Through Air Drying (TAD)

Principles of Design, Operation, and Runnability

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Valmet

Presentation Outline

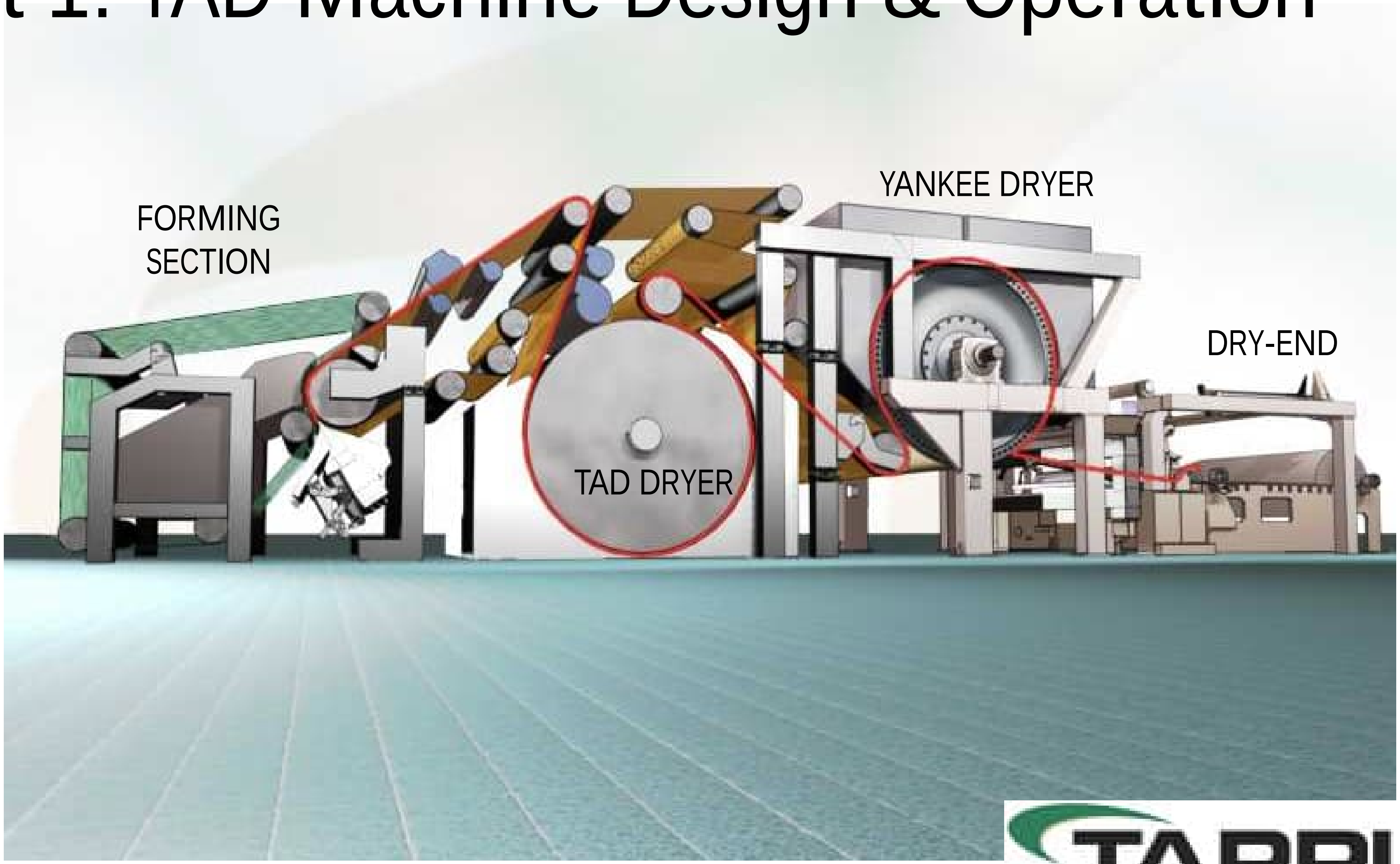
PART 1:

- TAD MACHINE DESIGN AND OPERATION

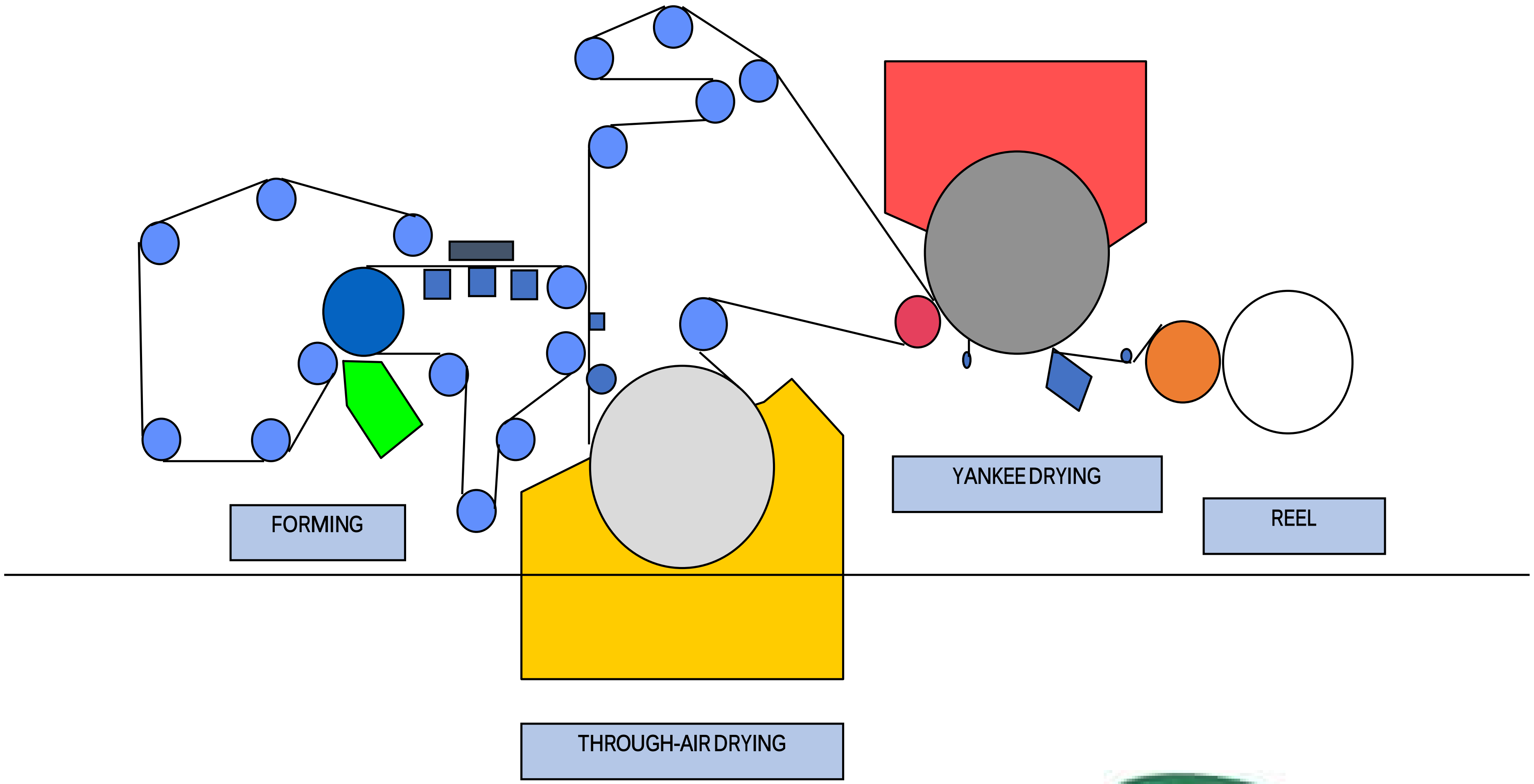
PART 2:

