Fourdrinier – multicylinders drying

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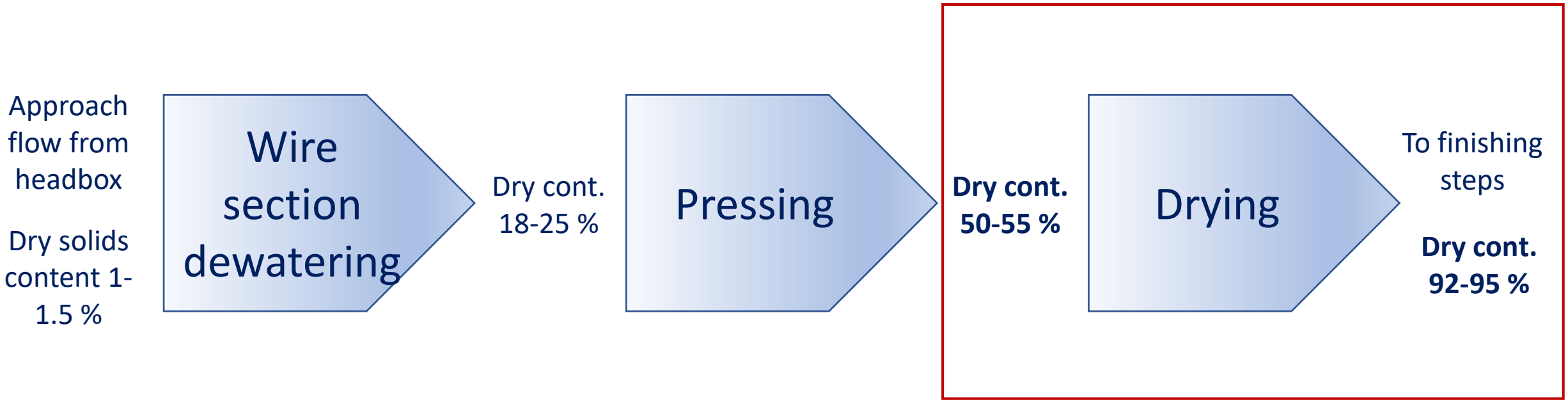
Paper dewatering and drying steps



Drying is 300 times more expensive than dewatering in forming section

Drying section

Targets

Water removal with evaporation

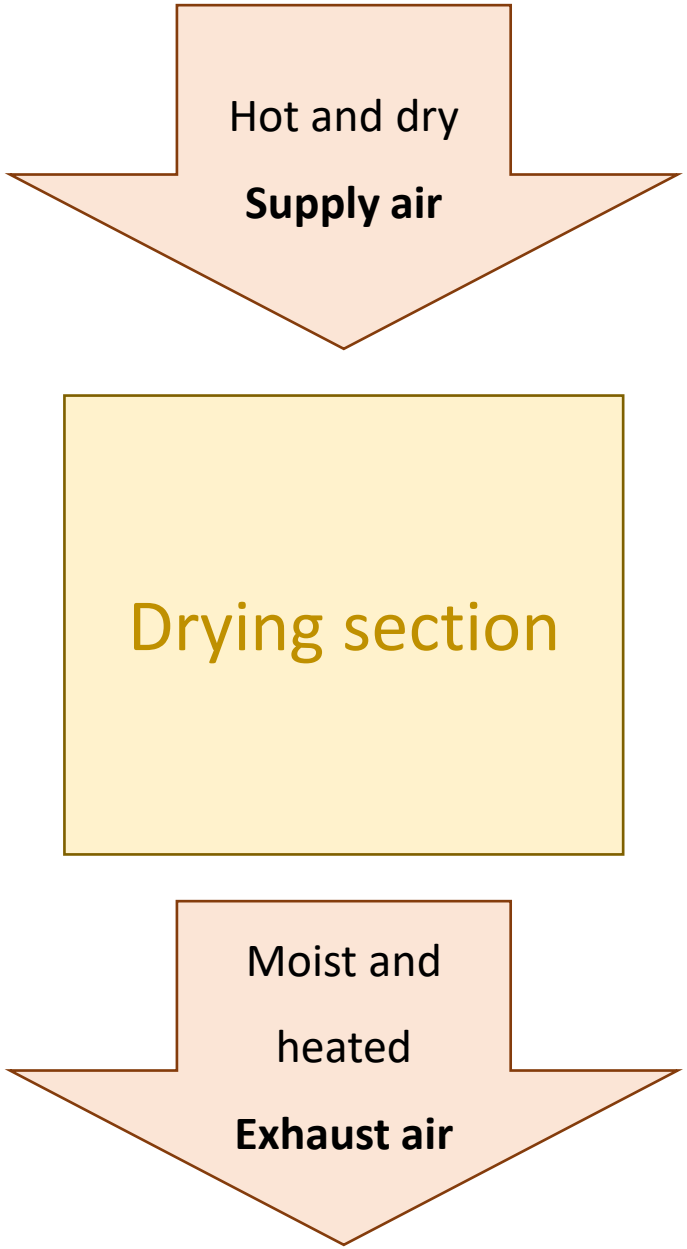
- Bringing the fibers closer to each other: fiber bonding
- Locking base paper properies
- Achieving the moisture content desired by customers

Challenges

- **High energy costs**
- Quick transfer of large energy quantities
- Quick evacuation of evaporated water
- Paper quality management

