



**IPPTA**  
Indian Pulp & Paper Technical Association

## Crash Course on Papermaking For Non-paper Maker

# Papermaking at a glance – Bird's view

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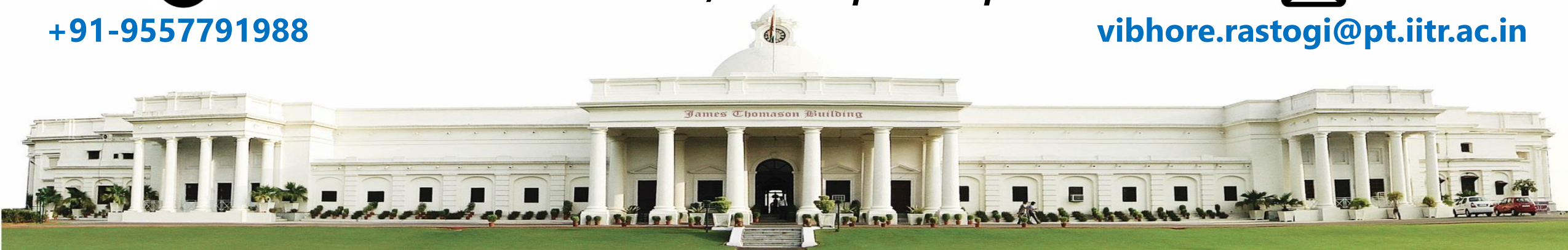
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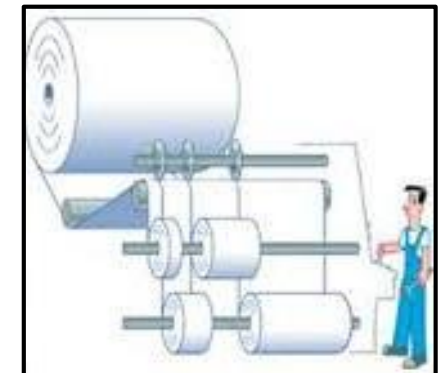
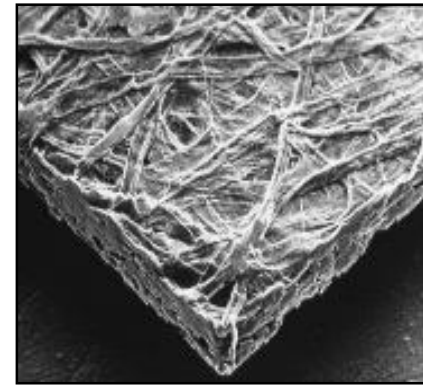
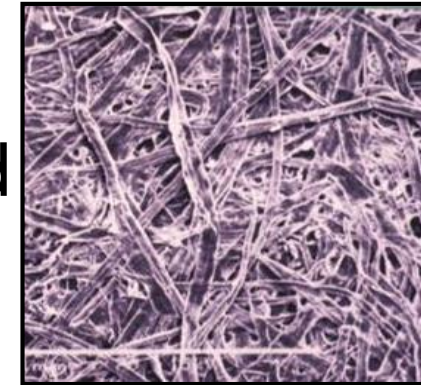


# Content

- Definition of paper
- Cornerstones of paper technology
- Invention of paper
- Integrated paper mill
- Non-Integrated paper mill
- Forming, pressing, drying, calendering of papers
- Cleaning of wire and press felt
- Paper machine general safety
- Recent trends in paper mill

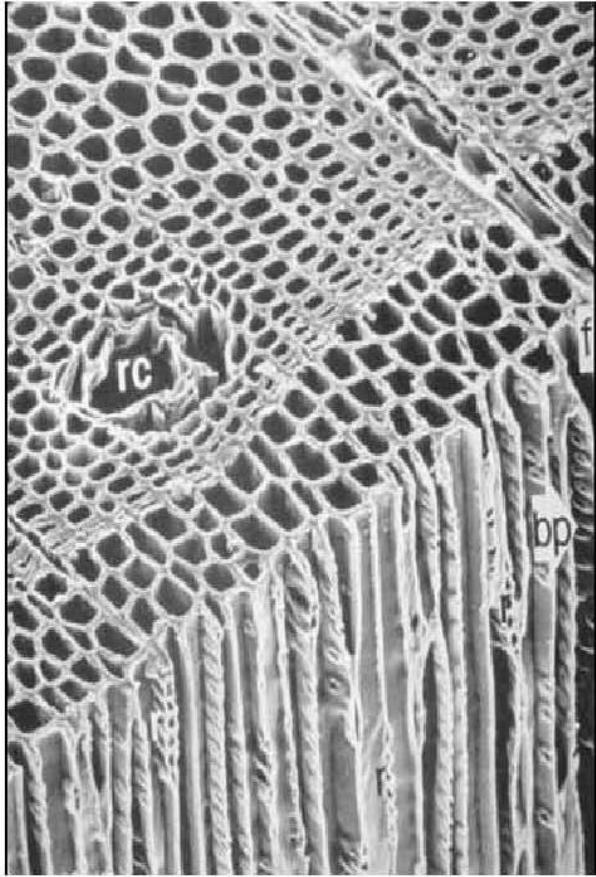
# What is a paper?

- A felted sheet, typically made from natural fibers
- By its macroscopic structure: 2-dimensional material
- By its microscopic structure: 3-dimensional material composed of nearly randomly oriented fibers with hydrogen-bonded joints that confer visco-elastic properties
- Produced through a roll-to-roll manufacturing process from a water suspension