- TAD MACHINE RUNNABILITY

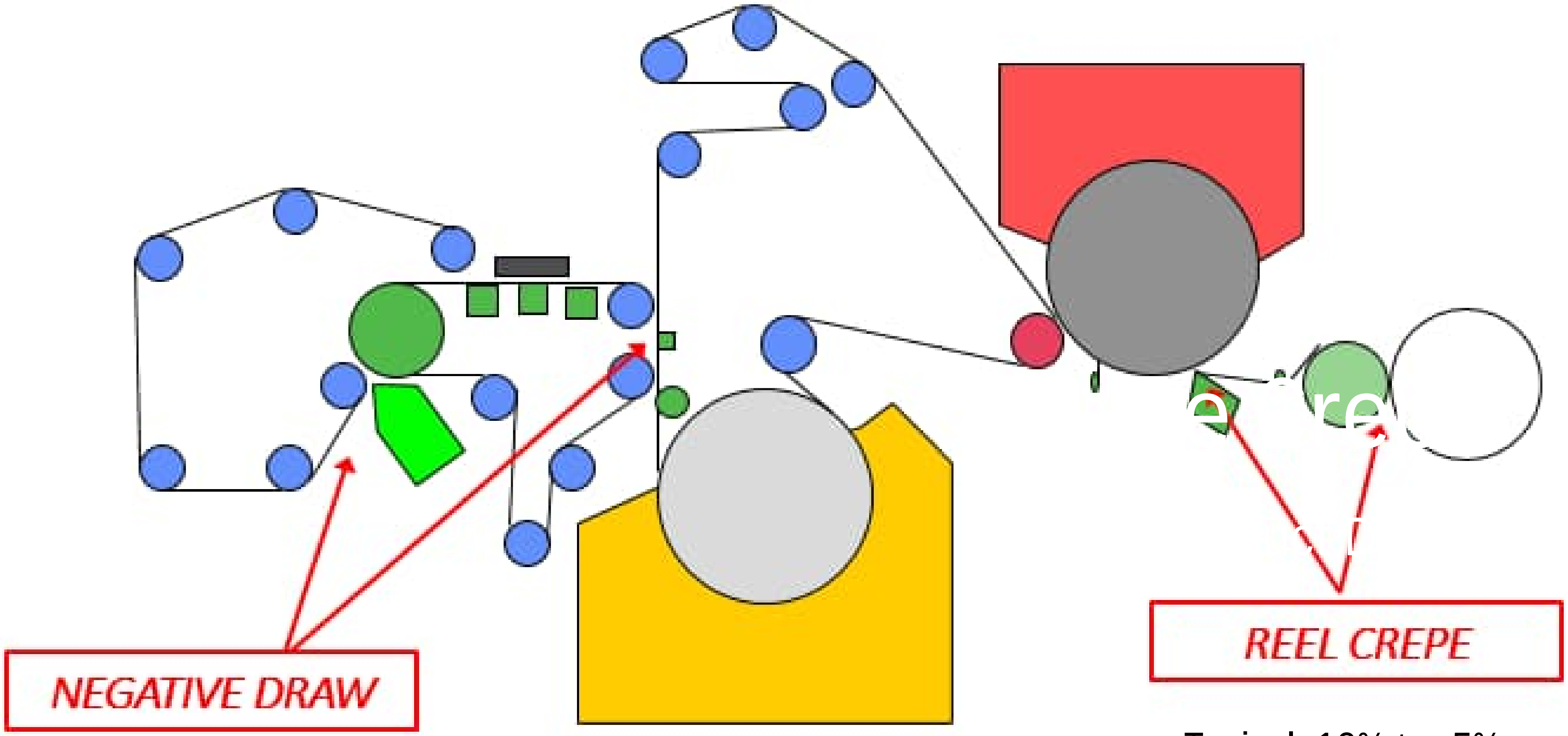
Part 1: TAD Machine Design & Operation



Elements of a TAD Machine



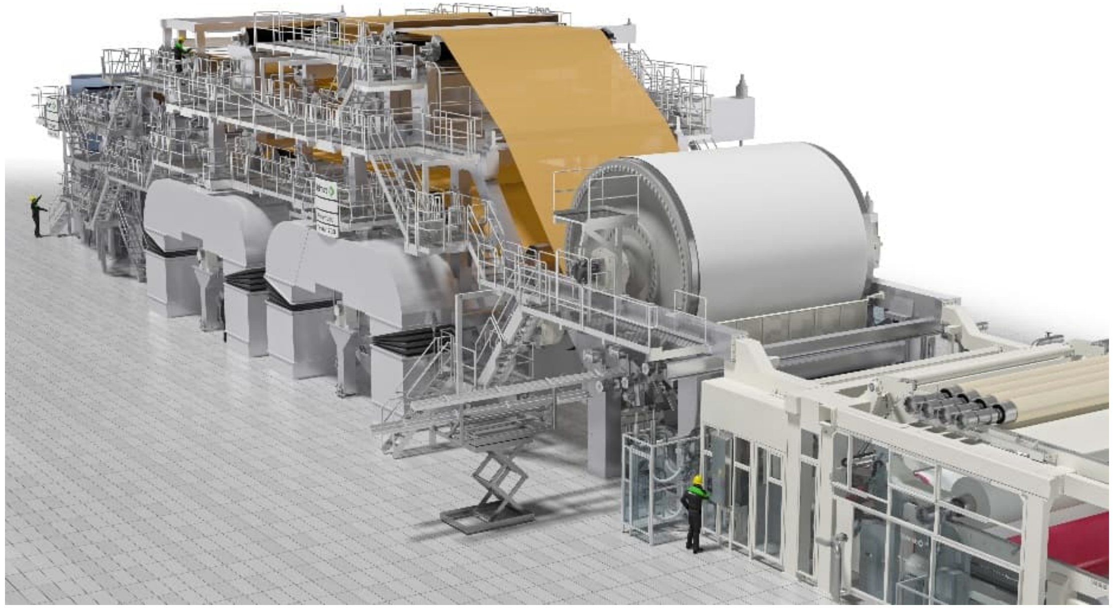
Elements of a TAD Machine

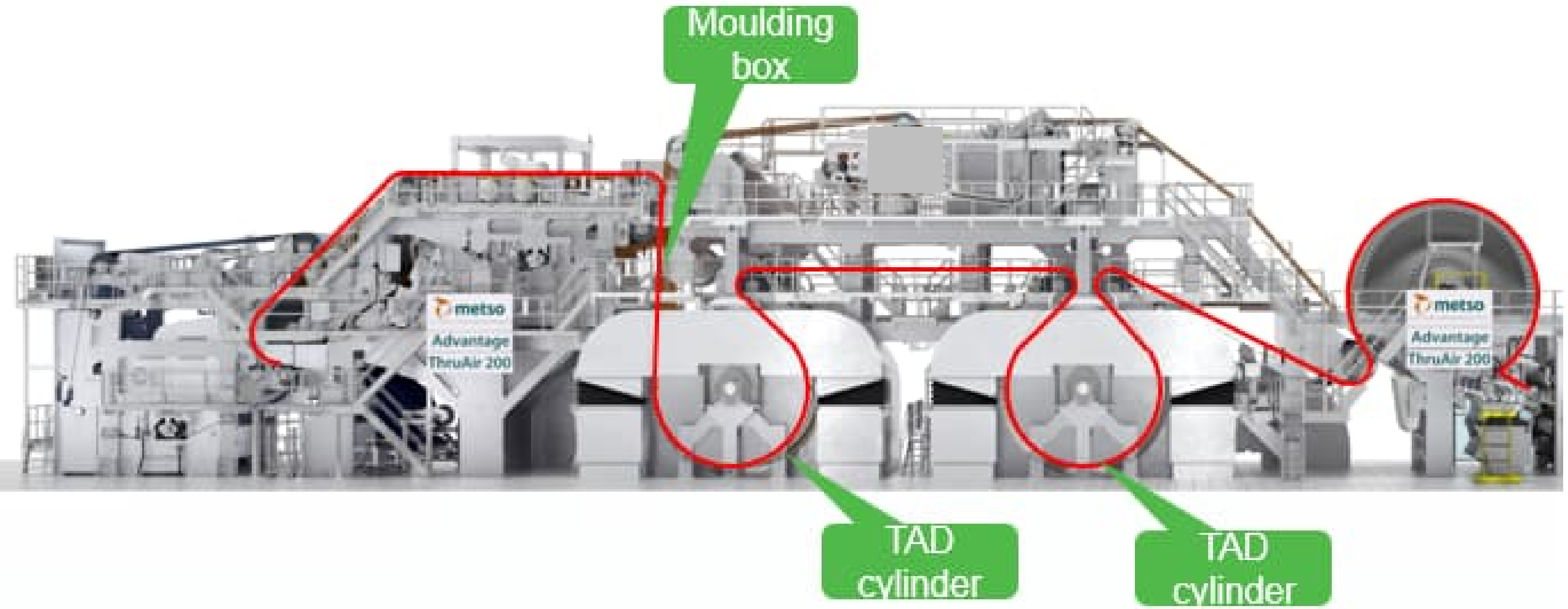


Typical: 0-25%

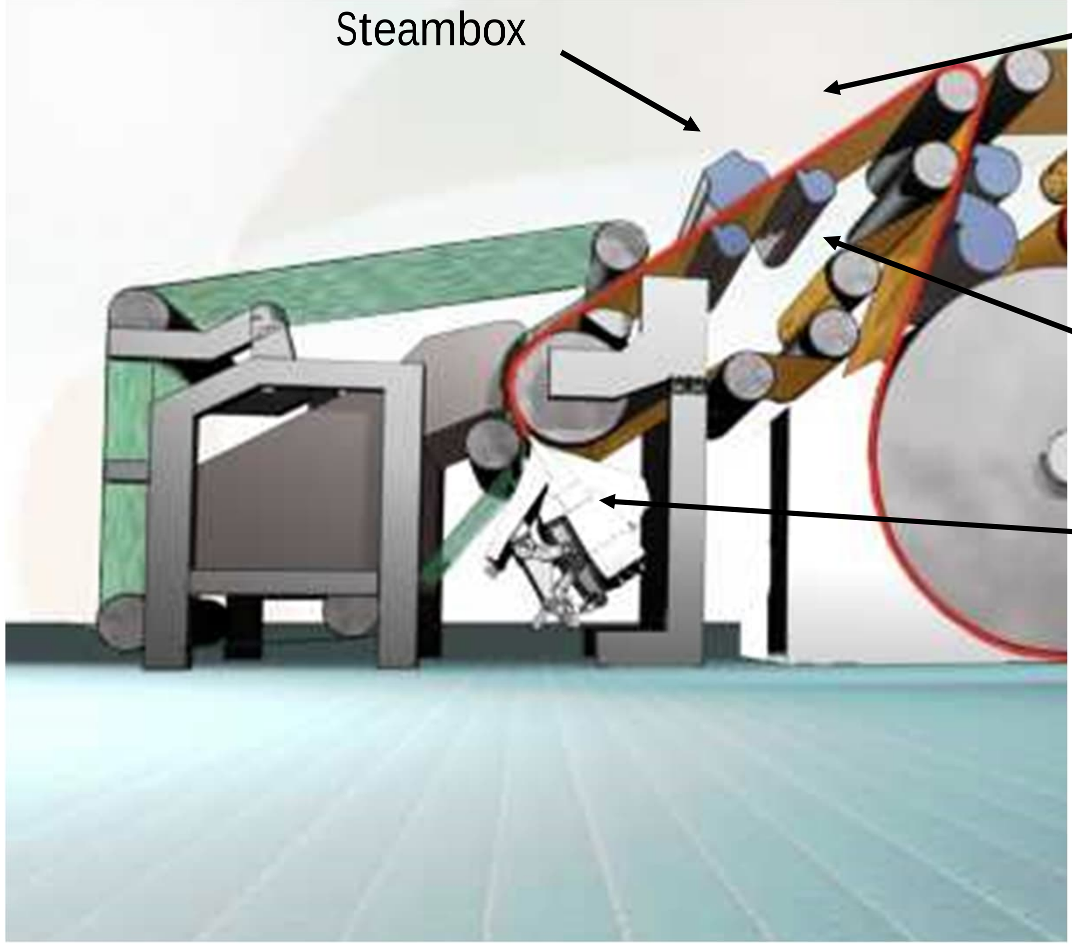
Typical: 10% to -5%

Modern TAD Machine





Forming Section Overview