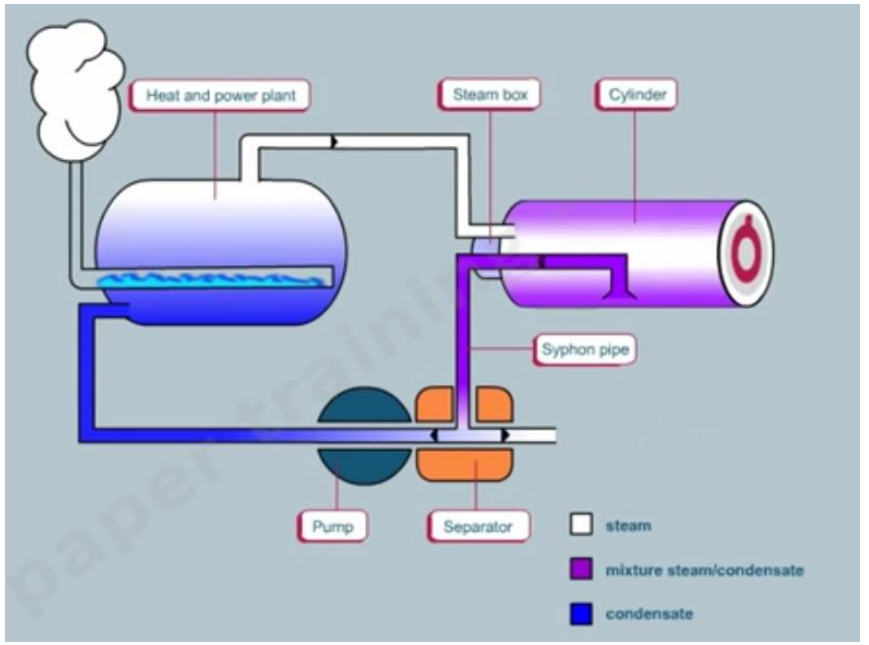
Drying process

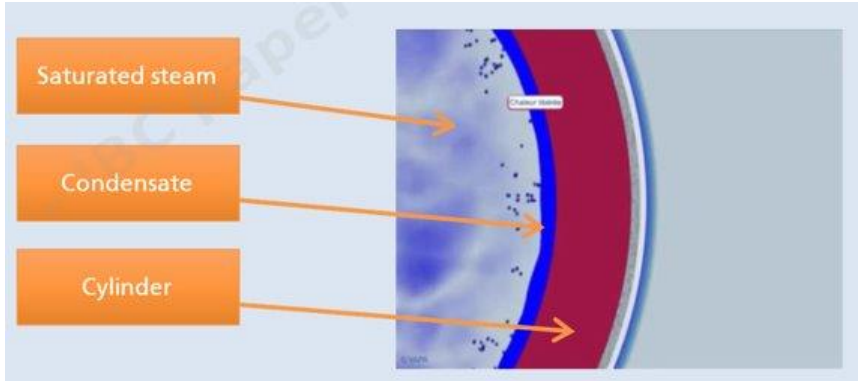
- Paper sheet runs between/on drying cylinders and drying fabric
- Steam inside the cylinders condensates and heats the cylinders
- Heat transfers to the sheet and evaporates water
- Hot air flow removes the evaporated water