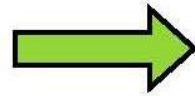


# The Papermaking Process



Wood

Separation  
of fibres



Dilution  
In water

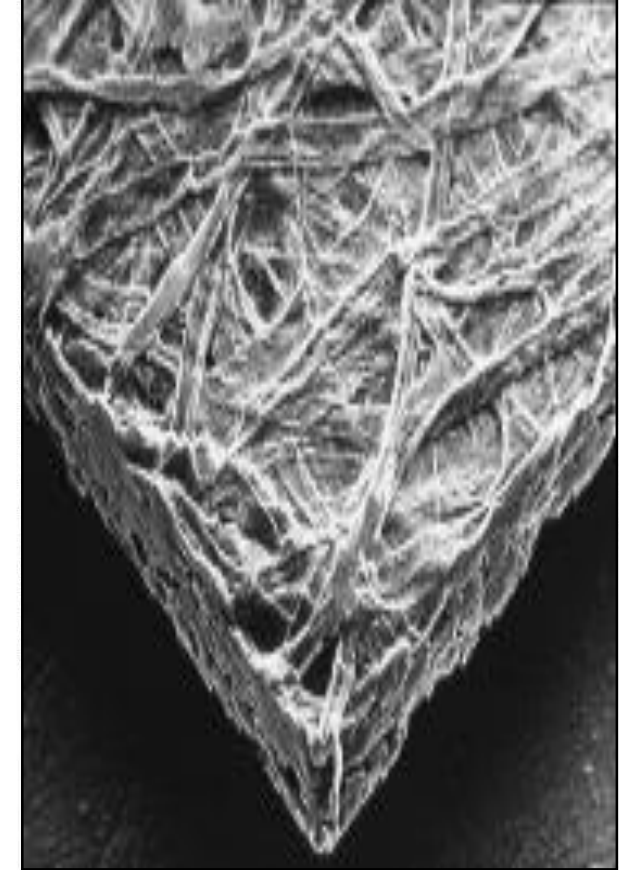


Fibres

Forming  
of web

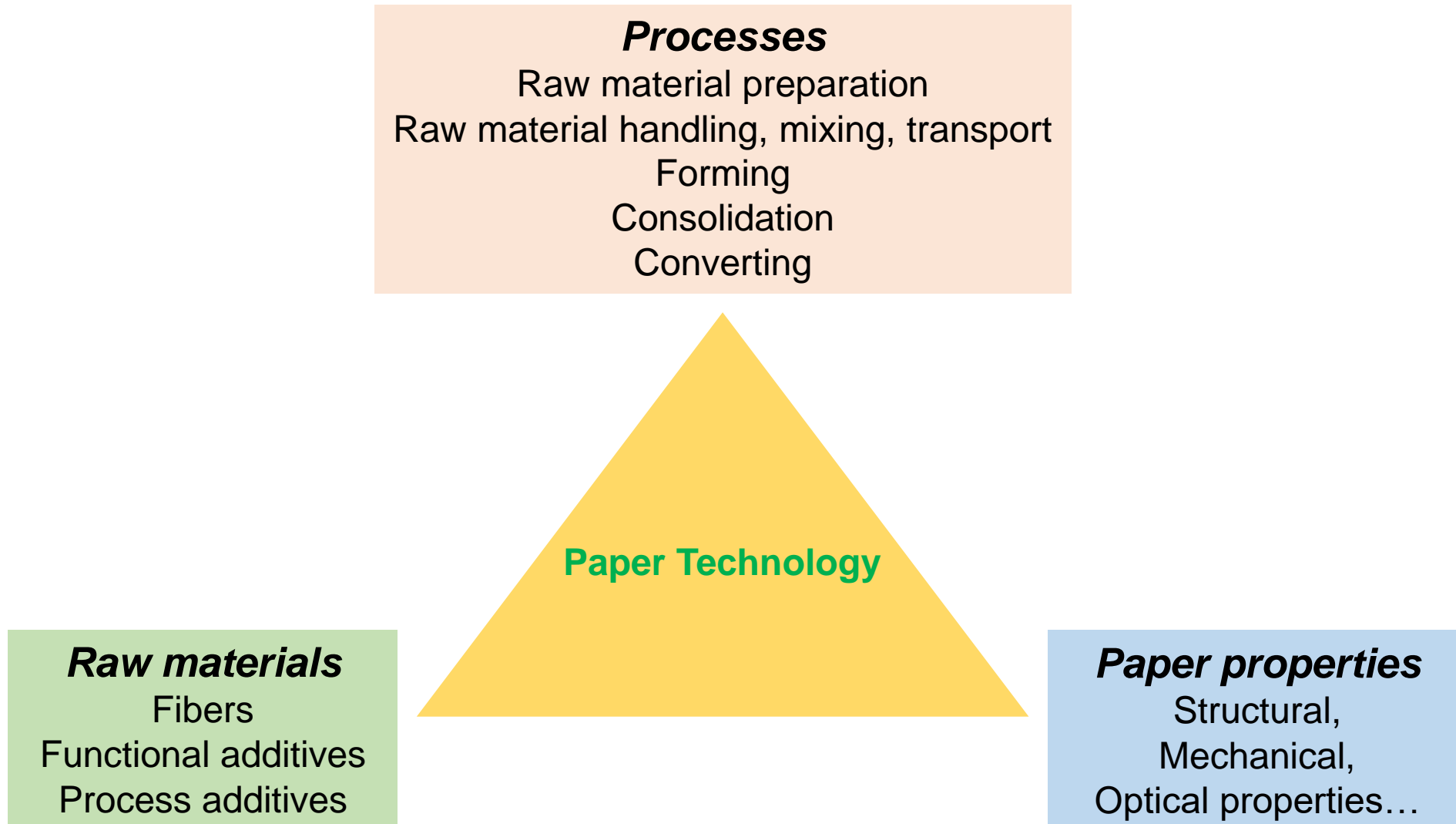


Removal  
of water



Paper

# Cornerstones of Paper Technology





# Why was paper invented?

Man has a deep and basic need to communicate!

Painting on walls



Leaves, bark and wood (*light-weight writing materials*)

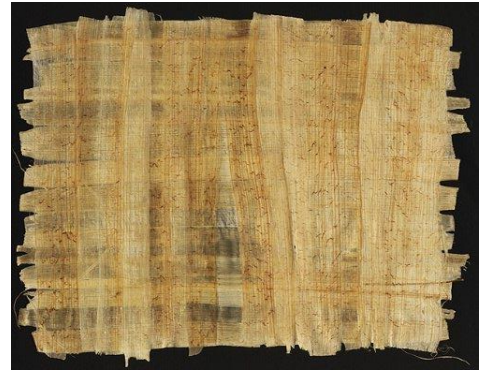


Clay Tablets



# Precursors to modern paper: Papyrus

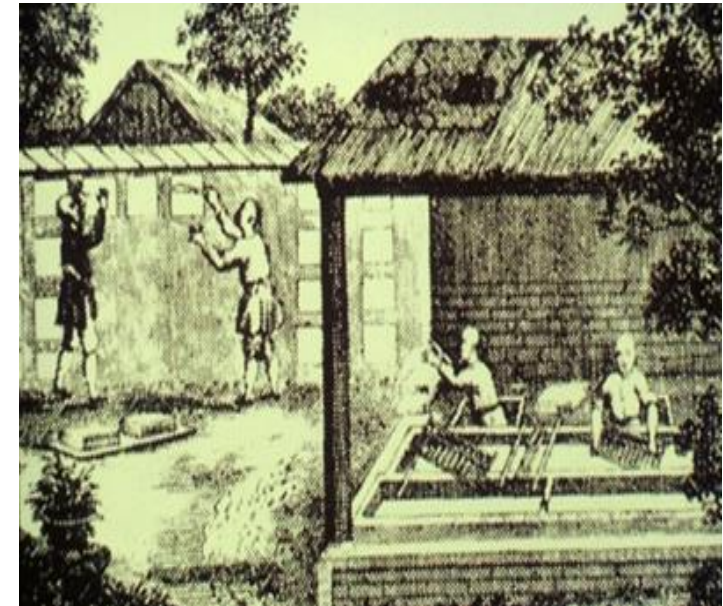
- Word *paper* derived from *papyrus* (Egyptian invention)
- The inner core of the stem of a reed plant (Cyperous Papyrus) was cut into longitudinal thin strips, softened, layered at right angles and then pressed to form a sheet
- The sheet so formed was finally hammered, dried in the sun, and smoothened by polishing with a shell or a stone
- Papyrus used extensively by the Greeks and Romans
- Although Papyrus is in sheet form it resembles plywood more than paper





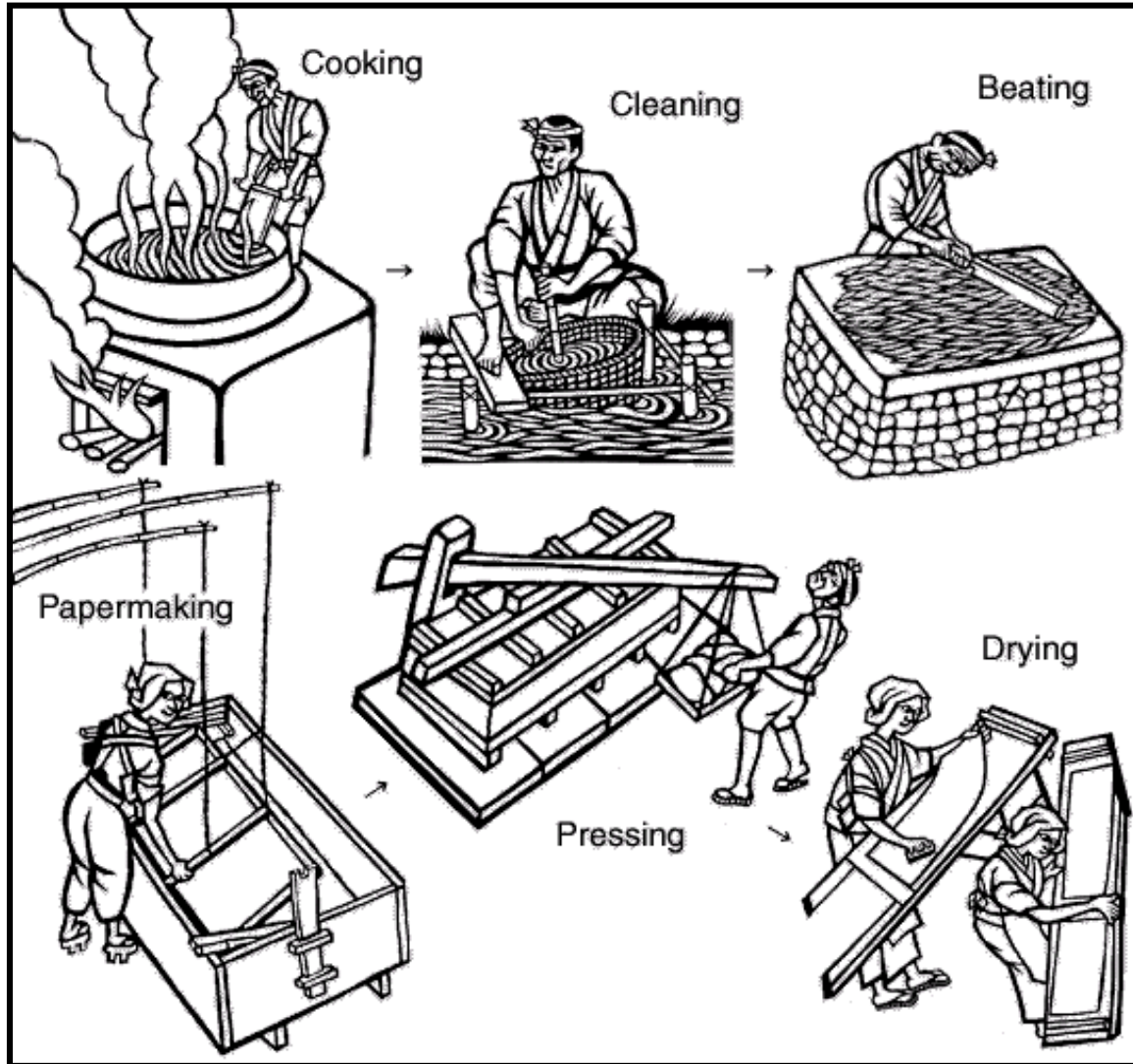
# Invention of Paper: 105 A.D.