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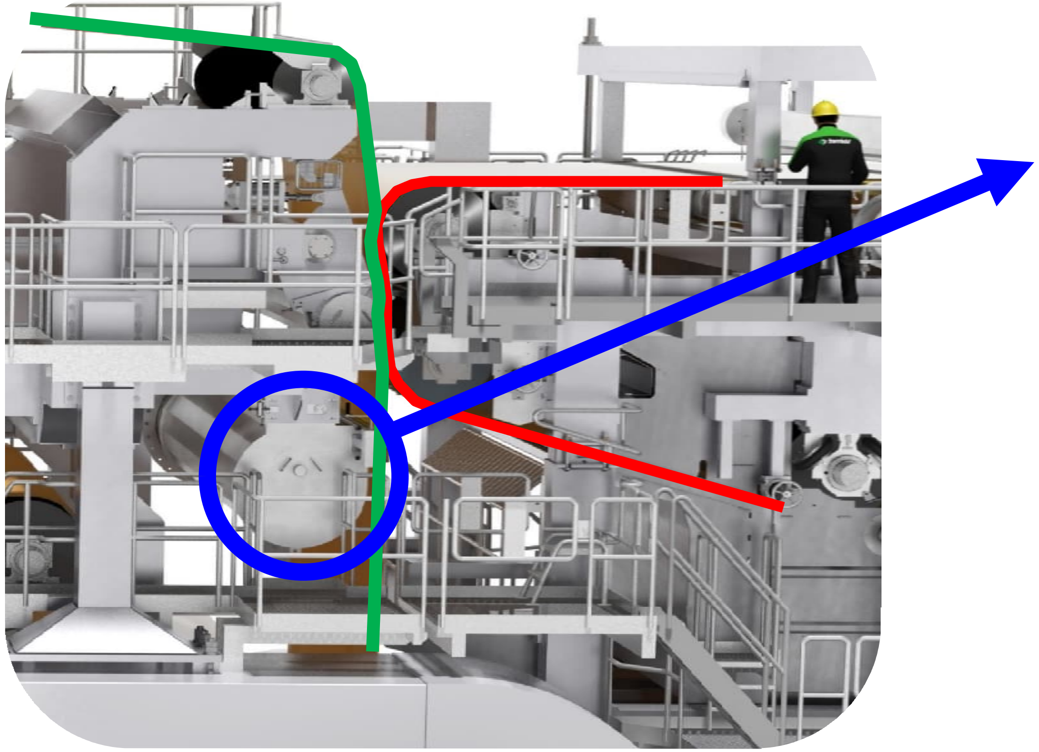
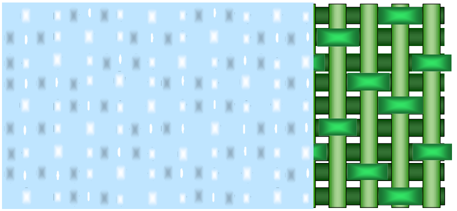
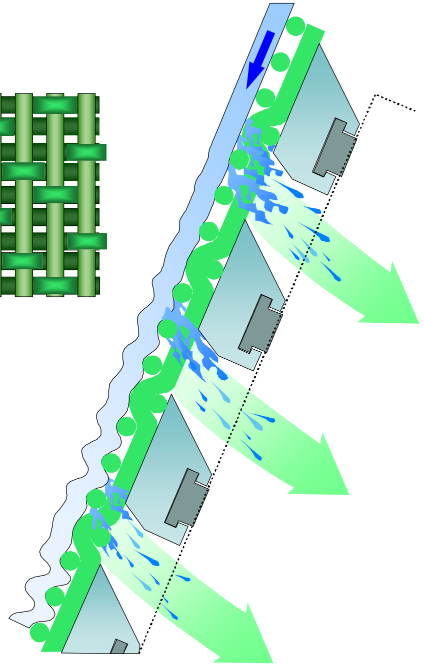
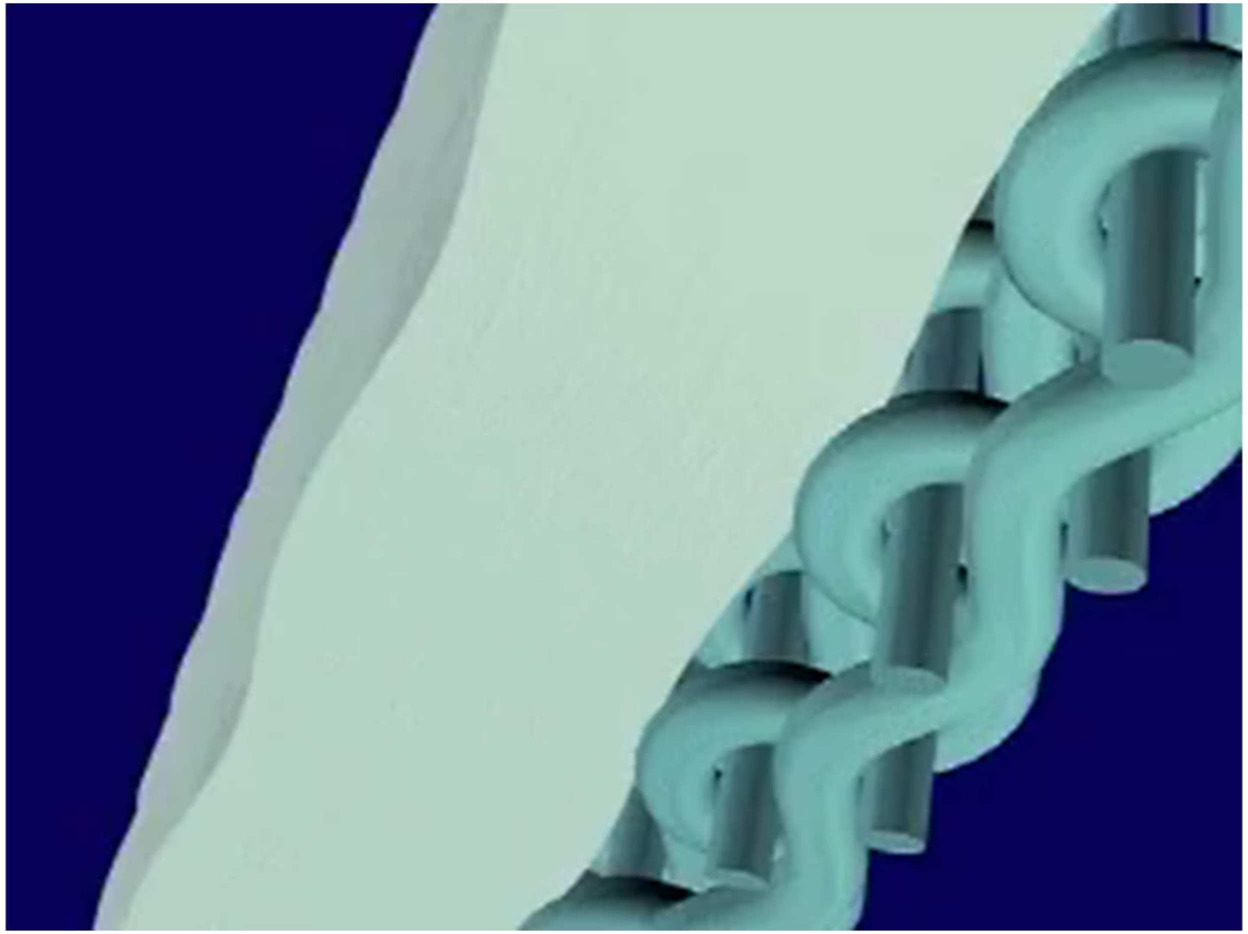
Molding

Sheet assumes the TAD fabric topography





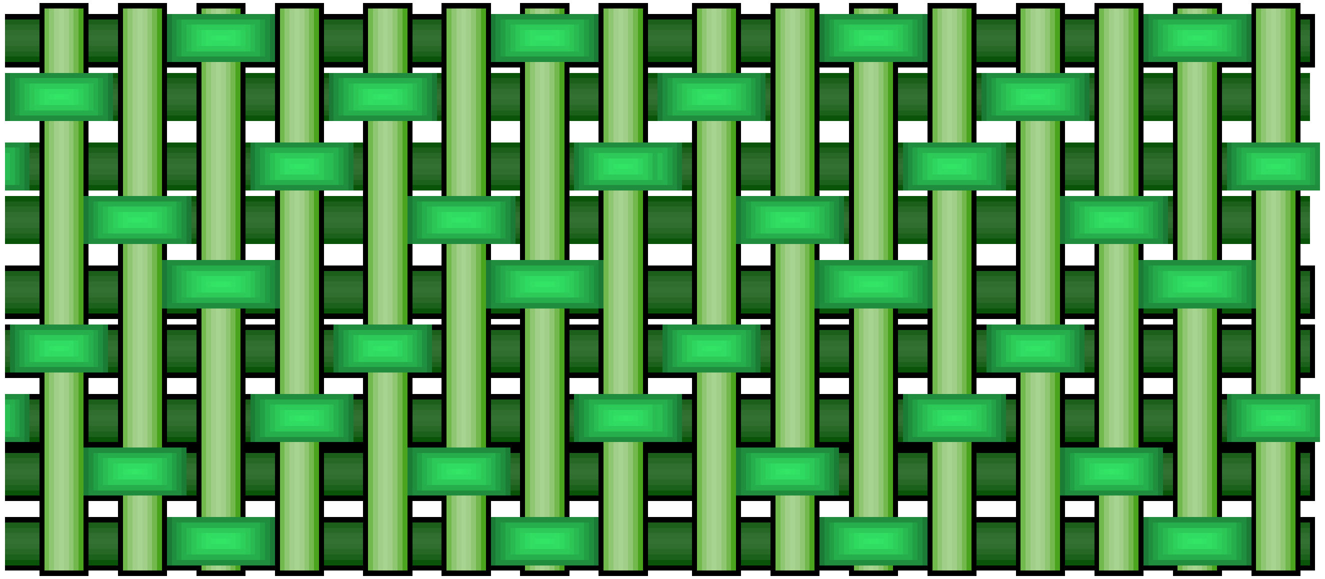




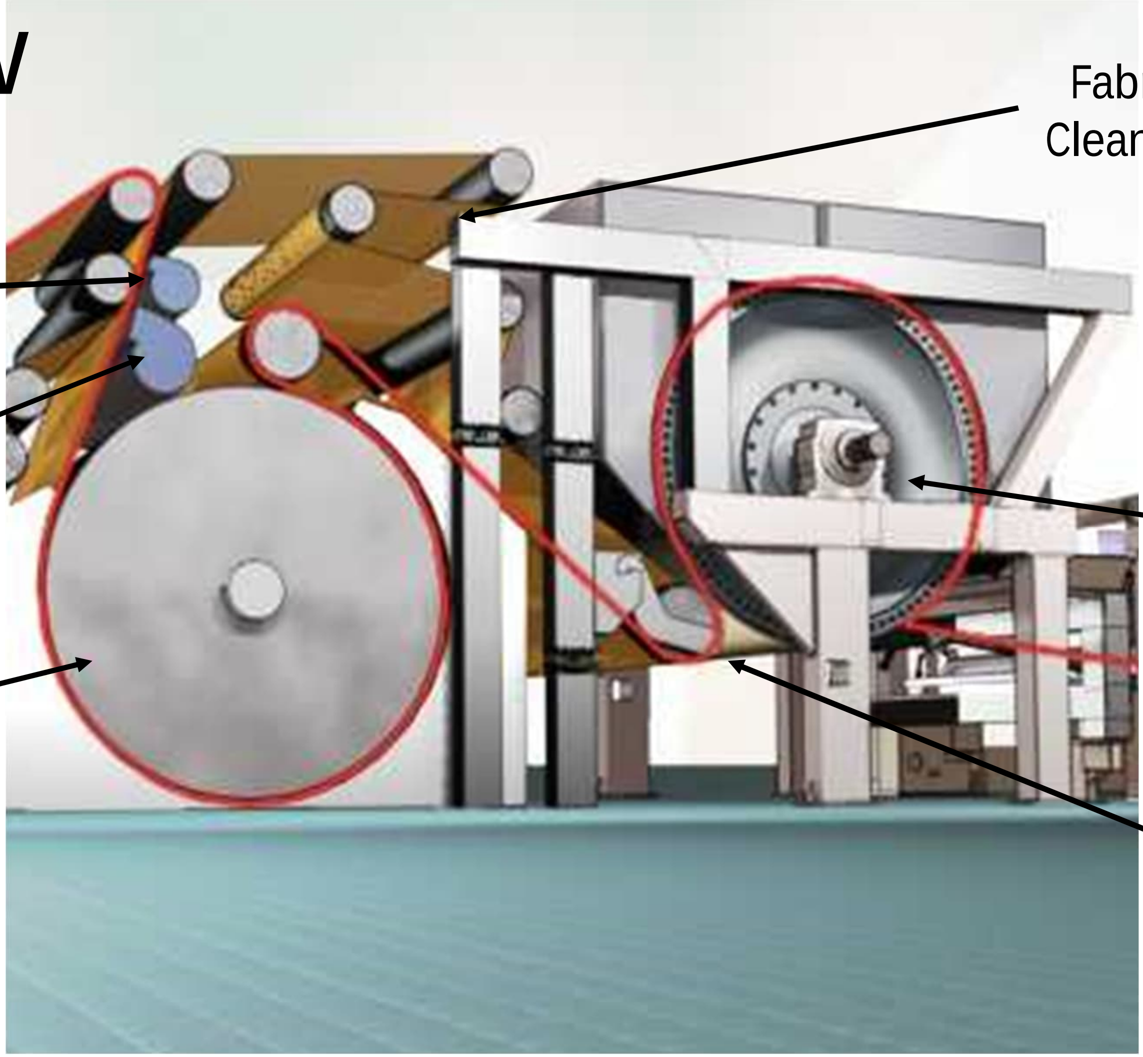
Drying Section
Fabric Conditioning Station

EQUIPMENT:

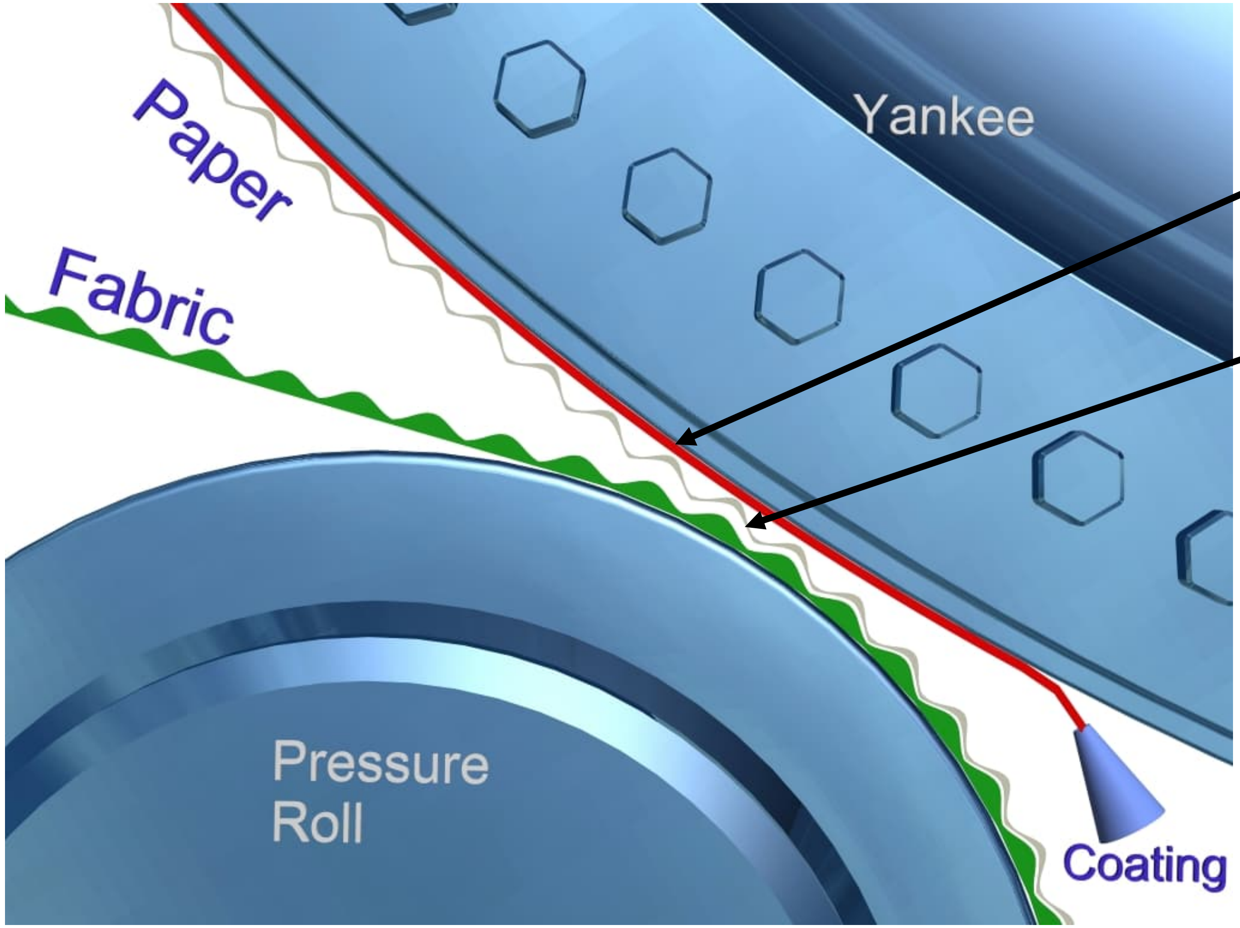
- ✓ LOW PRESSURE SHOWERS
- ✓ HIGH PRESSURE SHOWERS
- ✓ FLOODED NIP SHOWERS
- ✓ UHLE BOX
- ✓ FABRIC RELEASE SHOWER



Drying Section Overview

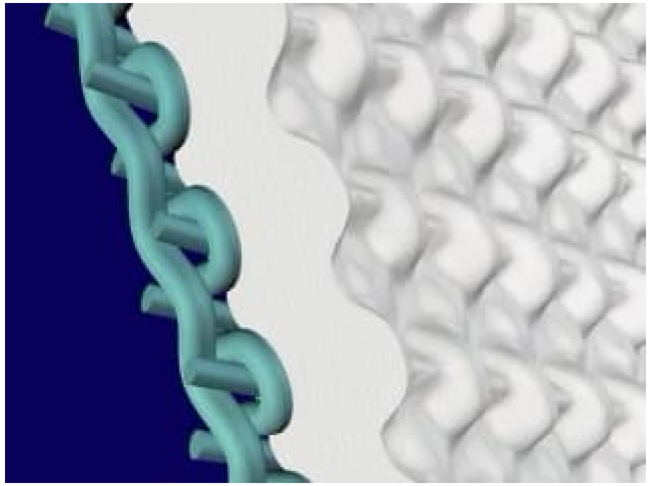


Drying Section
Sheet Transfer to Yankee



ONLY SHEET KNUCKLES CONTACT CYLINDER

SHEET POCKETS REMAIN PROTECTED



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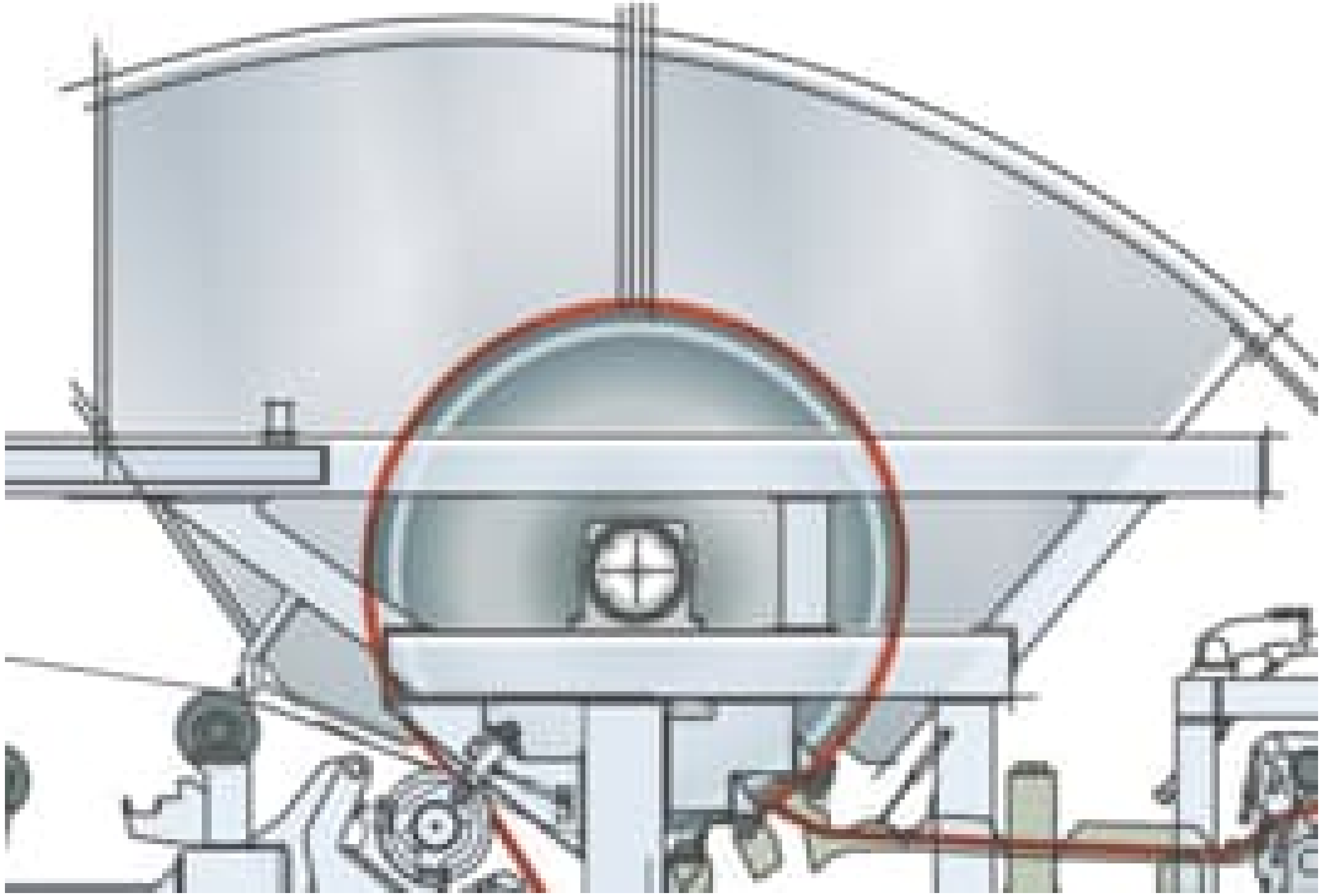
Drying Section
Yankee Cylinder

DESIGN SIMILAR TO CONVENTINOAL EXCEPT:

CROWN CACLCULATED FOR HIGHER CYLINDER TEMPERATURES

- CYLINDER TEMPERATURE > 100°C (212°F)
- LOWER PRESS LOADING, 50% OF CONVENTIONAL, 45kN/m
- SIGNIFICANTLY HIGHER YANKEE COATING ADD-ON (45-80mg/m^2)

Drying Section



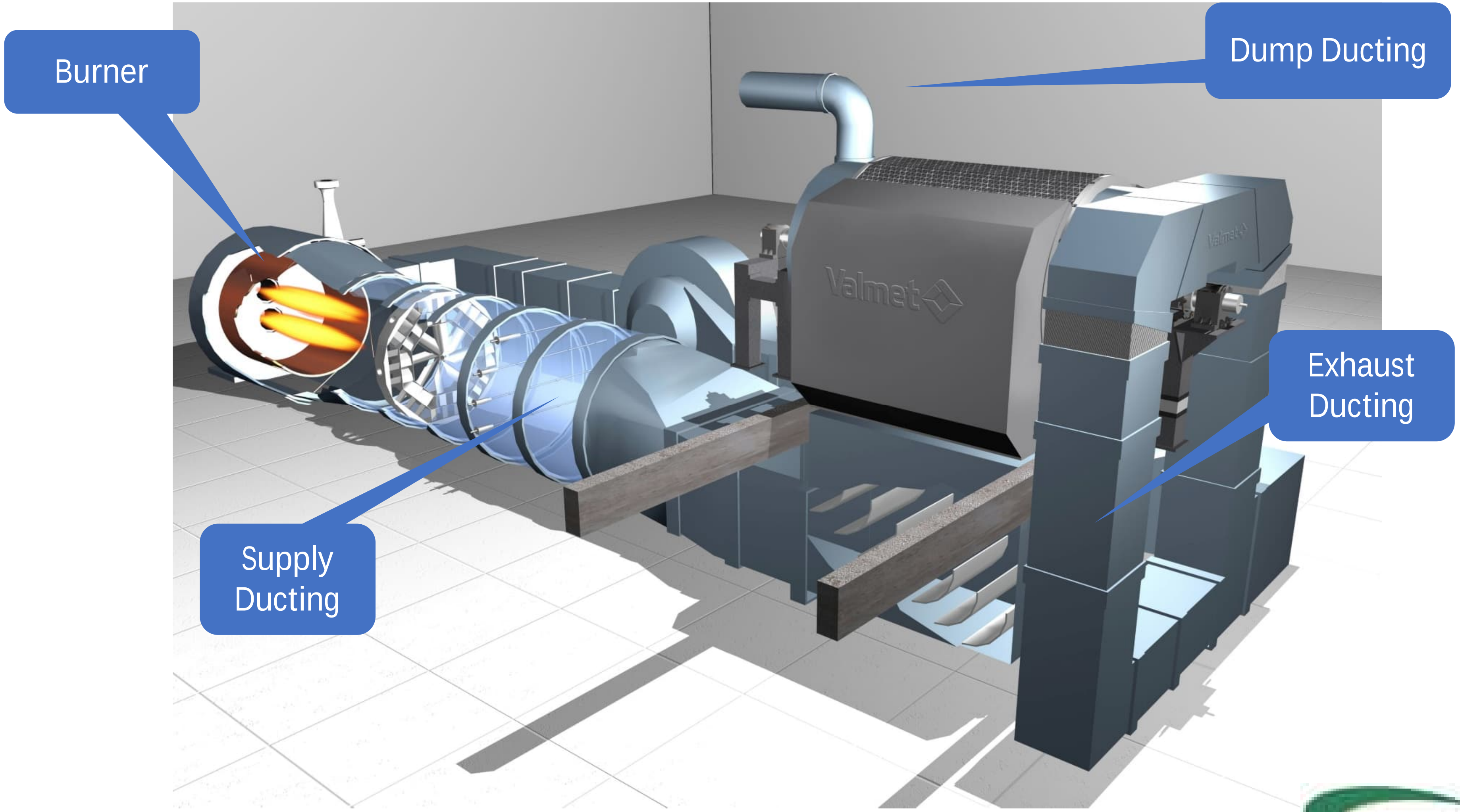
DESIGN SIMILAR TO CONVENTINOAL EXCEPT:

- MAY NOT HAVE PROFILING CAPABILITIES

OPERATION SIMILAR TO CONVENTINOAL EXCEPT:

- LOWER SUPPLY TEMPERATURE
- LOWER BLOWING VELOCITY
- DRYNESS AT CREPING DOCTOR ~96-99%

TAD Air System



- MAIN FAN CONTROLS SUPPLY PRESSURE
- DUMP FAN CONTROLS GAP PRESSURE

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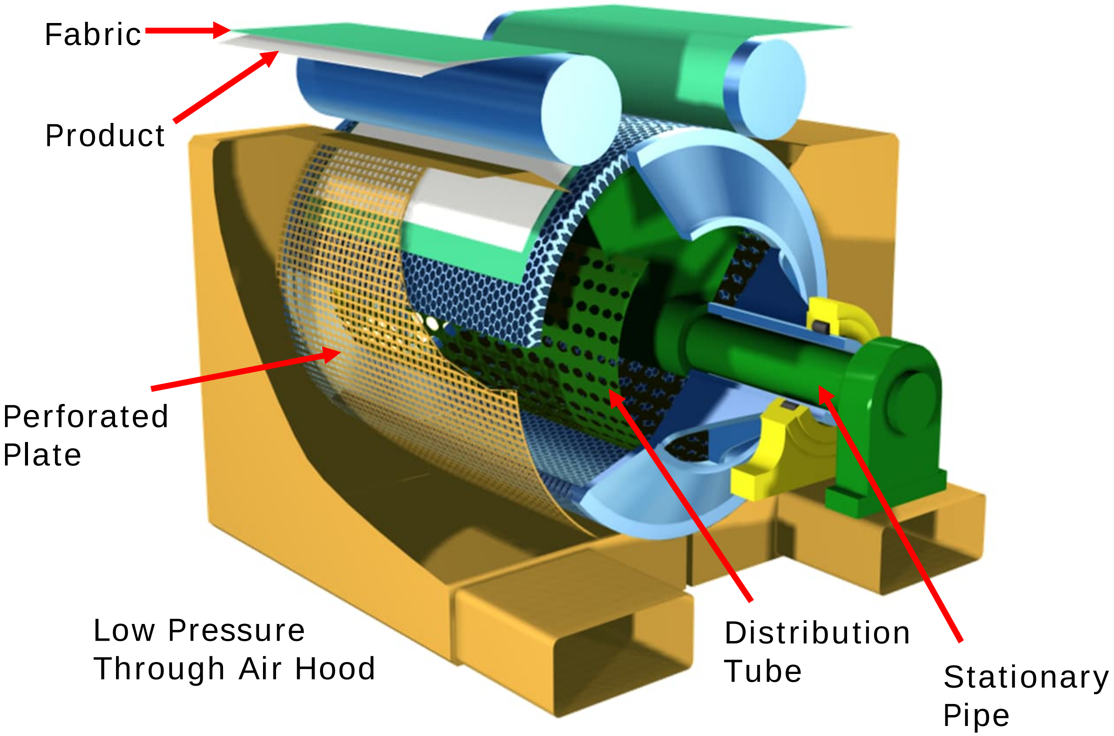
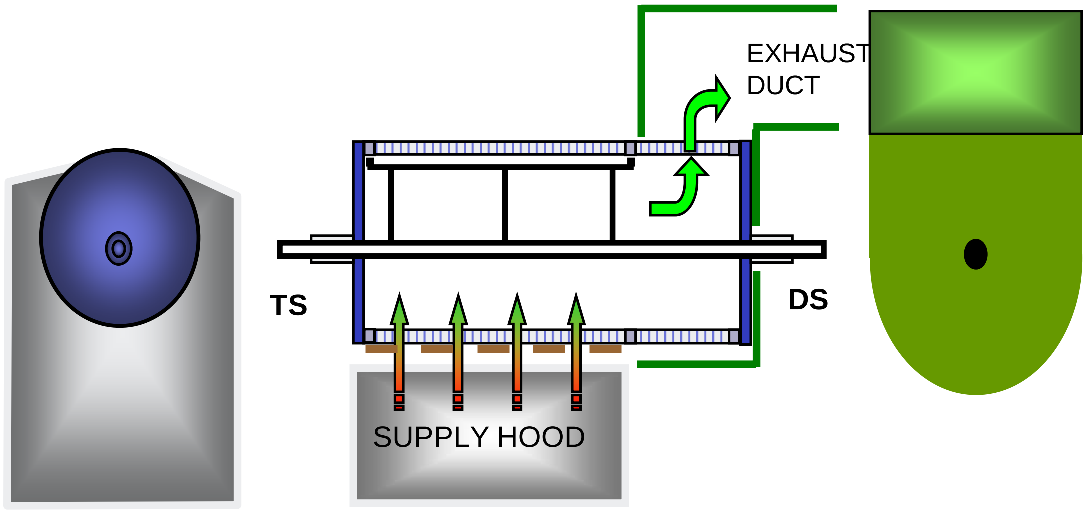
TAD Drying System Components

AXIAL EXHAUST ROLL



RADIAL EXHAUST ROLL



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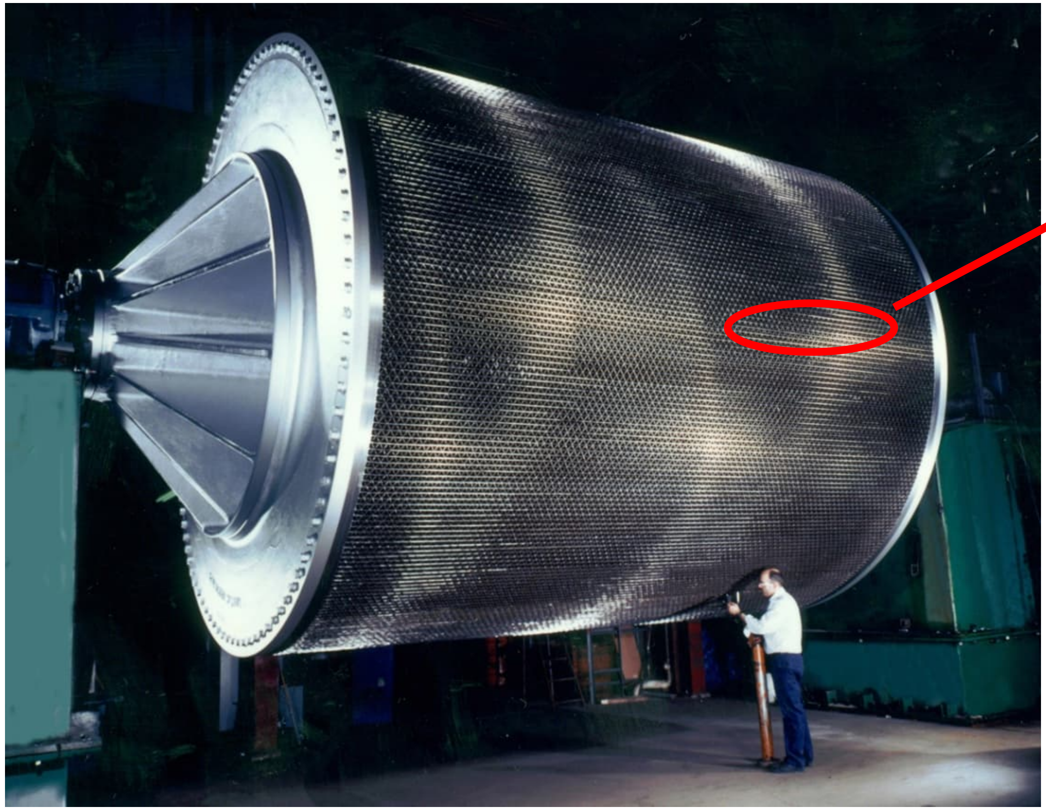
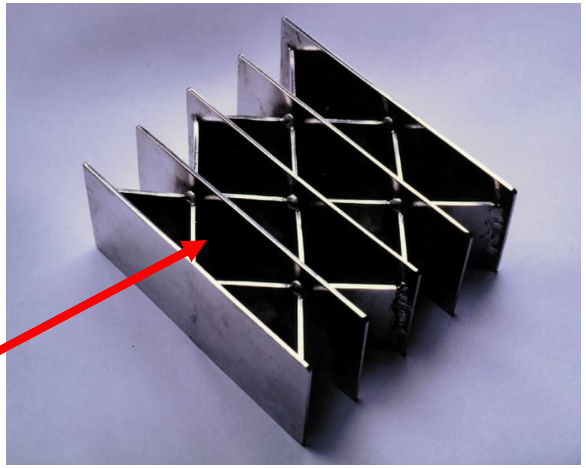
TAD Roll

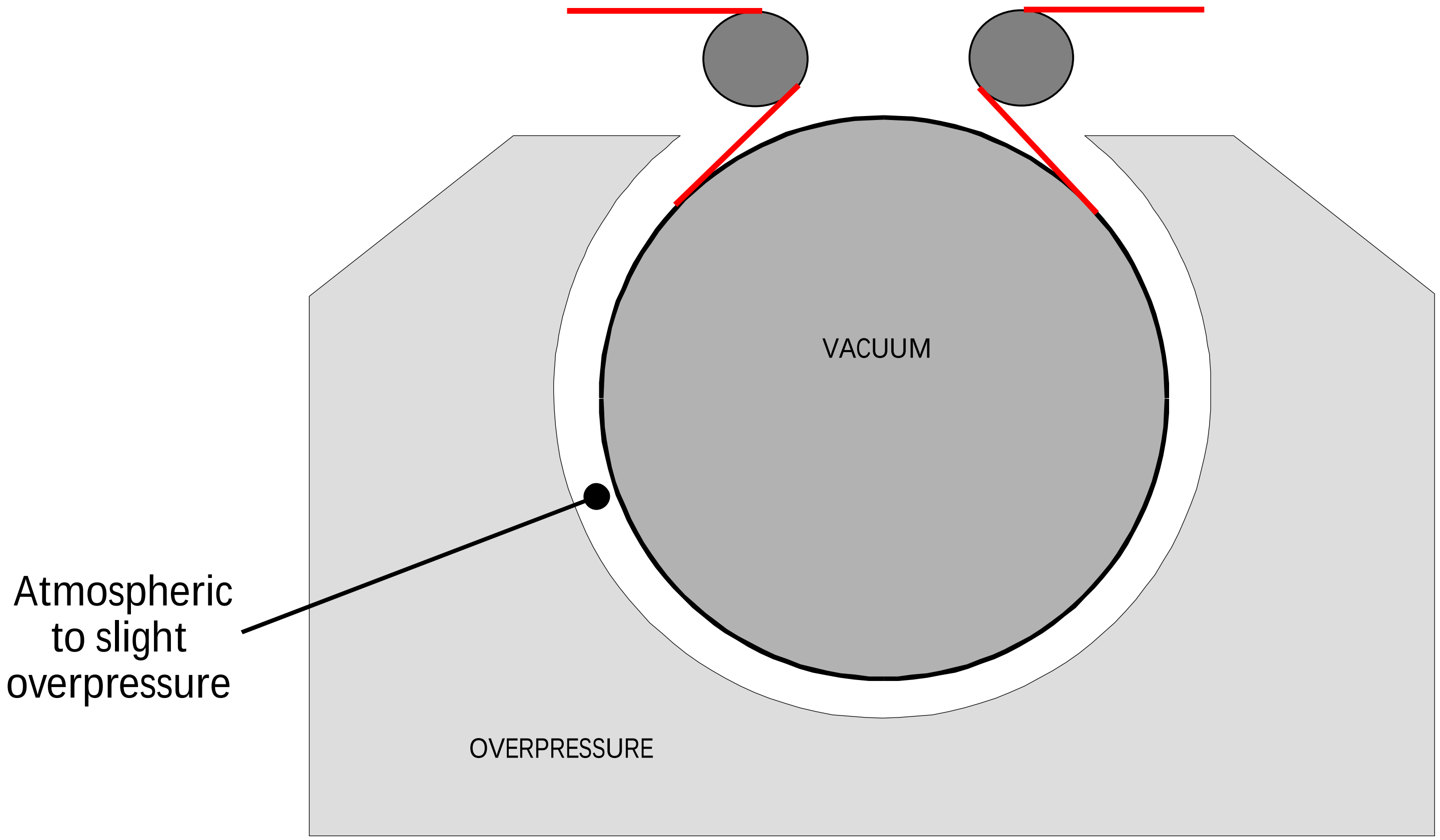




- STRUCTURAL INTEGRITY THROUGHOUT SPEED, TEMPERATURE REGIME
- HIGH OPEN AREA TO MINIMIZE PRESSURE DROP
- LOW CONTACT AREA TO MINIMIZE AREAS WITH ZERO THROUGH FLOW