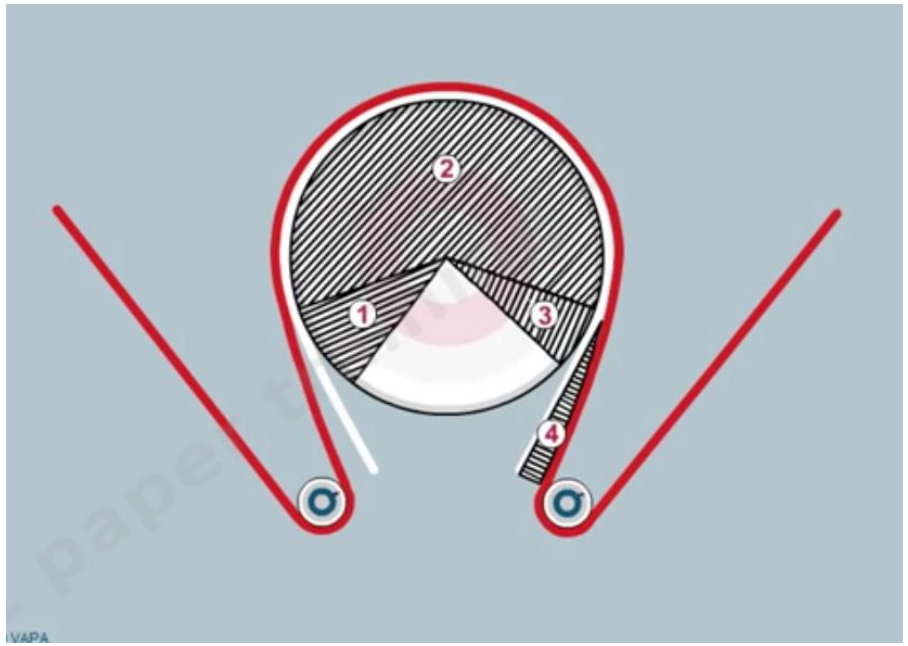
Steam and Condensates

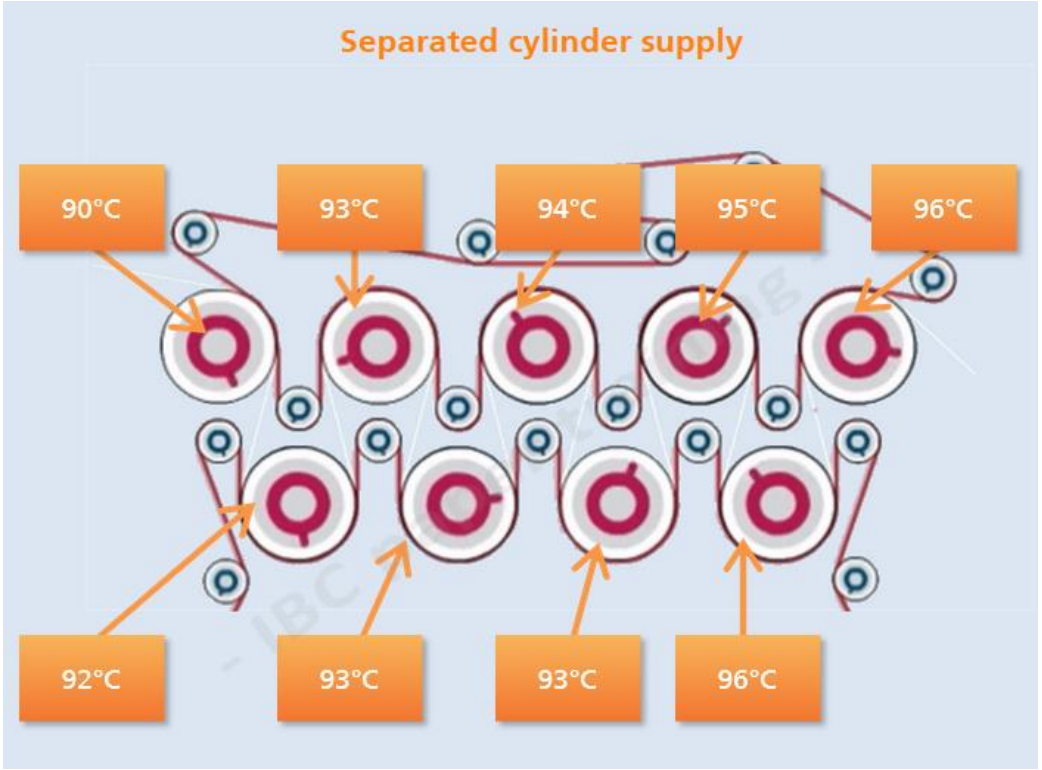
- Contact drying is the most utilized principle in paper drying
  - Heat source saturated steam
  - High energy efficiency
- Cast iron/steel cylinder
  - Good heat transfer
- Saturated steam
- Superheated steam
- Condensation inside the cylinder





Drying on the cylinder



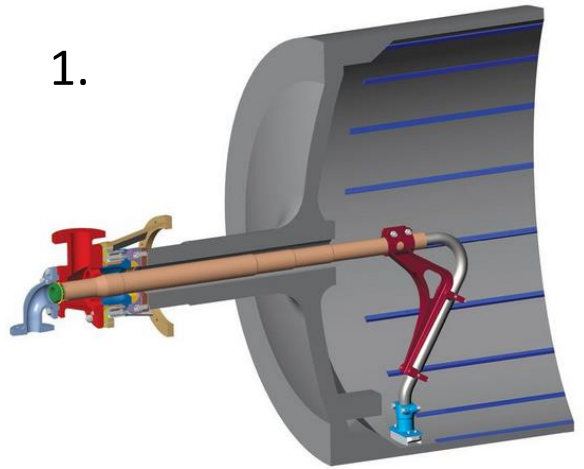


Zone 1	Slow rise in temperature
Zone 2	Rise of the evaporation rate
Zone 3	Slower rise of the evaporation rate
Zone 4	High evaporation rate

Removal of the condensate

- Condensate buildup reduces the drying efficiency
- Can lead to wet streaks
- Three main types of syphons used to remove condensate
  1. Stationary syphon
  2. Rotary syphon
  3. Condensate scoop

1.



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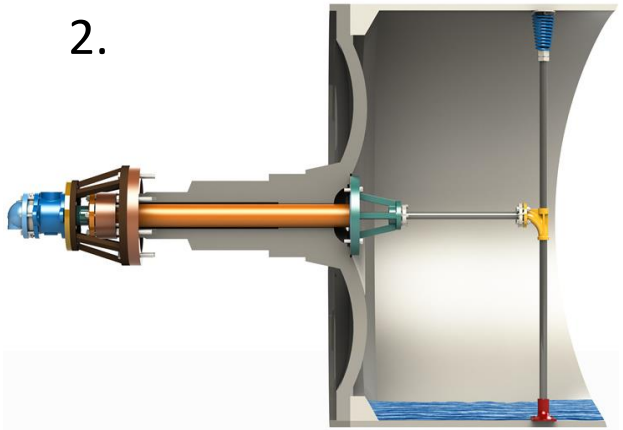

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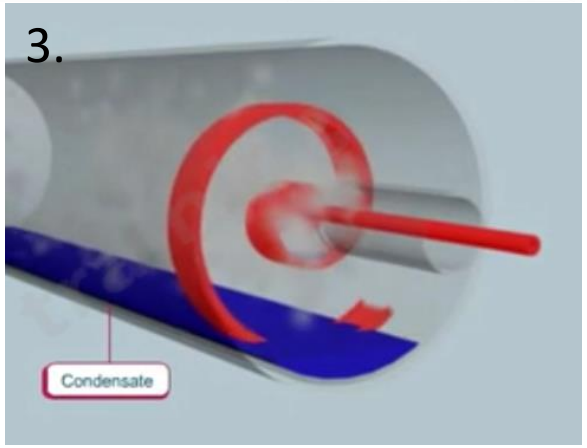
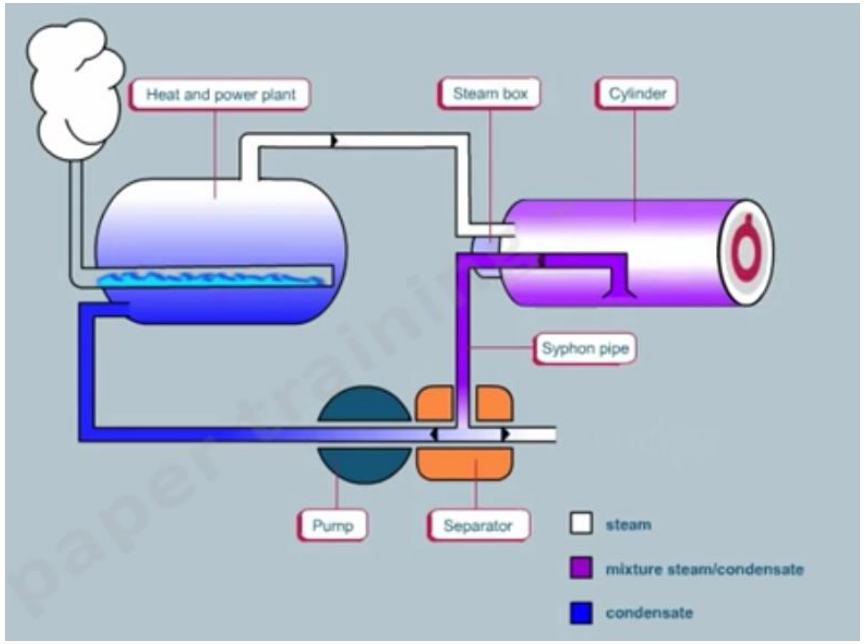