- *Cai Lun*, a Chinese, experimented with many materials (hemp, mulberry) & developed process of macerating/softening plants to liberate fibers
- To make paper, fibers were mixed with water in a large vat. A screen was submerged in the vat and lifted up through the water, catching the fibers on its surface
- When dried, this thin layer of intertwined fiber became what today we call paper
- The secret stayed in China for centuries, but was smuggled to Europe by Arab traders sometimes after the 10<sup>th</sup> century





# Hand made Paper in Asia: Video



# Paper Making: Integrated Paper mill

## Steps Involved in Integrated Paper Mill:

1. Debarking

2. Chipping

3. Pulping

4. Washing

5. Bleaching

6. Refining

7. Blending

8. Forming

9. Pressing

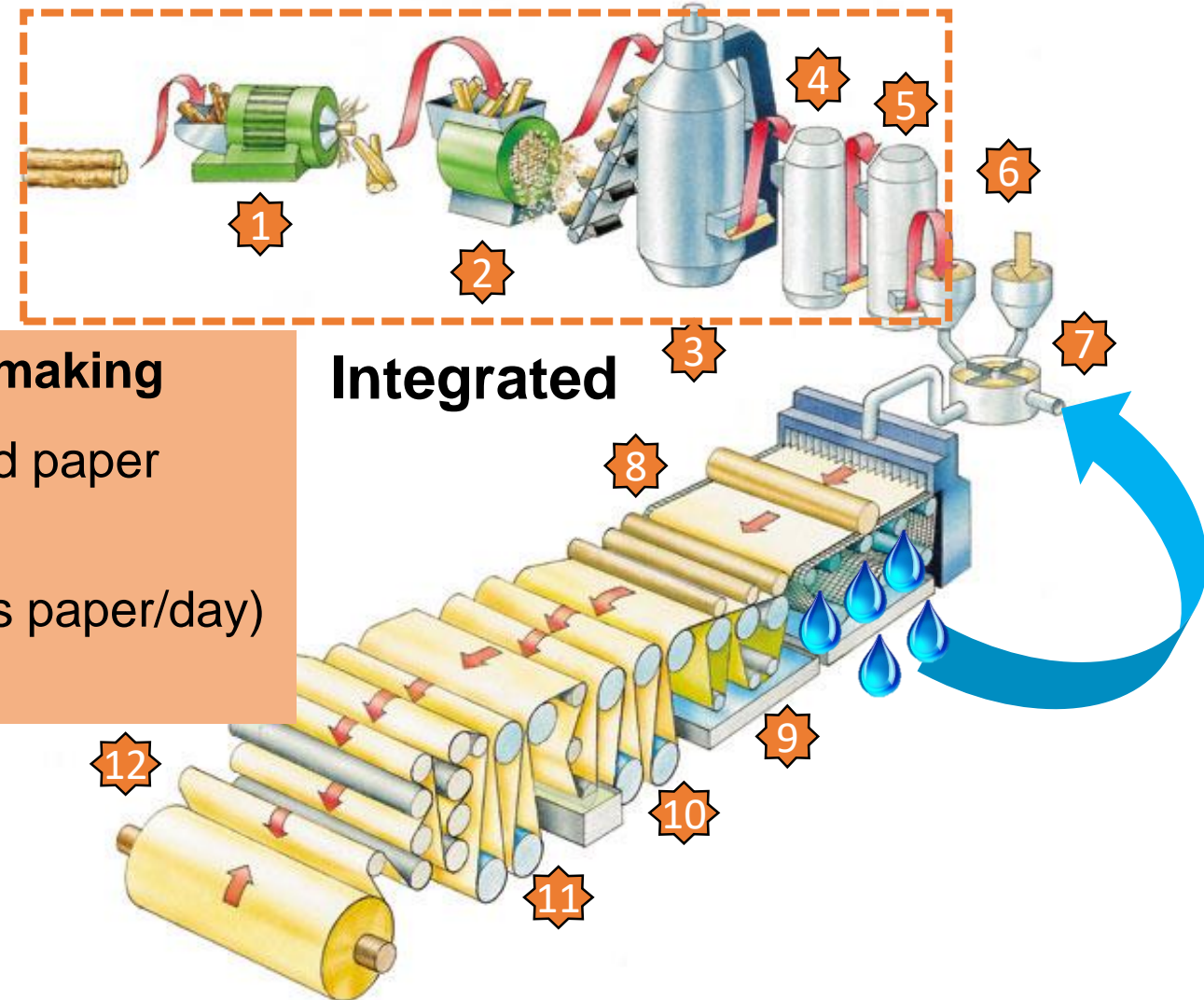
10. Drying

11. Calendering

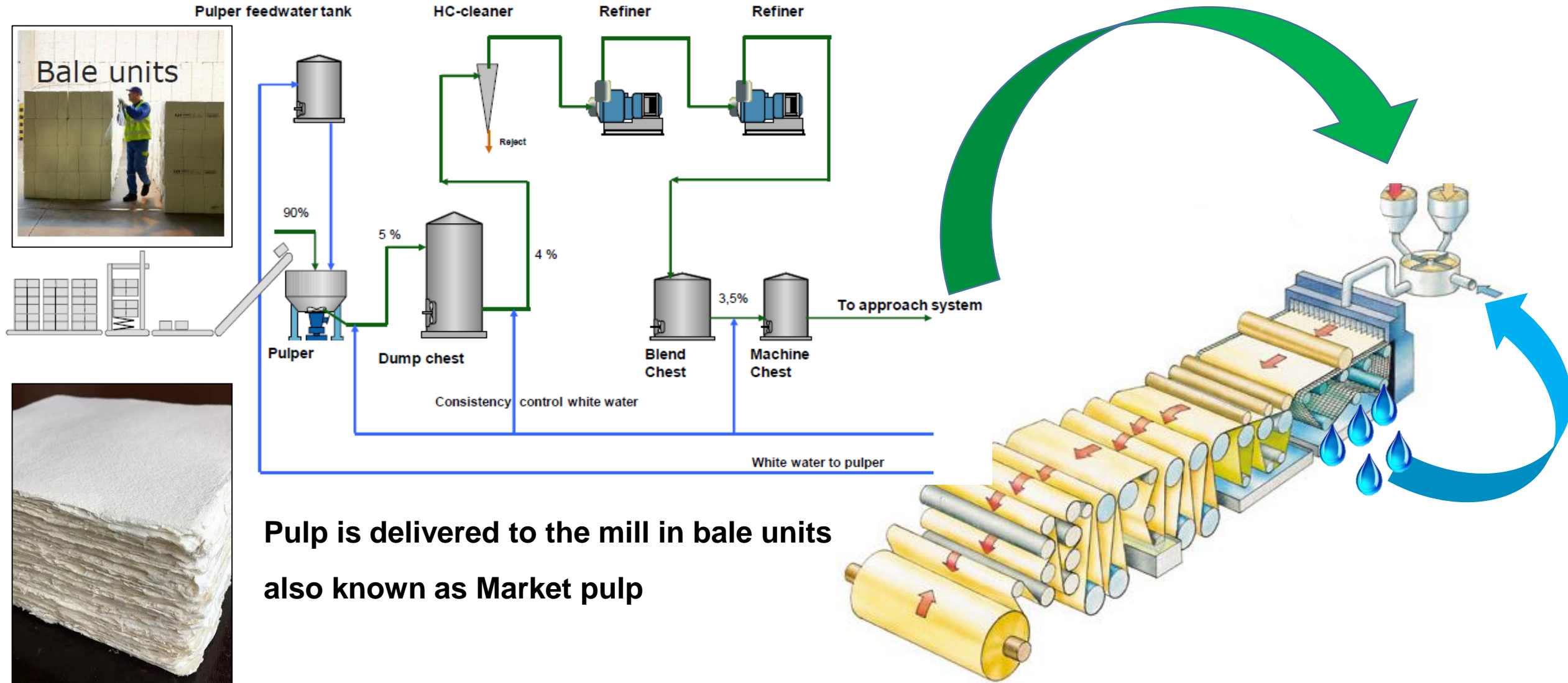
12. Winding & Trimming

### Objectives of Paper making

- Good formation and paper properties
- High Capacity (tons paper/day)
- Low cost