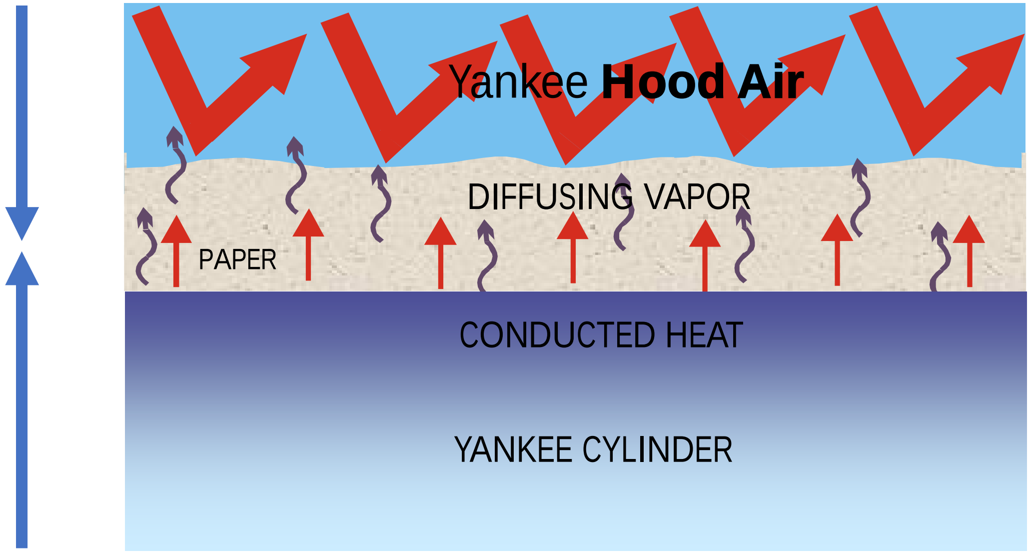
TAD Drying Process

- Supply air is not *BLOWN* through the sheet, it is *PULLED* through.
- Gap to be atmospheric to slight overpressure.
- Too much overpressure, or under pressure needs to be corrected.



Drying Section - Heat Transfer Mechanisms

YANKEE DRYING



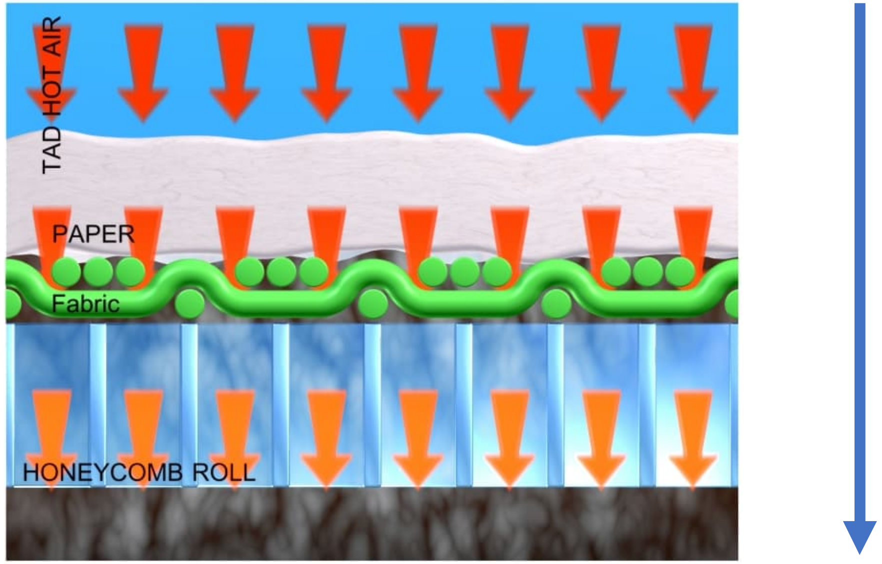
CYLINDER

- Heat transfer at cylinder surface

IMPINGEMENT HOOD

- Direct heat transfer to sheet surface
- Mass transfer only at sheet surface

THROUGH-AIR DRYING



- Direct heat transfer through entire medium
- Mass transfer through entire medium

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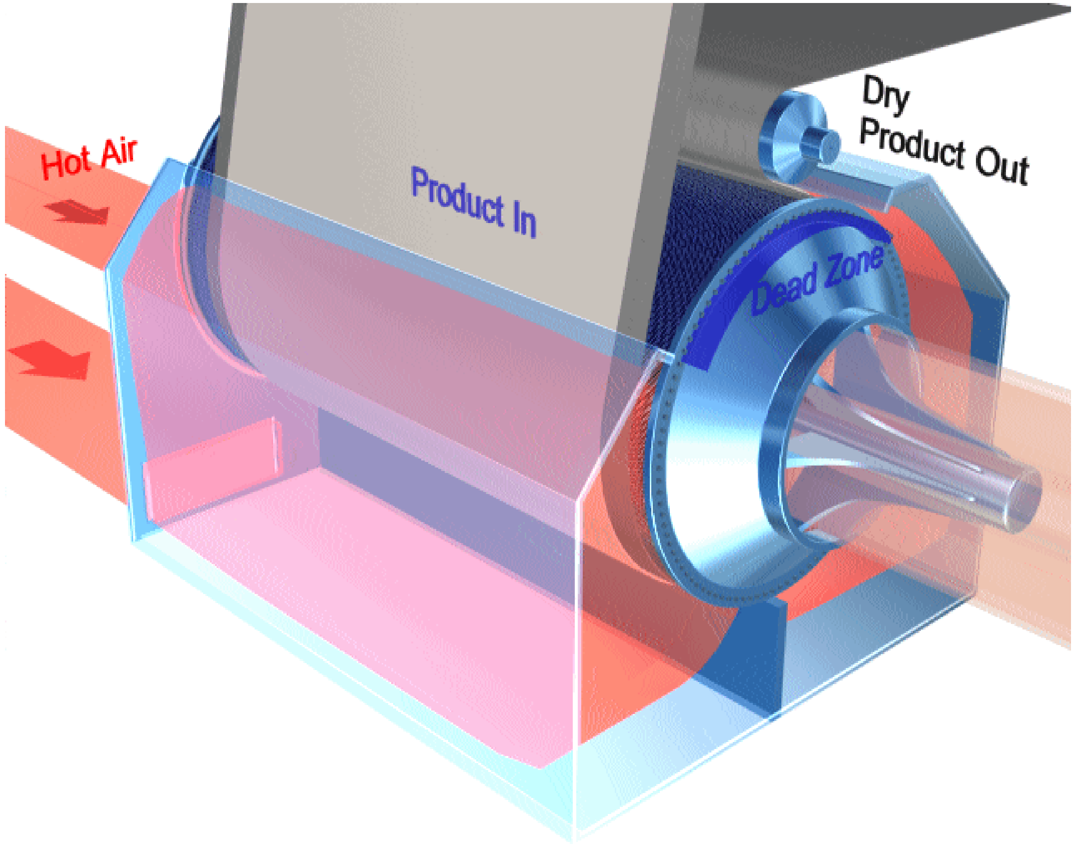
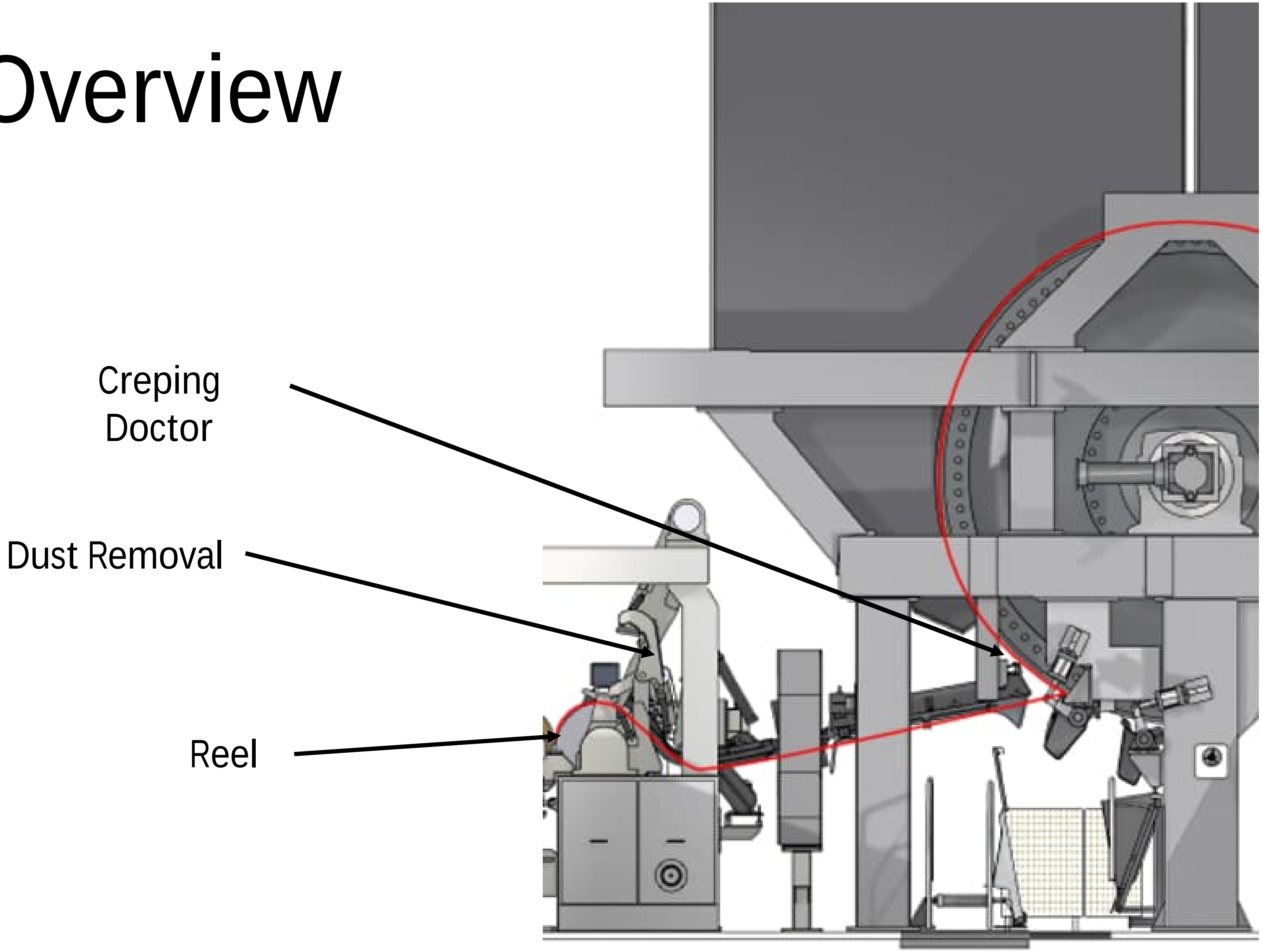
Drying Section - Air flow through TAD roll

SUPPLY AIR IN



EXHAUST AIR OUT

Dry End Overview



Dry-End Section Design & Operation

CREPING DOCTOR:

- SIMILAR TO CONVENTIONAL IN DESIGN AND GEOMETRY
- BLADE LOAD UP TO 3X CONVENTIONAL
- BLADE BEVEL ANGLE 65° VERSES 70-90° ON CONVENTIONAL.