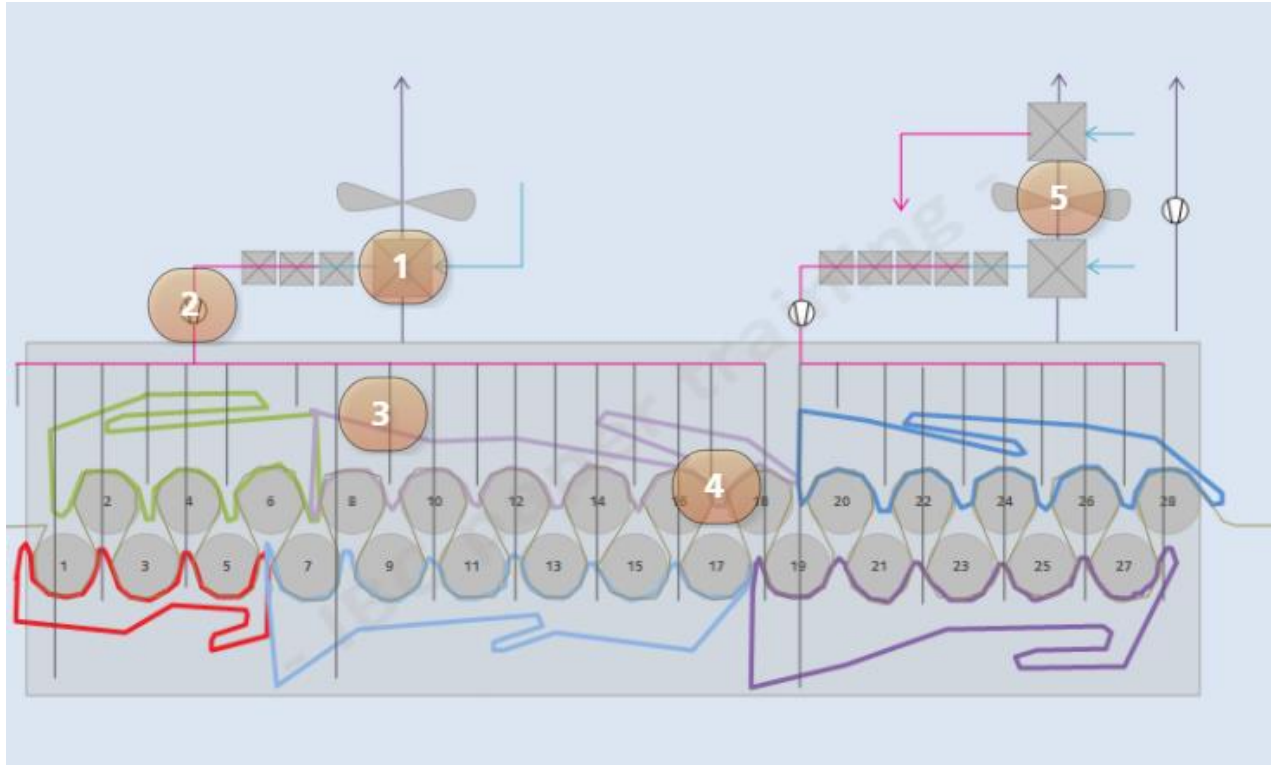
After the cylinder

- Condensate is collected into a flask tank
- From flask tank the vaporized condensate (flash steam) can be used again in cylinders if run through a thermocompressor
- The flash steam can also be condensed with condensator
- The condensate from the tank is sent to the boiler and saturated steam is created -> cycle to cylinders



Ventilation

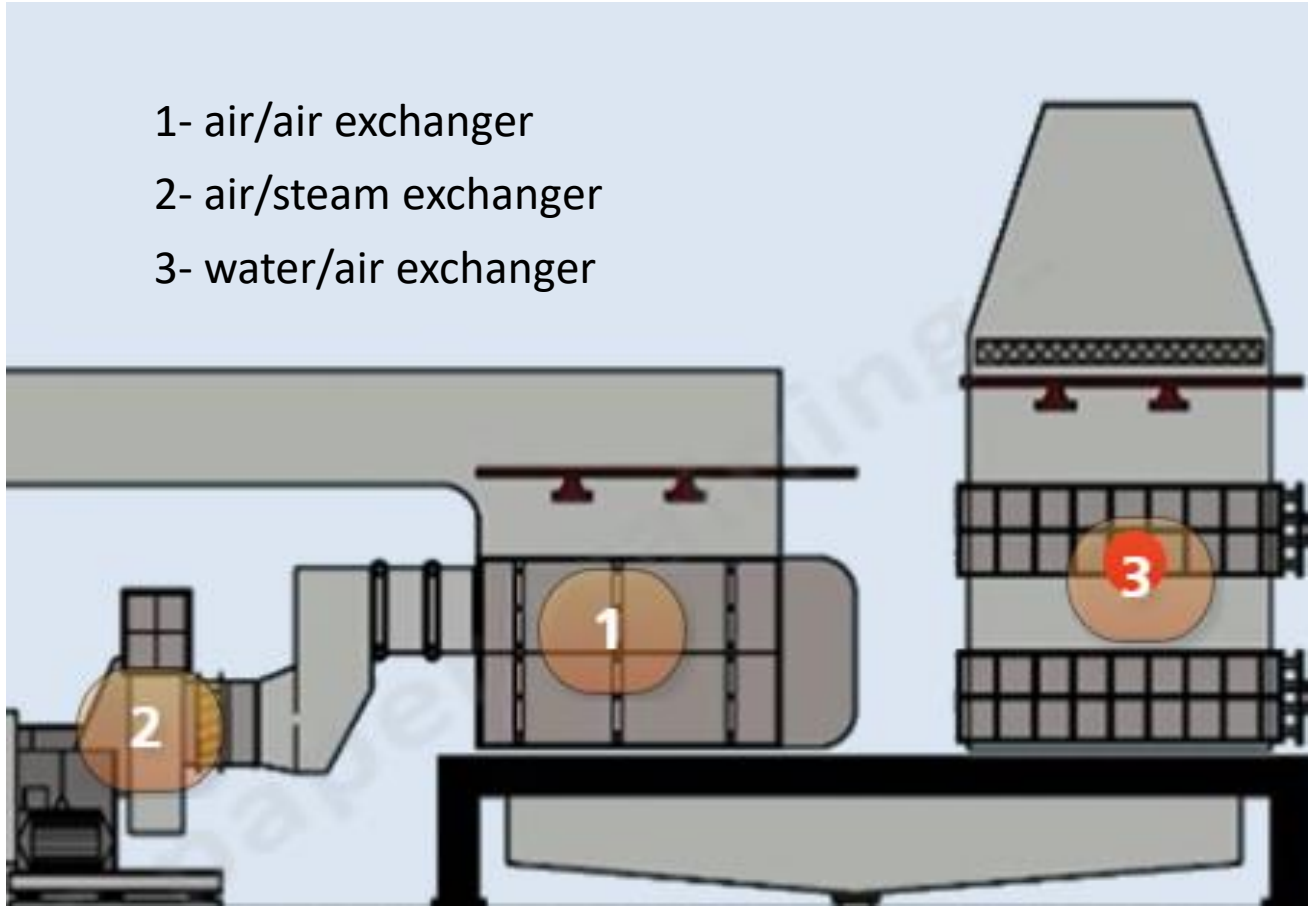
- Main components of the ventilation:
  - Exchangers
    - Air/air exchanger
    - Air/steam exchanger
    - Water/air exchanger
  - Supply fan
  - Hood
  - Pocket ventilation
  - Exhaust fan