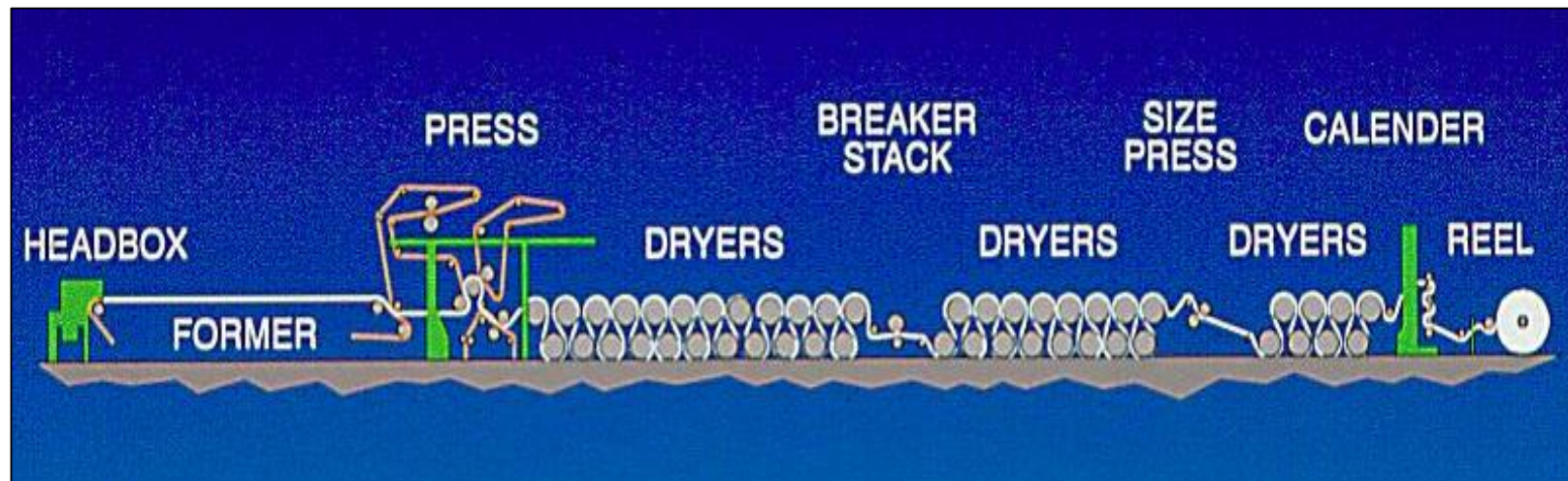
# Paper Making: Non-Integrated Paper mill





# Paper Manufacture


- The steps are as follows:
- **Forming** - applying the pulp slurry to a screen/wire through headbox, and allowing water to drain by means of a force such as gravity or a vacuum
- **Pressing** - further dewatering by squeezing water from the sheet
- **Drying** - air drying or drying of the sheet over a hot surface



Fourdrinier Paper Machine

# Headbox or Flow-box Video

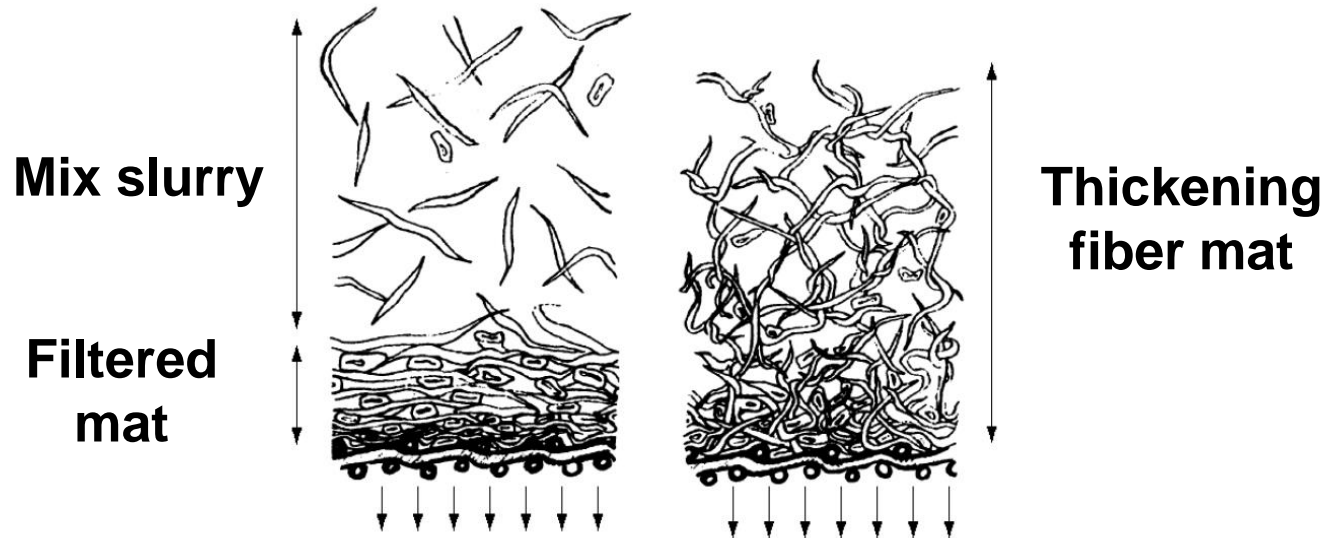


 This is an excerpt from our **Air-Padded Headboxes** training module.

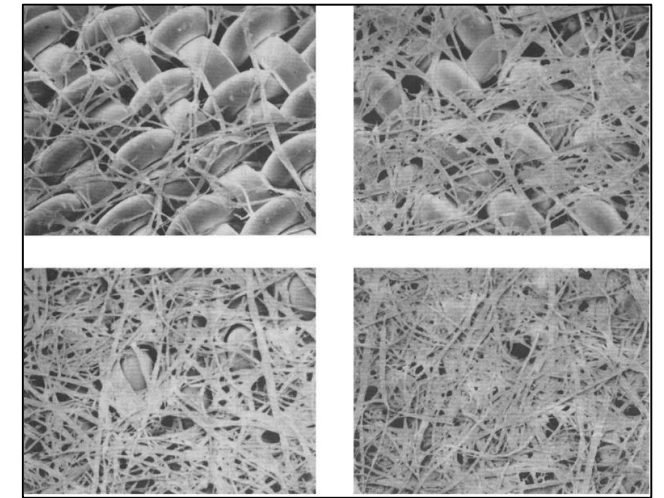
[https://www.youtube.com/watch?v=FIUSQmH0Xvc&list=PLkcz0bP31BHEKXhpwFomtiYwwecOEknvN&index=56&ab\\_channel=VectorSolutionsIndustrial](https://www.youtube.com/watch?v=FIUSQmH0Xvc&list=PLkcz0bP31BHEKXhpwFomtiYwwecOEknvN&index=56&ab_channel=VectorSolutionsIndustrial)

# Targets of the Forming/wire section

- To efficiently remove water, increases solids from about 1% to 20%
- To retain maximum material in the web (high retention)
- Give an even sheet structure (one-sided sheet)
- Avoid the formation of defects e.g. pinholes in the sheet