DUST REMOVAL:

- DUST ENCLOSURE
- REMOVAL BY WET-DUST COLLECTORS AND SERIES OF AIR SHOWERS AUTOMATICALLY ACTIVATED

REEL:

- BELTED REEL DESIGN TO PRESERVE BULK AND REDUCE BULK VARIATION IN THE SAME ROLL.
- CENTER-WIND ASSIST (CWA) ON SECONDARY CARRIAGE OR BOTH PRIMARY AND SECONDARY.

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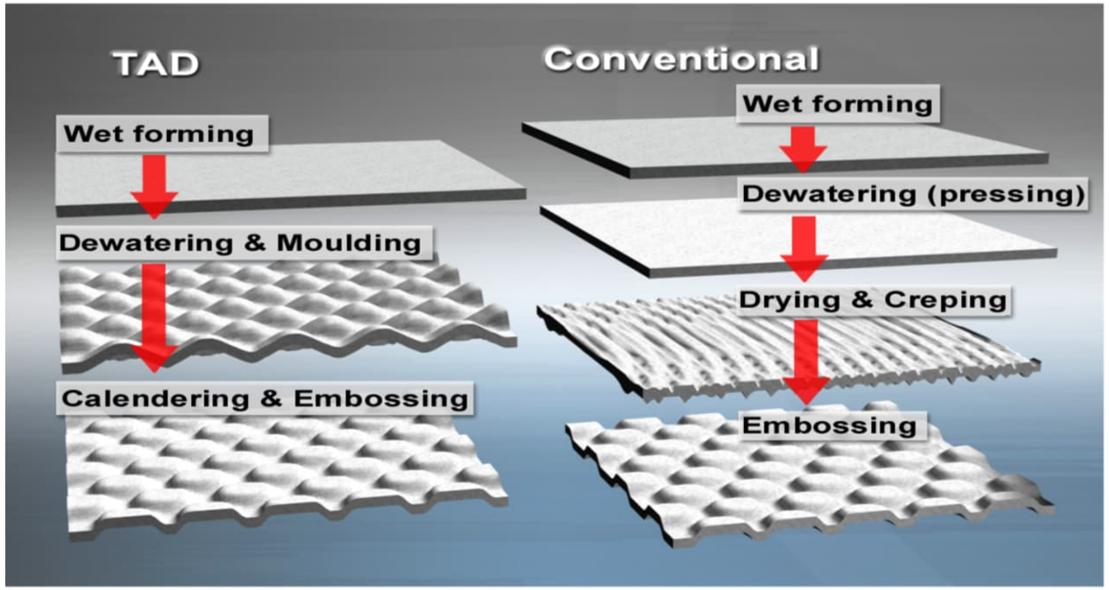
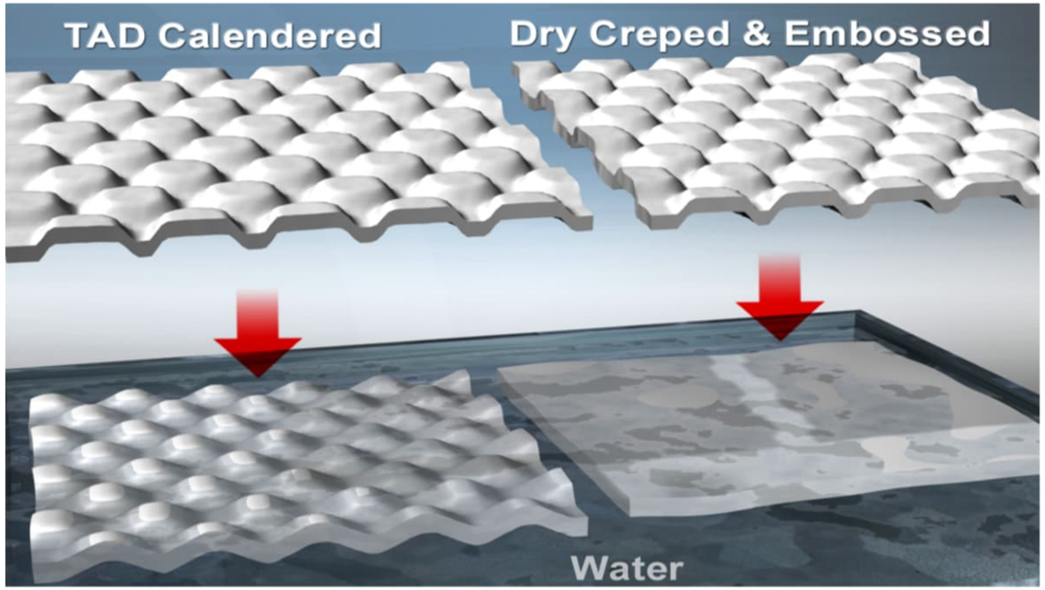
TAD Drying Process - Product comparison



BULK GENERATION

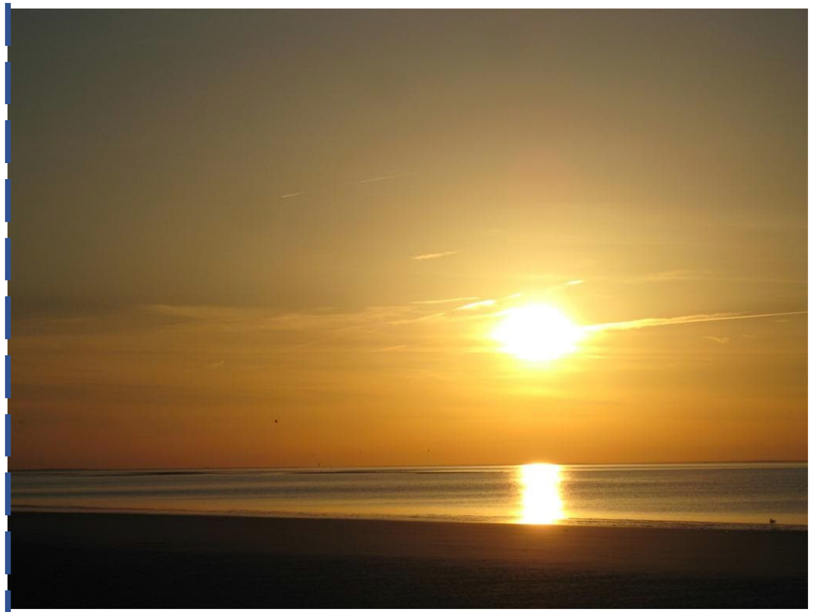


REWET PROPERTIES

Drying Variables

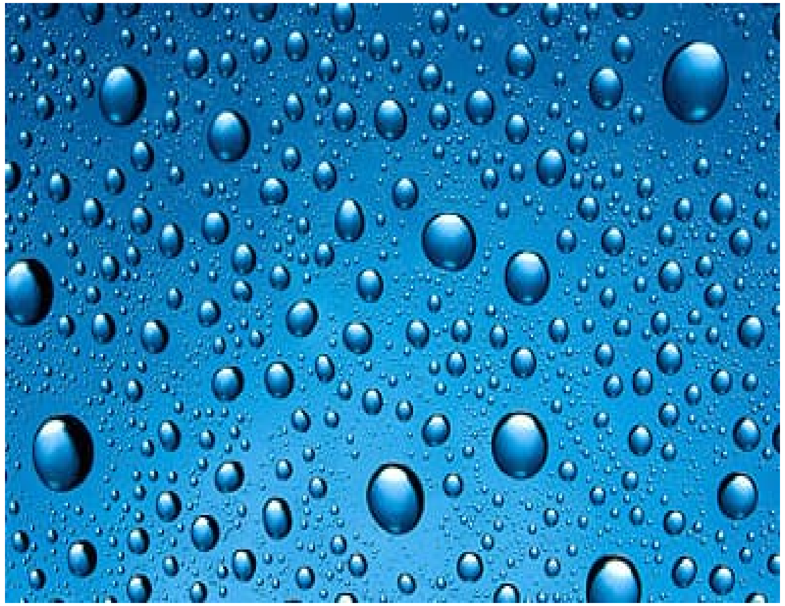
TAD DRYING RELIES MAINLY ON THESE FACTORS