1- exchangers 2- supply fan 3- the hood
4- pocket ventilation 5- exhaust fan

Exchangers

- Air/air exchanger
  - Exchange heat between the cold dry air and the host moist air
- Air/steam exhanger
  - Heat the dry air furthur
- Water/air exchanger
  - Recover the heat of the moist air



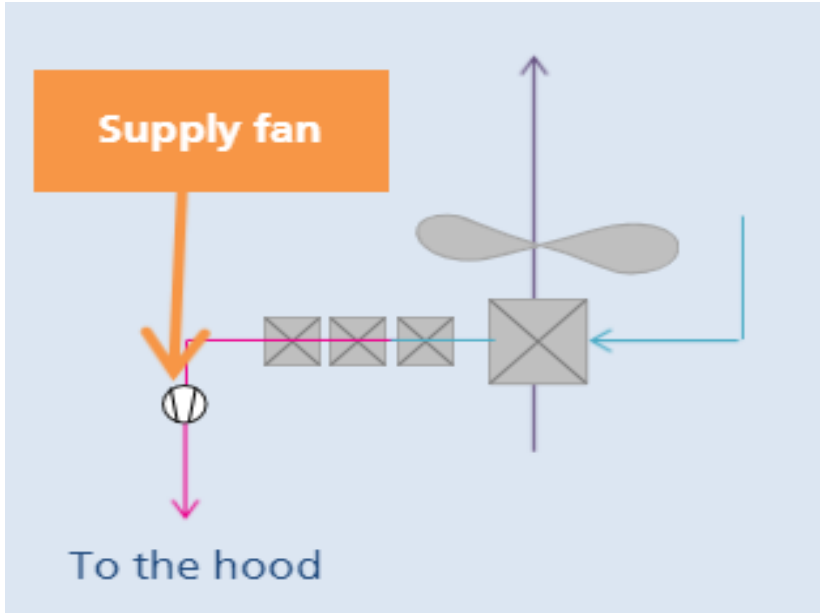
Drying hood

- Eliminate the evaporated water
- Recover the energy
- Stabilize the air flows around the machine
- Minimize the need of supply air
- Improve energy use
- Protect the machine

Supply fan & Exhause fan

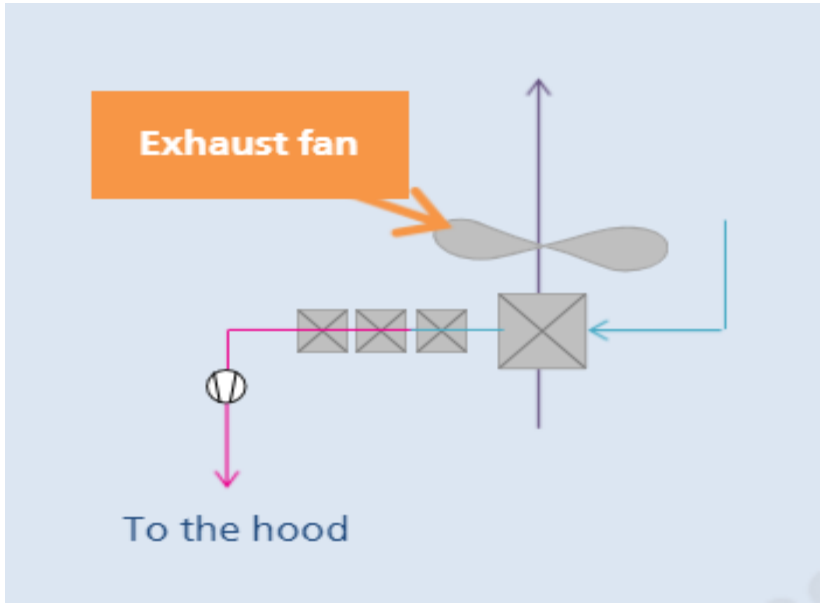
Supply fan

- blow hot dry air to the hood
- create ventilation



Exhaust fan

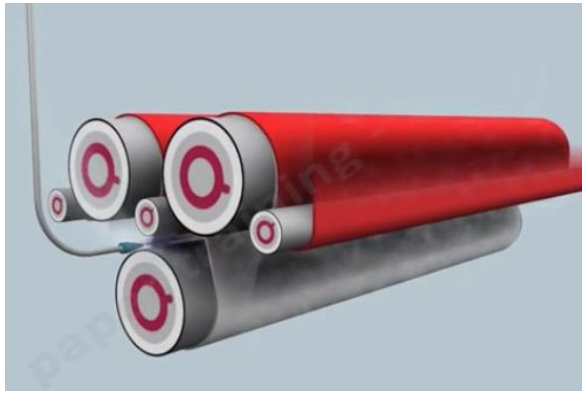
- Extract moist air from the hood
- create air flow in the hood