Sheet forming by filtration and thickening



Fiber deposition on screen/wire



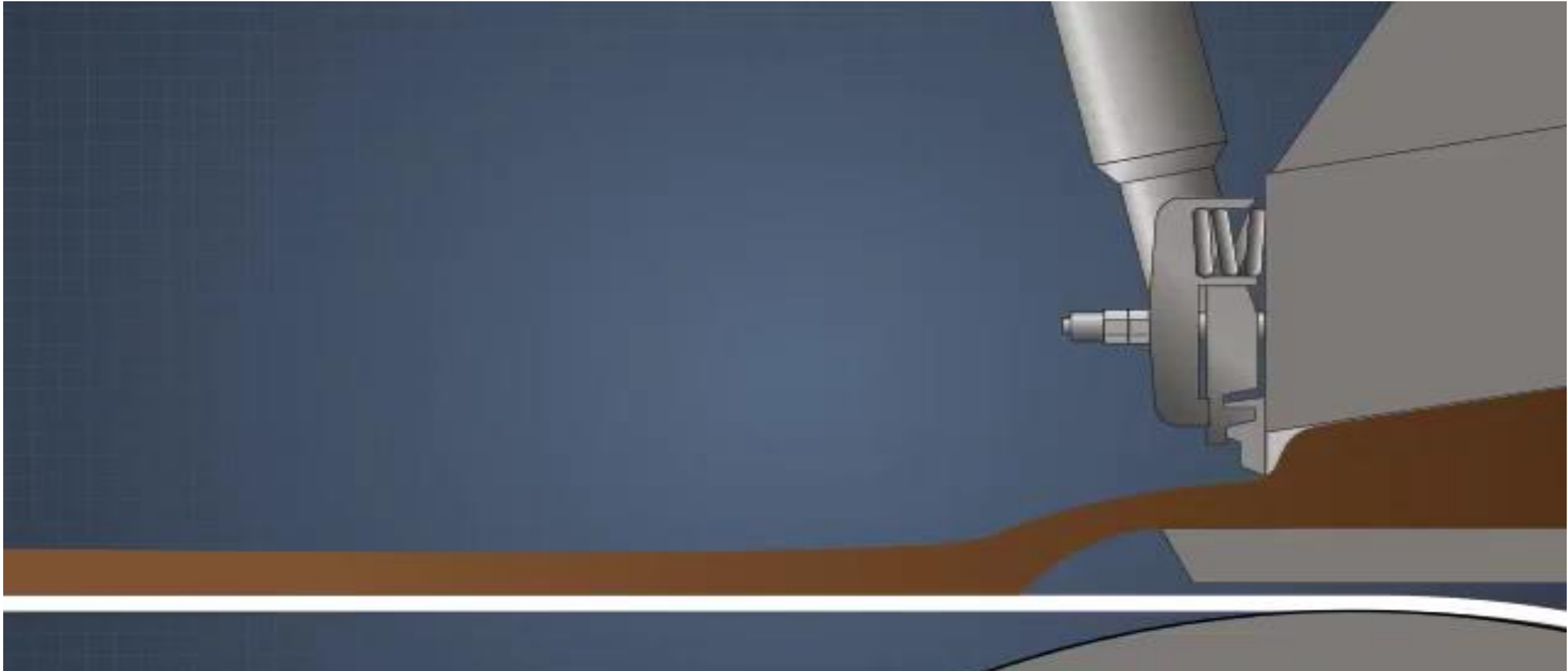
# Sheet Formation Video



This is an excerpt from our **Sheet Formation** training module.

[https://www.youtube.com/watch?v=YQp5\\_uk3fwA&list=PLkcz0bP31BHEKXhpwFomtiYwwecOEknvN&index=69&ab\\_channel=VectorSolutionsIndustrial](https://www.youtube.com/watch?v=YQp5_uk3fwA&list=PLkcz0bP31BHEKXhpwFomtiYwwecOEknvN&index=69&ab_channel=VectorSolutionsIndustrial)

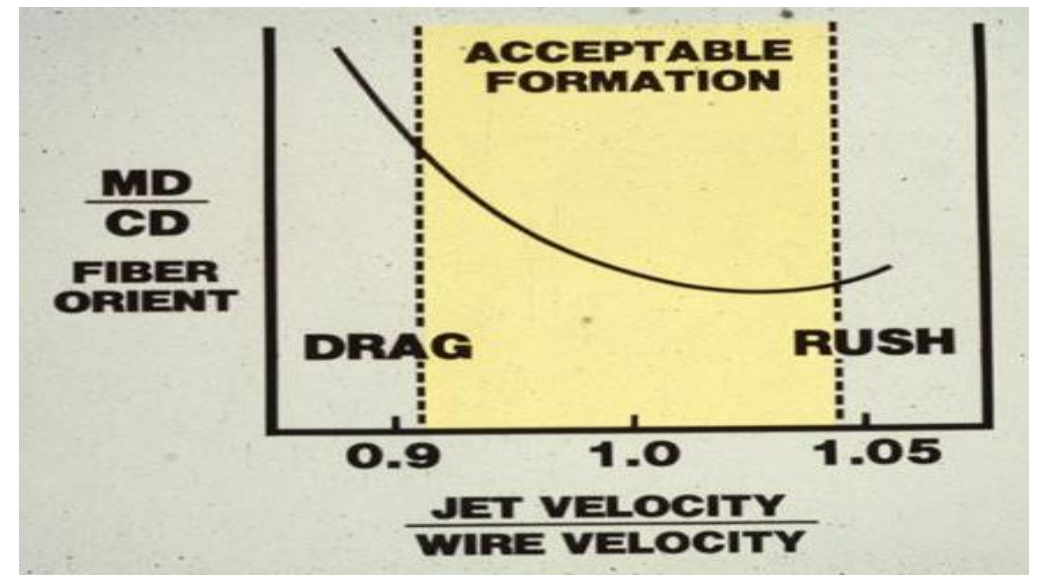
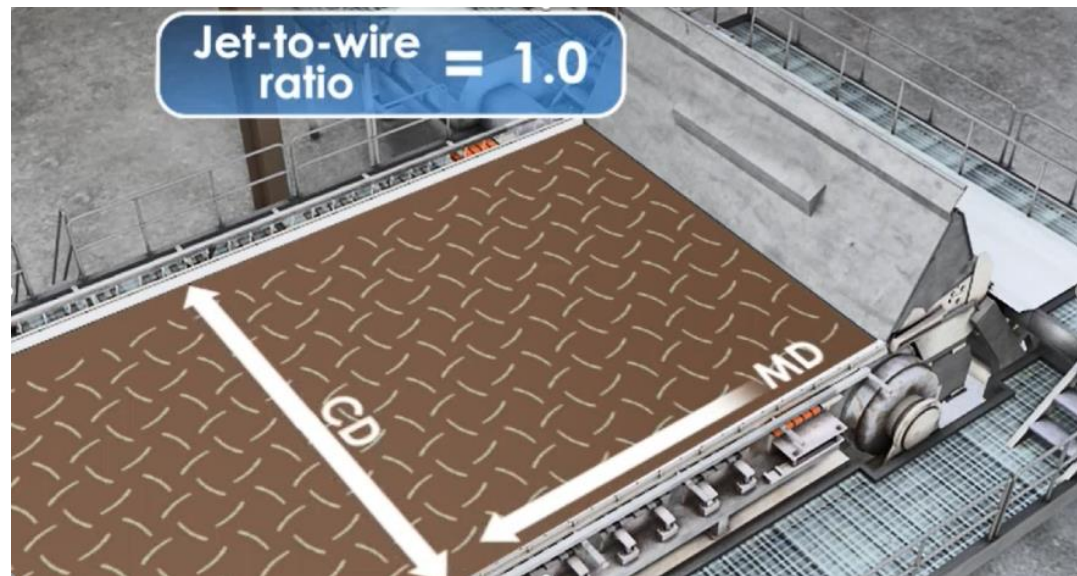
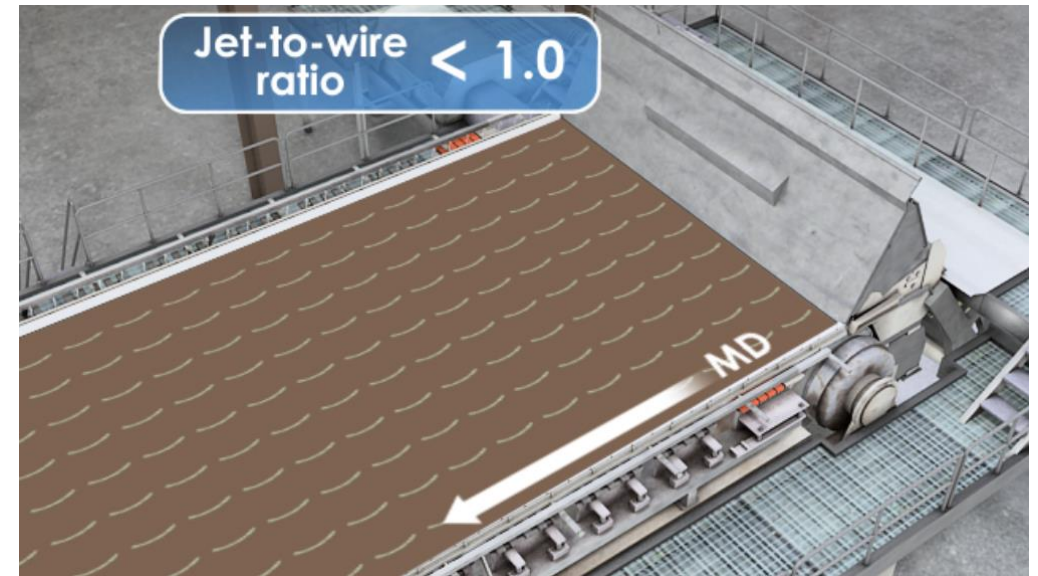
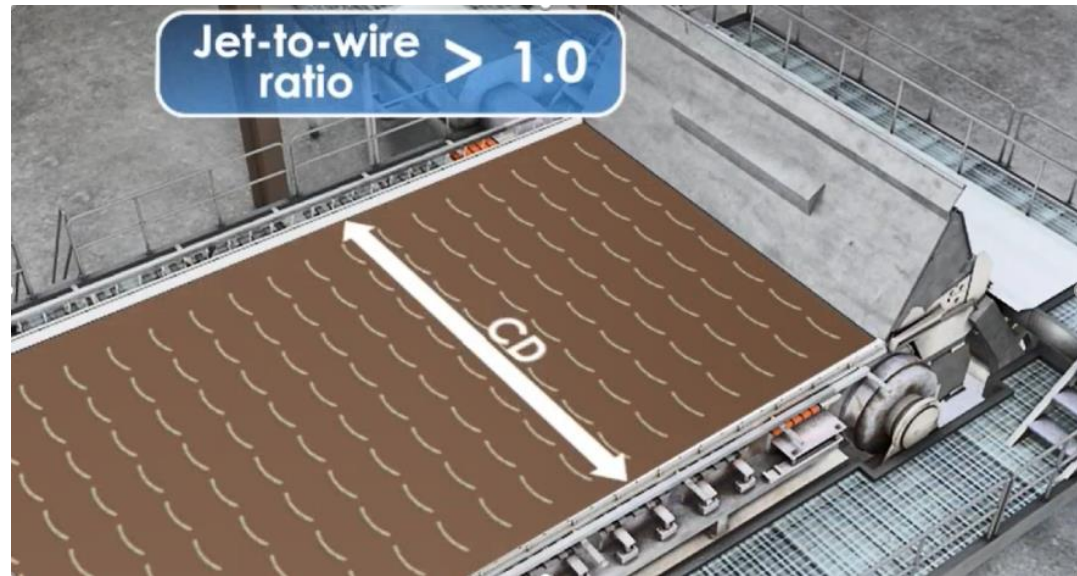
# Jet-to-Wire Speed Ratio Video



