated within an enclosed chamber and the warp sheet passes through the chamber

Uniform drying by exposing both sides of the warp sheet to the hot air

However, poor efficiency

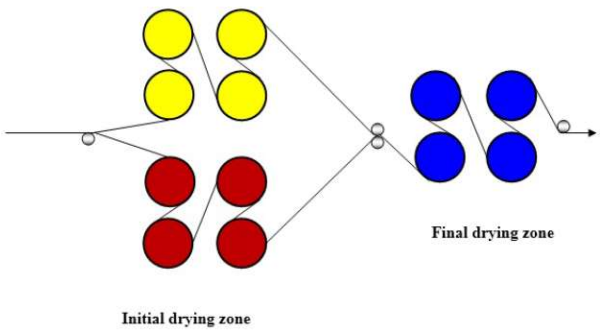


Methods of Drying

To ensure better drying and reduction of load on individual cylinders, the wet warp sheet is often splitted into multiple sheets.

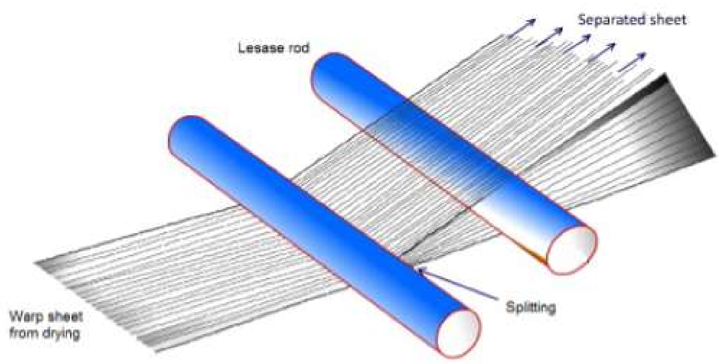
Each sheet is then dried by a separate group of drying cylinders

The initial drying is generally done at lower temperature.



Splitting

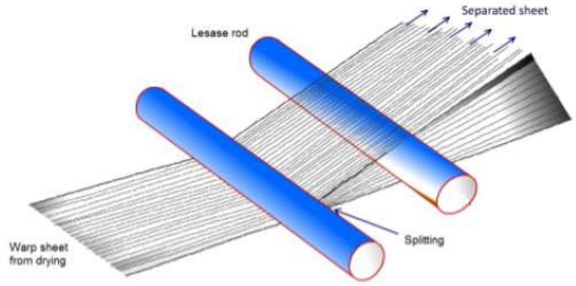
After drying, the warp sheet is splitted so that the yarns regain their individual identity before they are wound on the weaver's beam.



Splitting

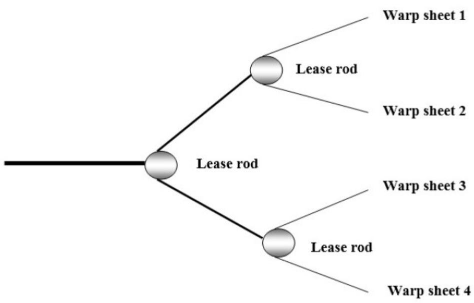
Splitting is required because warp sheet coming out of the drying section adhere to each other depending on the efficiency of the pre-drying section.

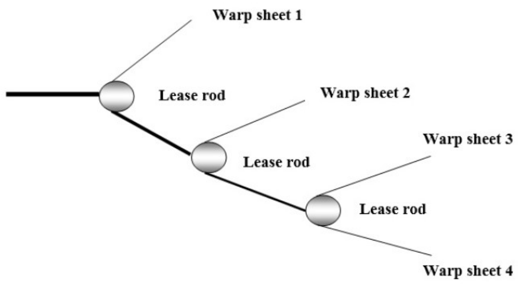
Lease rods which are often coated with chromium are used to split the warp sheet in a systematic manner



Splitting

Figure depicts different situation when the lease rods split the incoming warp sheet into equal parts.



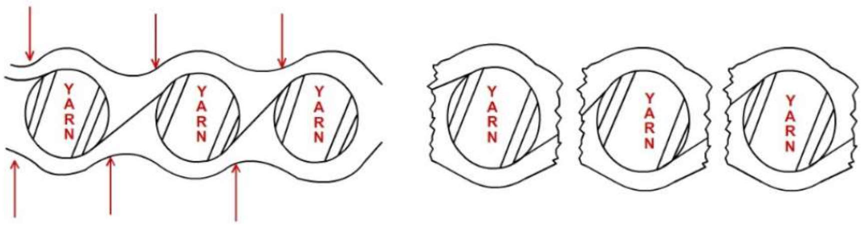


Splitting

During the splitting some amount of size film would be dropped as waste.

However, a large number of longer fibres, bridging two adjacent yarns would also get broken into smaller pieces.

Therefore, splitting is considered to have some beneficial effect from hairiness viewpoint.



Beaming

After the splitting, the warp sheet is finally wound on the weaver's beam.

The warp sheet passes through an adjustable reed which can be expanded or collapsed based on the width of the beam.