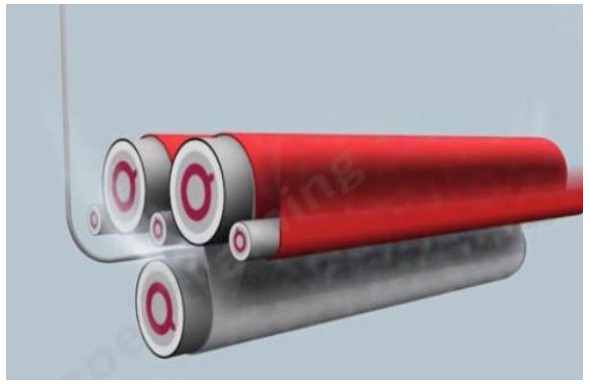
Pocket ventilation

Method

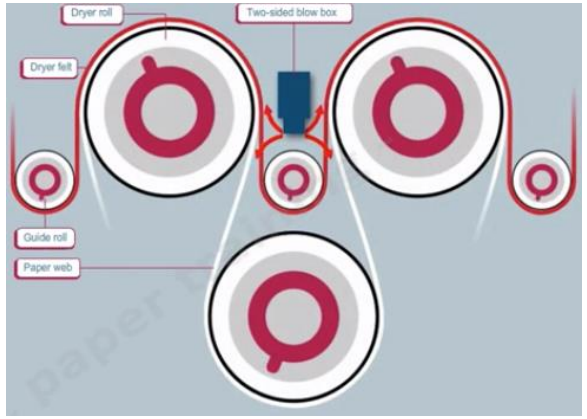
- Injection of air: inject compressed air to the edge of the pockets
- Blow box: blow hot dry air cross the entire width of the pockets
- Two sided blow box
- Pocket ventilation roll



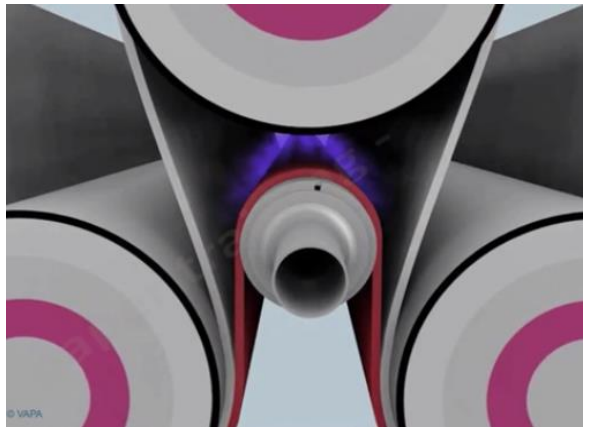
Injection of air



Blow box



Two sided blow box

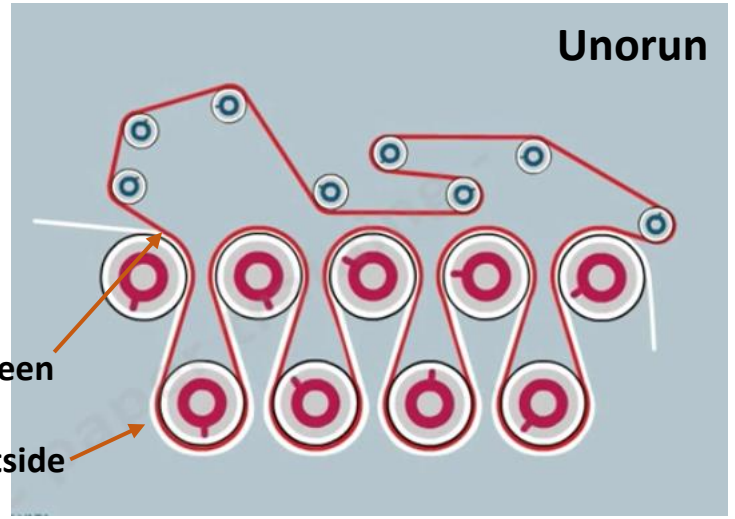


Ventilation roll

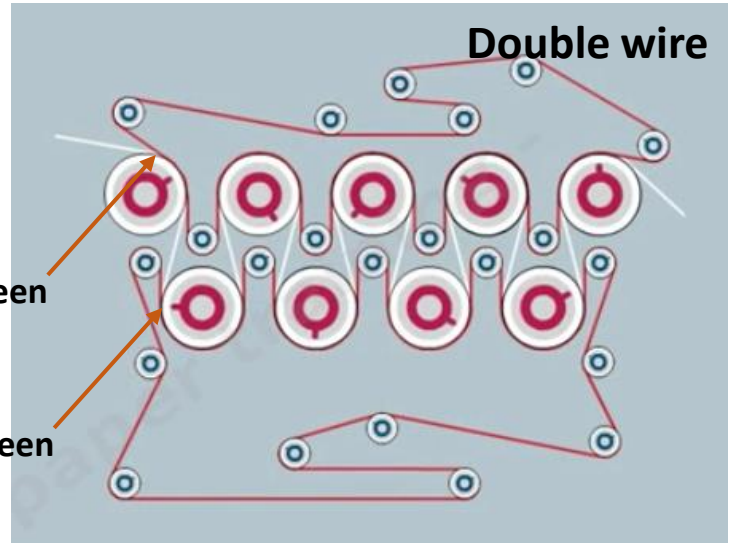
Drying fabric

- Looping wire that guides the paper during drying
- Two main types: unorun & double wire
- Double wire is most used