[https://www.youtube.com/watch?v=2friO3UzuB0&ab\\_channel=SHAIKNAGULUMEERA](https://www.youtube.com/watch?v=2friO3UzuB0&ab_channel=SHAIKNAGULUMEERA)



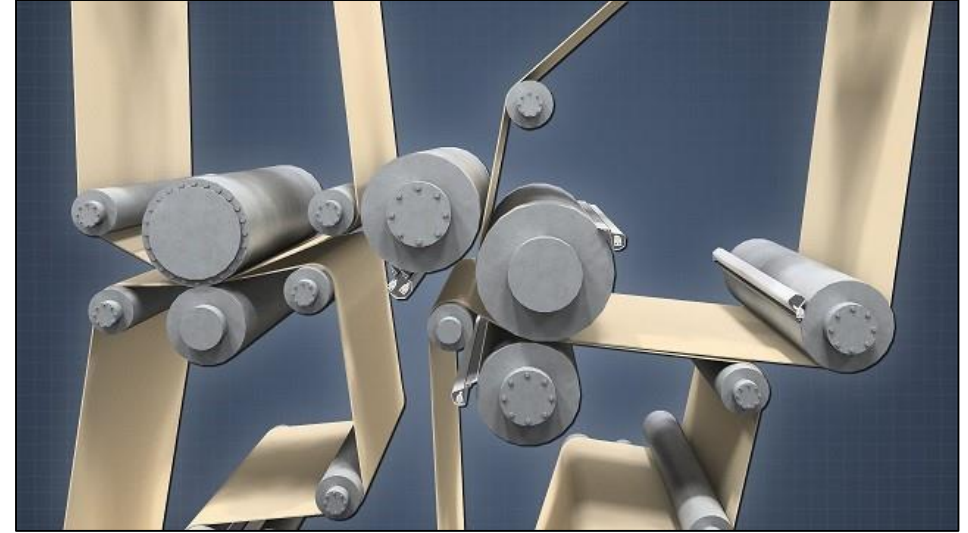
# Fiber Orientation



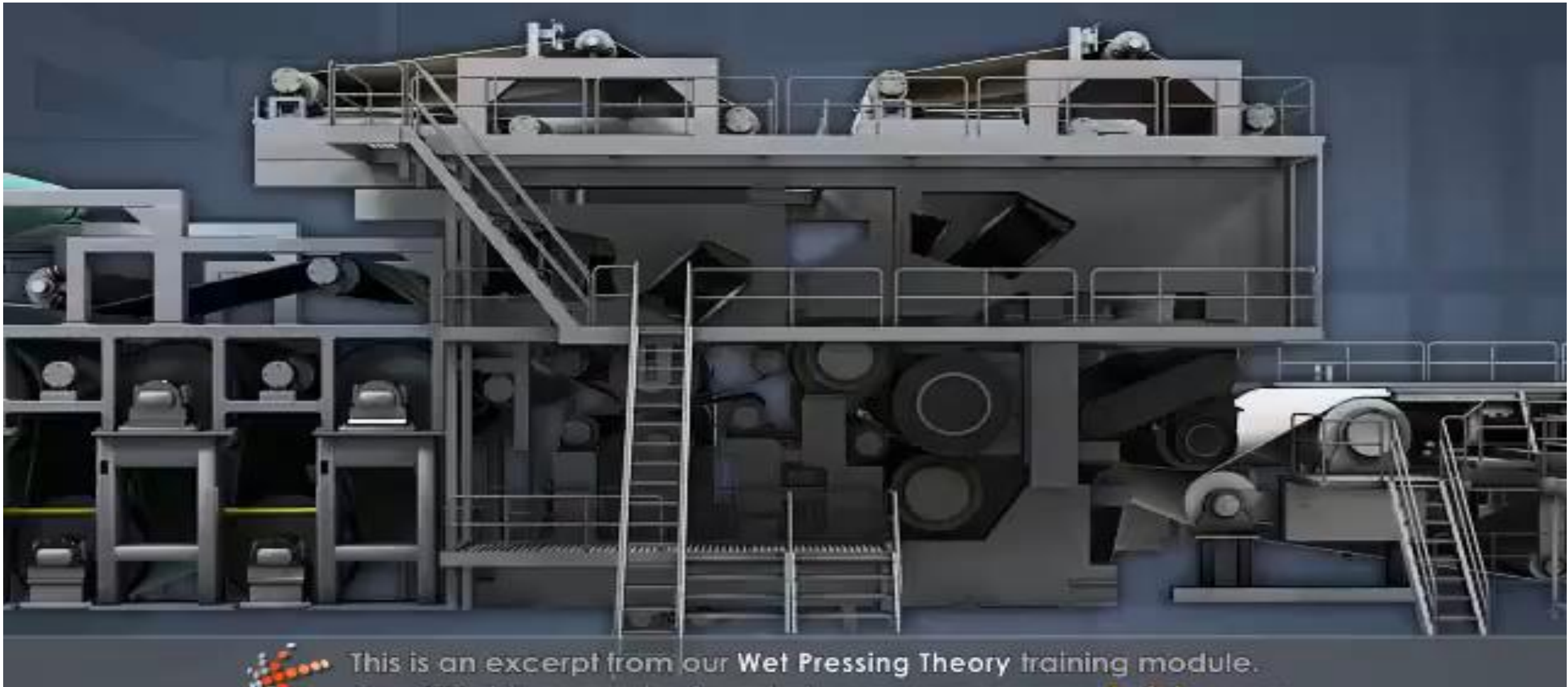


# Pressing

- The pressing section of a paper machine removes water from the wet paper sheet by pressing it between **rollers** covered with **felt**
- This step reduces the moisture content significantly before the sheet enters the drying section
- It also helps improve sheet strength and smoothness by compacting the fibers
- Sheet passes in to pressing section at dry solid contents of 15-25%
- Wet web attains total dry solid contents 40-45% for most of the grades of paper after pressing section



# Pressing Video



[https://www.youtube.com/watch?v=I3gYAF55ep4&list=PLkcZ0bP31BHEKXhbwFomtiYwwecOEknvN&index=57&ab\\_channel=VectorSolutionsIndustrial](https://www.youtube.com/watch?v=I3gYAF55ep4&list=PLkcZ0bP31BHEKXhbwFomtiYwwecOEknvN&index=57&ab_channel=VectorSolutionsIndustrial)

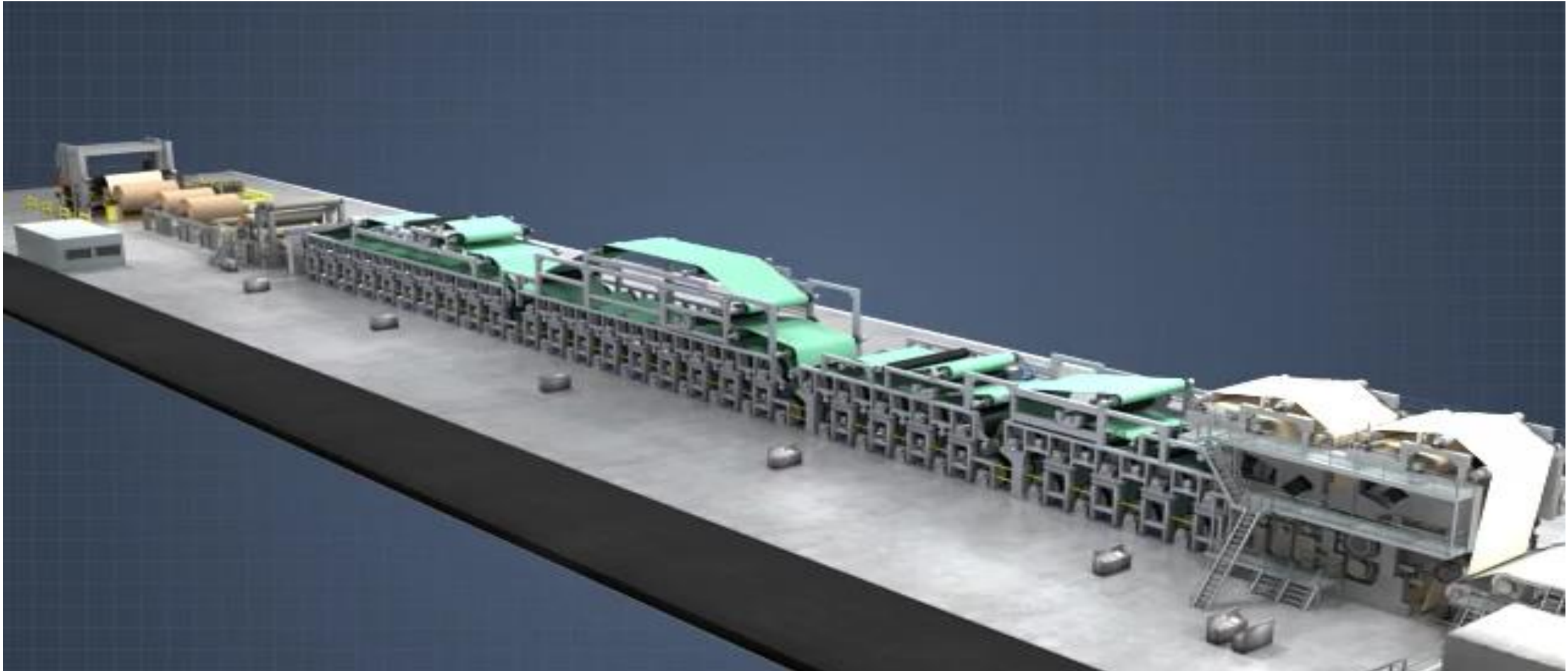
# Drying

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- Wet web of paper attains total dry solid contents 40-45% for most of the grades of paper after pressing section and the rest of the water is removed in dryer section of paper machine
- In papermaking, drying works through heat and mass transfer, heat evaporates moisture from the paper, and mass transfer carries that moisture away as vapor
- The steam heated cylinder for paper drying appears in two classical designs:
- MG or Yankee cylinder: the moist web is pressed hard on to a large single dryer cylinder with polished surface and stay there until the drying is completed
- The multi-cylinder dryer-section: The paper web is taken from one cylinder to the next in a long sequence until paper is dried



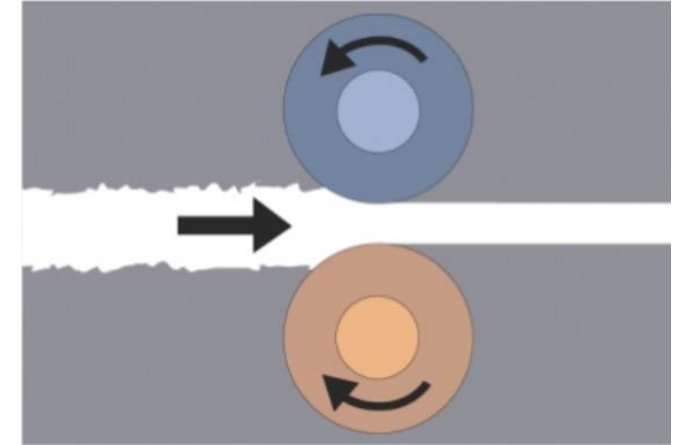
# Drying Video



[https://www.youtube.com/watch?v=9PdCmHjAt\\_E&list=PLkcz0bP31BHEKXhpwFomtiYwwecOEknvN&index=20&ab\\_channel=VectorSolutionsIndustrial](https://www.youtube.com/watch?v=9PdCmHjAt_E&list=PLkcz0bP31BHEKXhpwFomtiYwwecOEknvN&index=20&ab_channel=VectorSolutionsIndustrial)

# Calendering

- Smoothing with Pressure and Heat
- Pressing with a roll
- Reduce sheet thickness
- Even out caliper variations
- Impart smoothness and gloss



## Positive effect

Smoothness ↑

Gloss ↑

Absorption and porosity ↓

Calliper control

Two-sidedness control

## Negative Effects

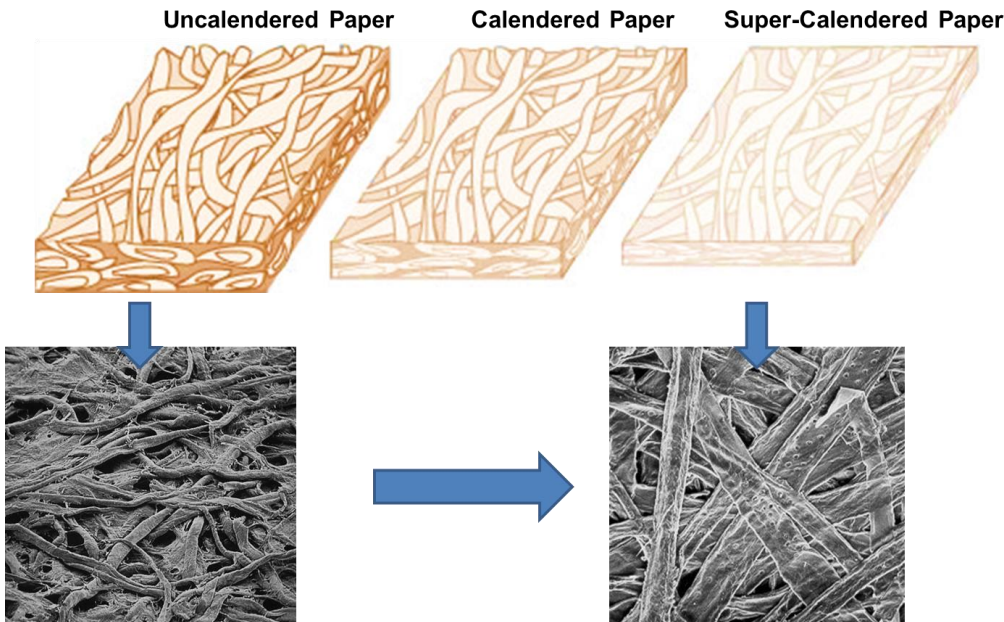
Bulk and stiffness ↓

Strength properties ↓

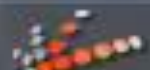
Opacity and brightness ↓

Light scattering ↓

Costs ↑



# Calendering Video

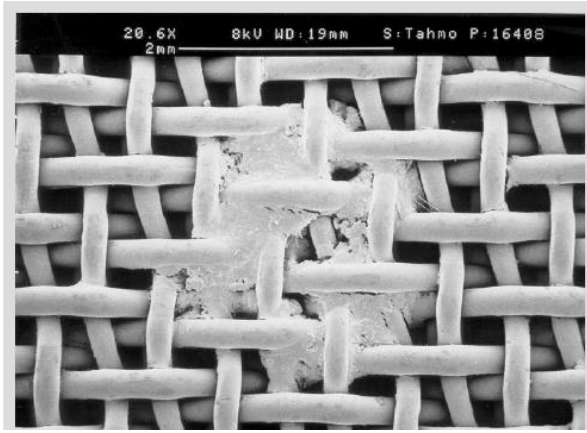


This is an excerpt from our Calendering - Hard Nip training module.