Increases	Decreases
• Drying efficiency • Surrounding temperature • Evaporation rate	• Steam consumption • Condensation risks



+ Less break or rip due to free draws
- Drying on the low cylinders is not effective

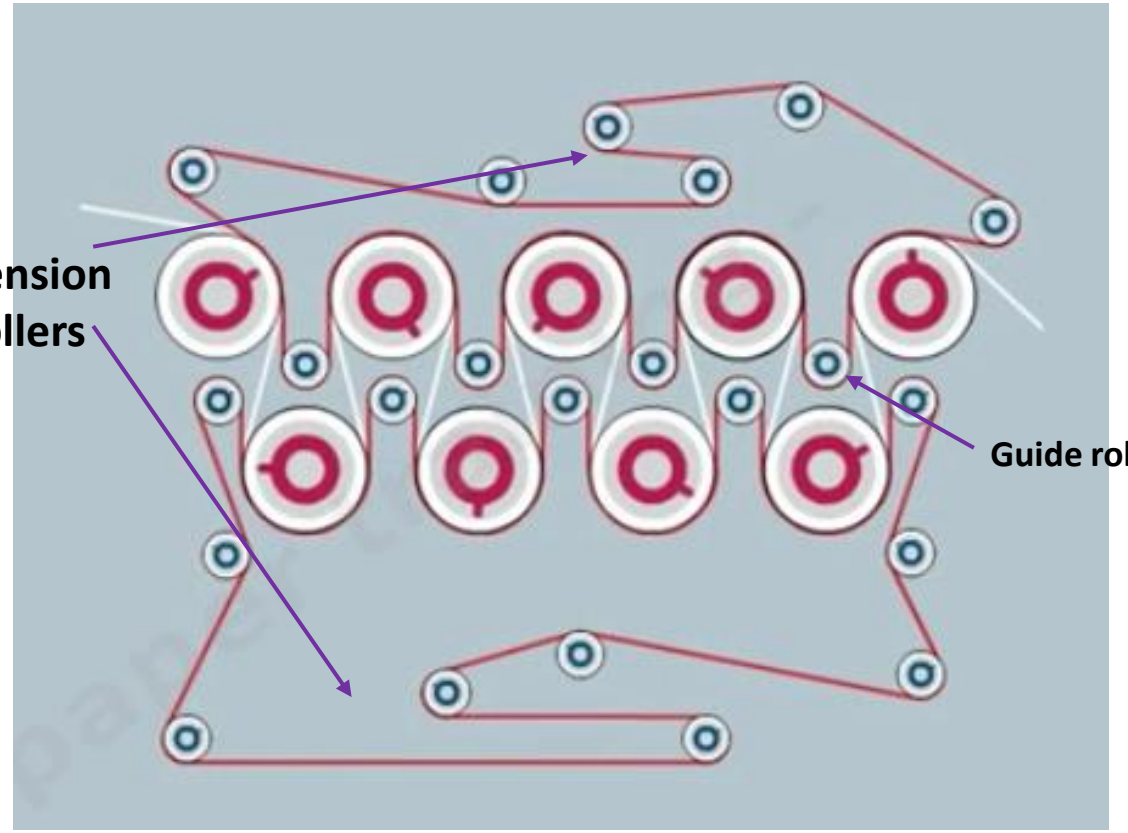


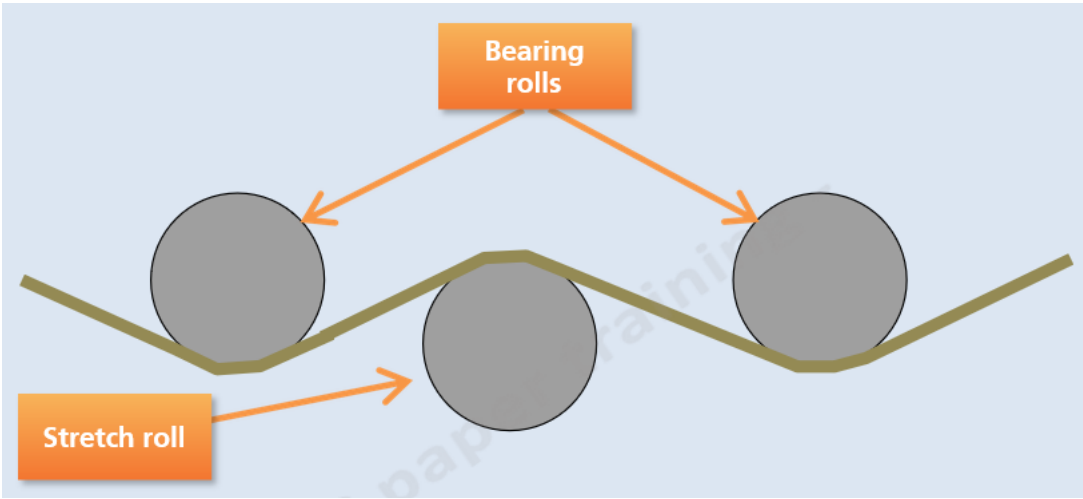
+ Paper is always pressed against the cylinders
- Free tension parts can cause breaks and rips

Drying fabric tension

- Needs to be adequate
- Adjusted by tension rollers: stretching roll is moved up or down
- Also friction is needed

Too high	Too low
• Guide roll distortion: uneven moisture profile • High friction: wear • More energy needed • Felt marking	• Poor heat transfer • Paper ribbing • Guiding trouble • Fabric sliding on rolls





Process impact

- Pulp type and properties and previous processing affect on the amount of drying needed
- Paper type produced affects of the drying speed, as all paper types cannot be heated to the same drying temperatures: higher refining lowers the drying temperature

Requires more drying

- Chemical pulp (does not contain lignin)
- Never dried virgin pulp (high water absorption)
- Non refined fibers (small surface area)
- Low filler content (fibers absorb more water)

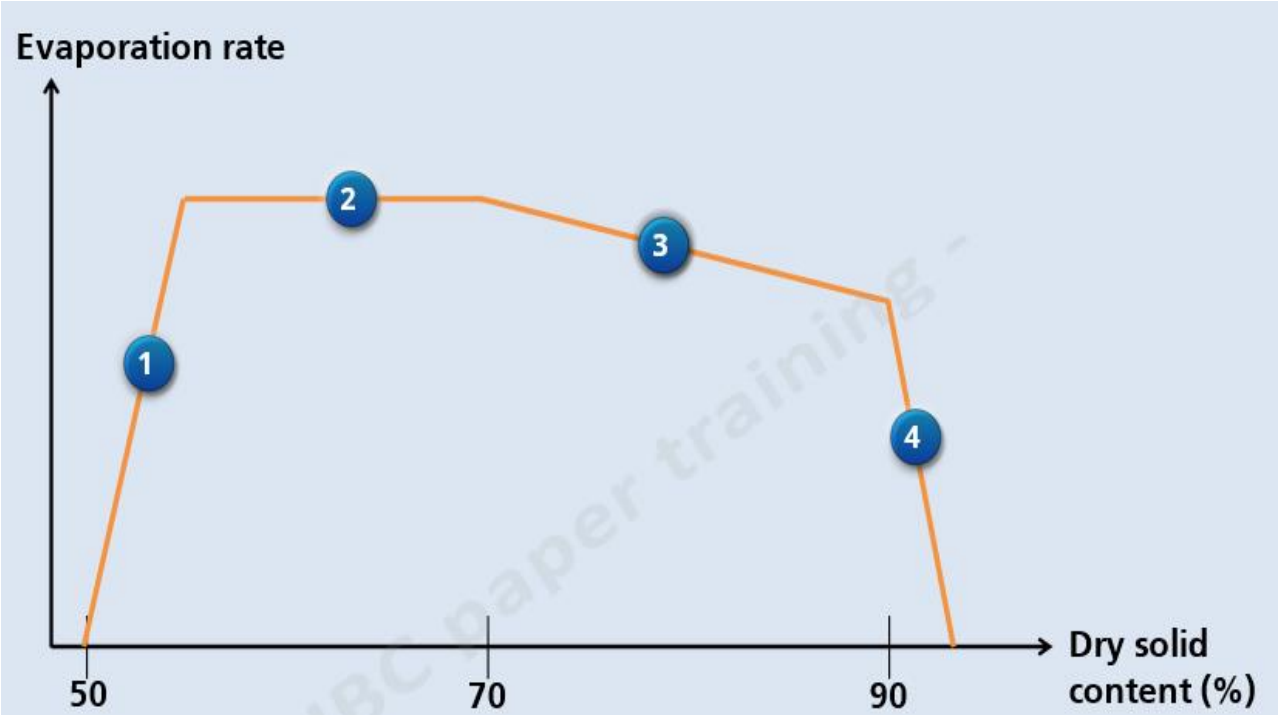
Requires less drying

- Mechanical pulp and TMP
- Once dried or recycled pulp
- Refined fibers
- High filler content

Drying rate

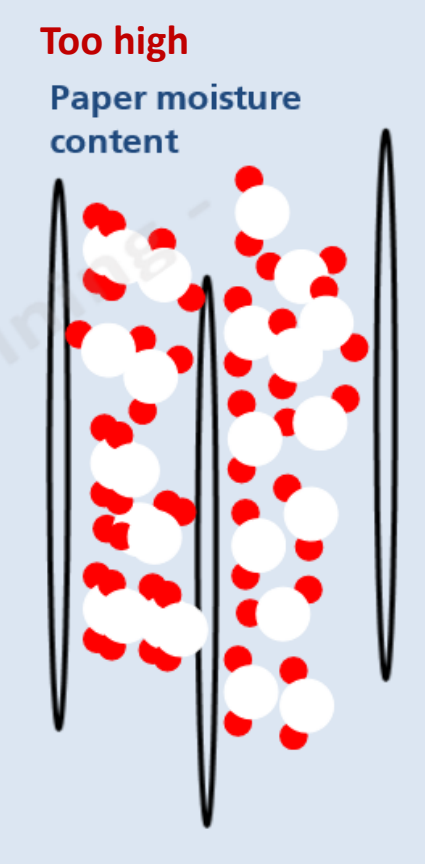
- Drying rate is not constant during the drying step: water inside the fibers is more difficult to evaporate than the ’free’ water between fibers

1. Rising temperature in the sheet
2. Water between fibers is evaporating
3. Less free water to remove, fiber shrinkage
4. Even less free water, electrical charging of the sheet

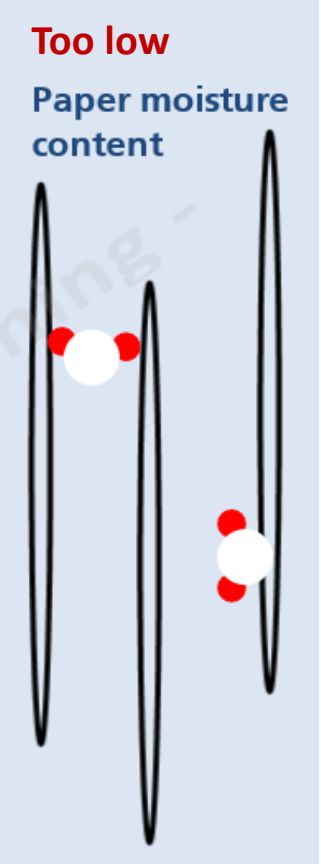


Final moisture content

- **Around 5 - 7 % moisture content**
- Water links the fibers to each other with hydrogen bonding



- Too much water between fibers
- Poor mechanical resistance



- Not enough water between fibers
- Poor mechanical resistance
- Brittle paper

Thank you!