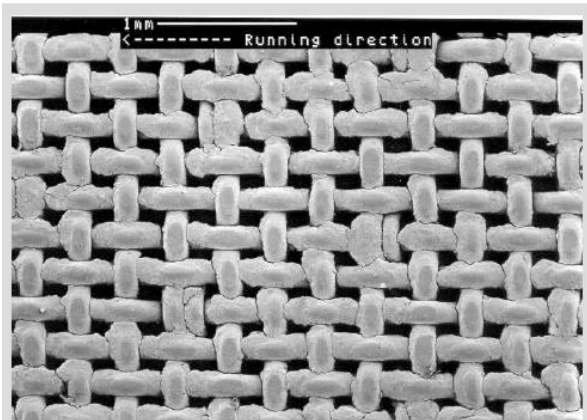
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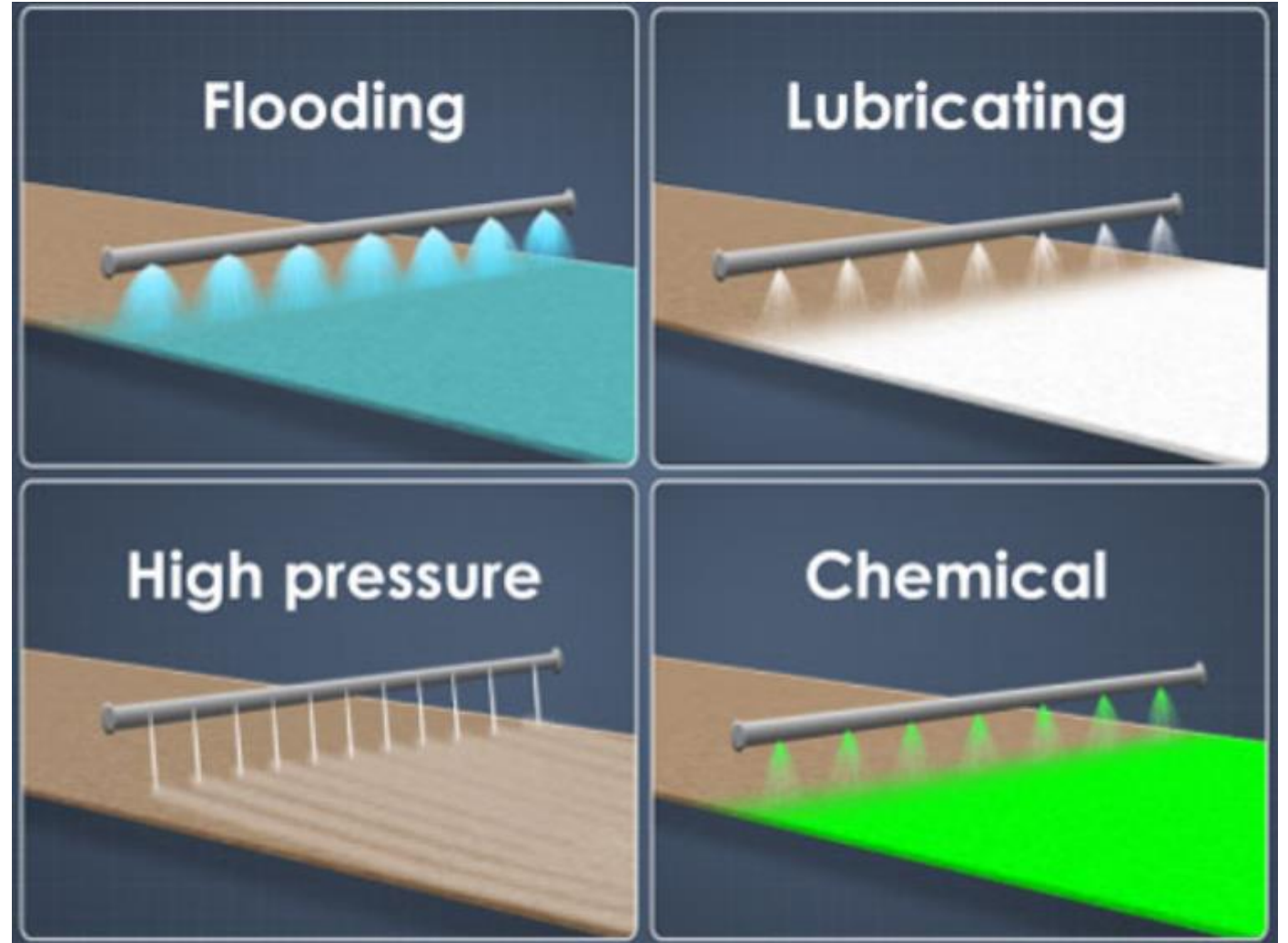
# Cleaning of Wire and Press felt



**Wire blocked by stickies**

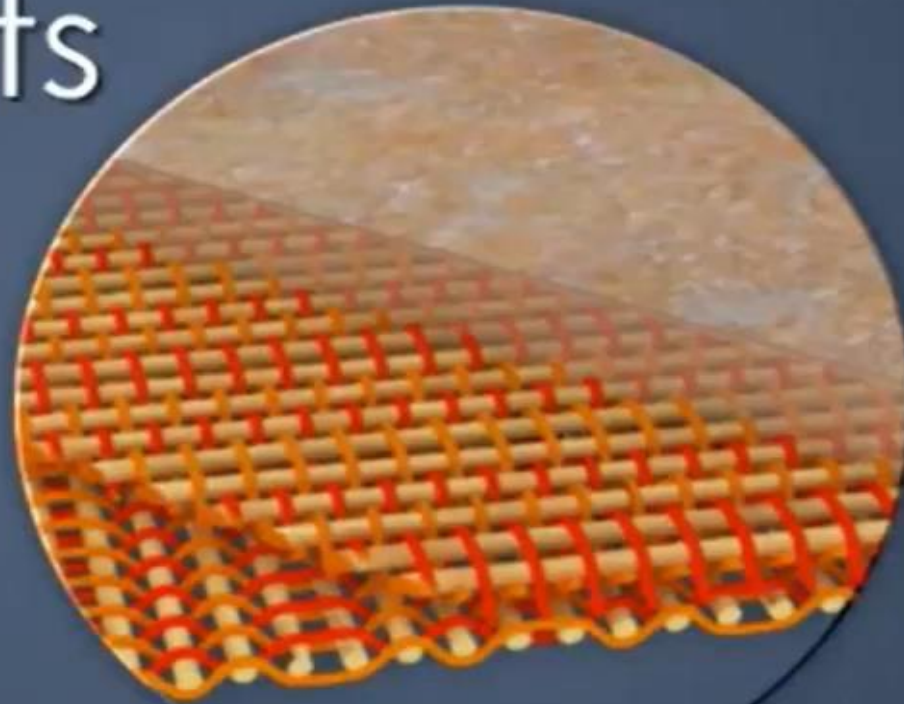


**AKD deposition on wire**



# Press Felt cleaning

Press Felts



[https://www.youtube.com/watch?v=jFiRR32UbfA&list=PLkcz0bP31BHEKXhpwFomtiYwwecOEknvN&index=68&ab\\_channel=VectorSolutionsIndustrial](https://www.youtube.com/watch?v=jFiRR32UbfA&list=PLkcz0bP31BHEKXhpwFomtiYwwecOEknvN&index=68&ab_channel=VectorSolutionsIndustrial)

# Paper Machine General Safety



[https://www.youtube.com/watch?v=TBX-S0KLEIM&list=PLkcz0bP31BHEKXhpwFomtiYwwecOEknvN&index=90&ab\\_channel=VectorSolutionsIndustrial](https://www.youtube.com/watch?v=TBX-S0KLEIM&list=PLkcz0bP31BHEKXhpwFomtiYwwecOEknvN&index=90&ab_channel=VectorSolutionsIndustrial)



# Safety in Paper Mill



**Safety, safety and safety!  
We only have one life!**

# Recent trends in the paper industry

- Printed media is being replaced by electronic media
- Cost efficiency is an overarching theme in most paper mills
- Biorefinery concept: Major initiatives in biofuel and biochemical development
- Raw material base shifts to fast growing species
- Sustainability emerges as overarching theme – *replacement of non-renewable resources*
- Globalization, low cost raw materials, energy conservation and production
- ***Packaging, specialties, composites and hygienics seen as exciting opportunities***





**Thank you for your kind  
attention!**