Temperature



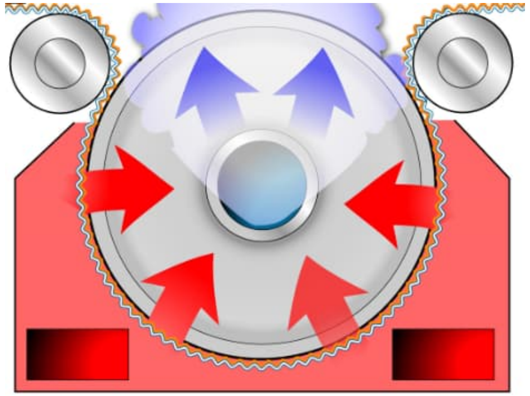
Pressure

Humidity

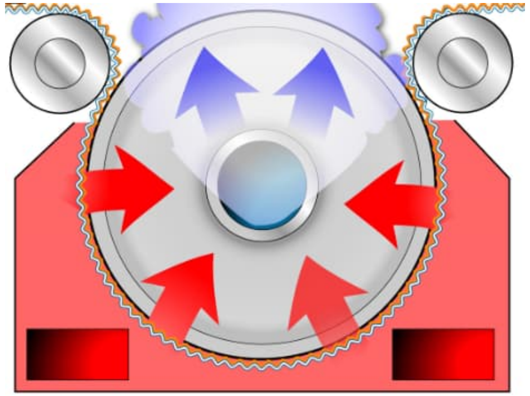


TAD Drying Process

Most Productive Drying Conditions = High Temperature + Dry Air

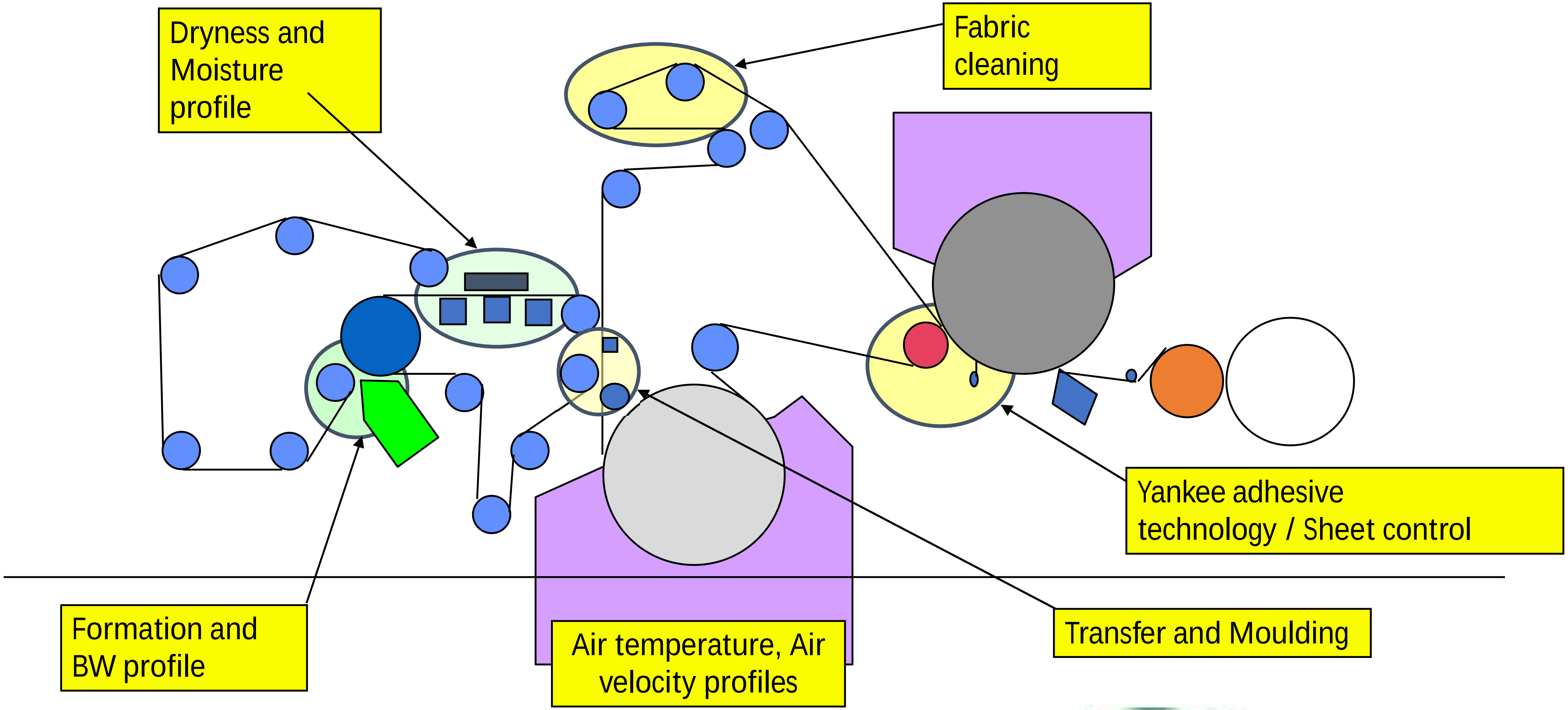


Most Efficient Drying Conditions = High Temperature + High Humidity



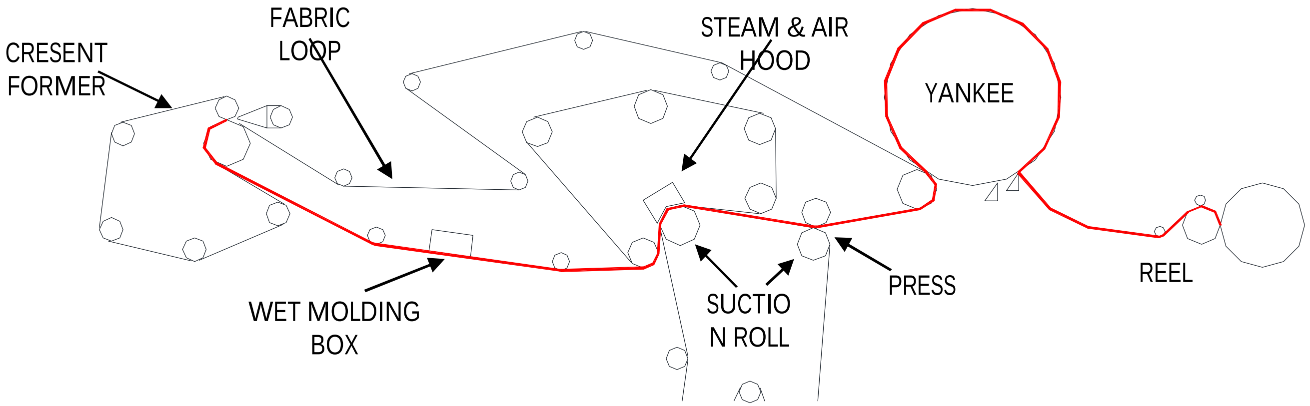
Q = M * Cp * delta T

Critical Run-ability Areas

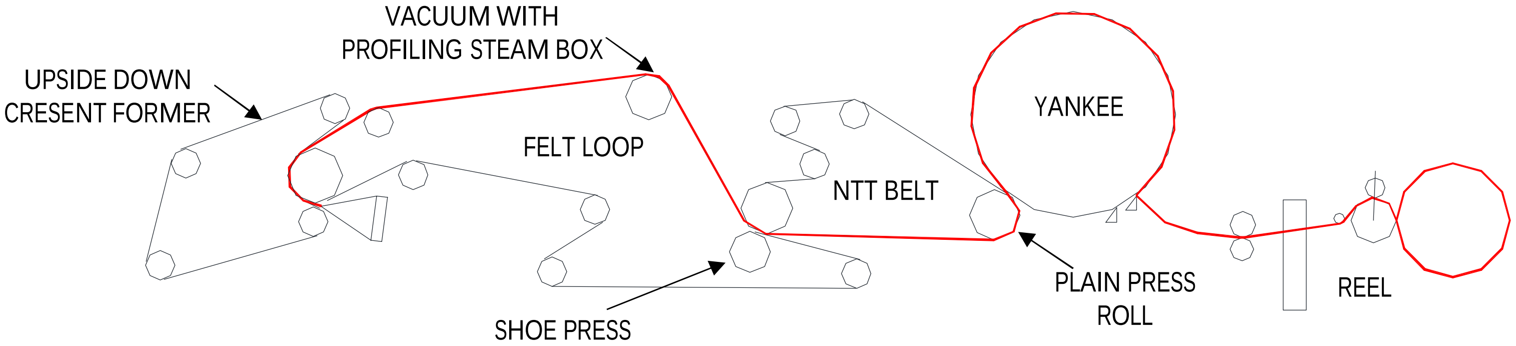


Other Technologies

ATMOS



NTT



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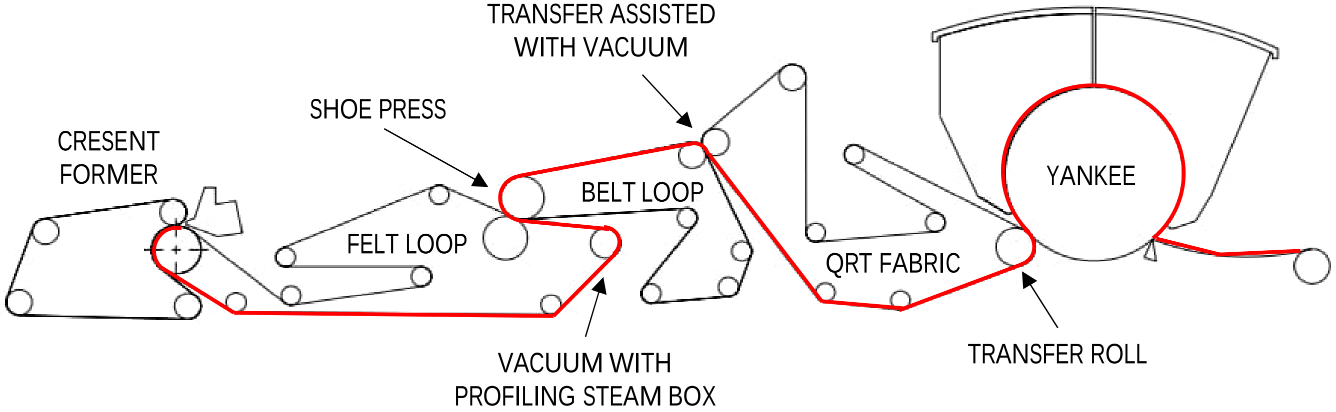
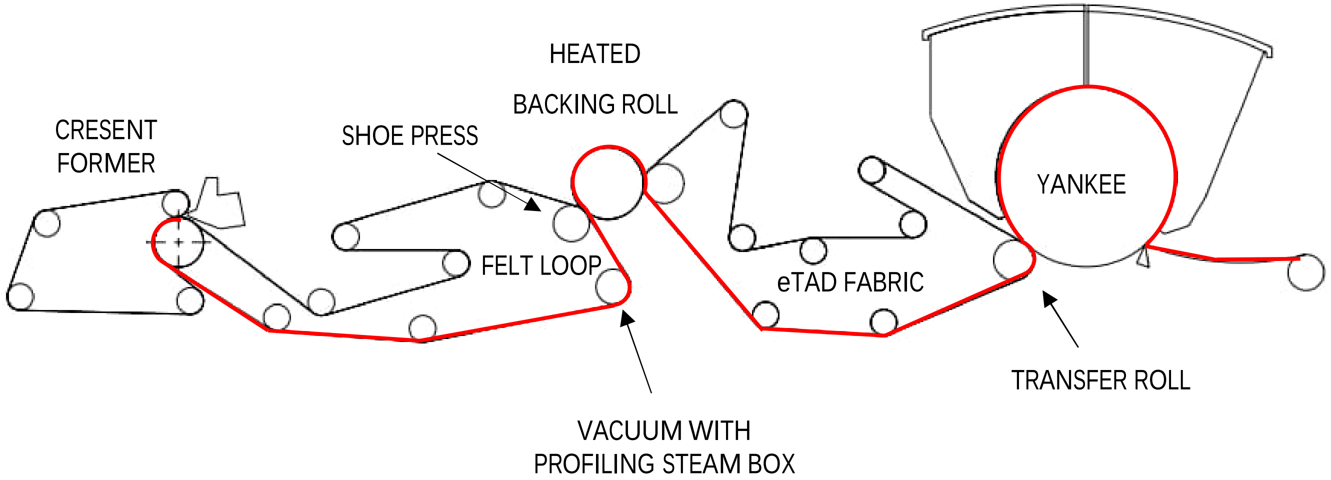
Other Technologies

QRT



eTAD



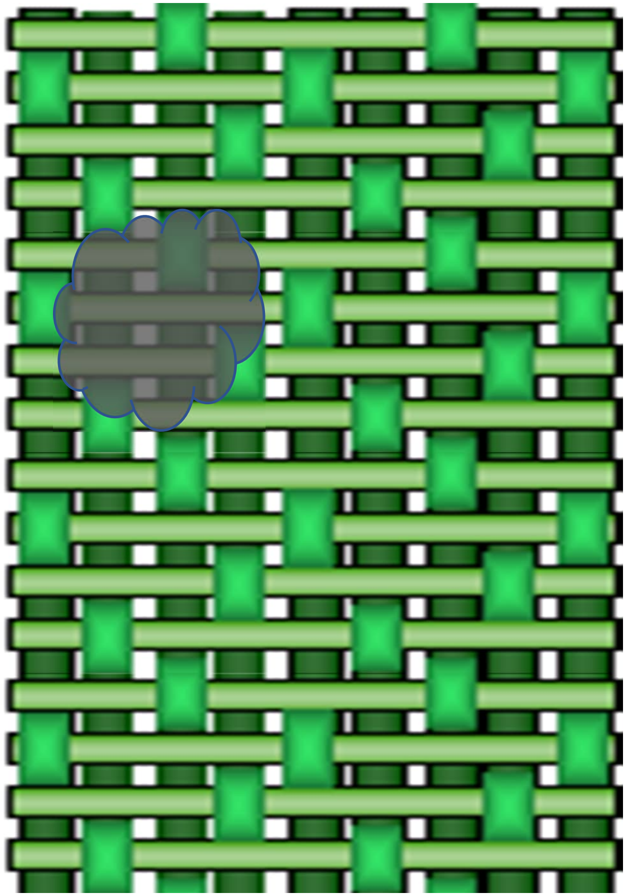
Part 2: TAD Machine Run-ability

- TAD FABRIC
- NON-UNIFORM TAD DRYING
- SHEET TRANSFER TO YANKEE
- DRY END

Fabric Protection

METHODS OF FABRIC PROTECTION

- Rapid turndown of the burners
- Diversion of supply air to the atmosphere
- Diversion of the supply air through an internal bypass
- Activation of load showers to cool the supply air stream



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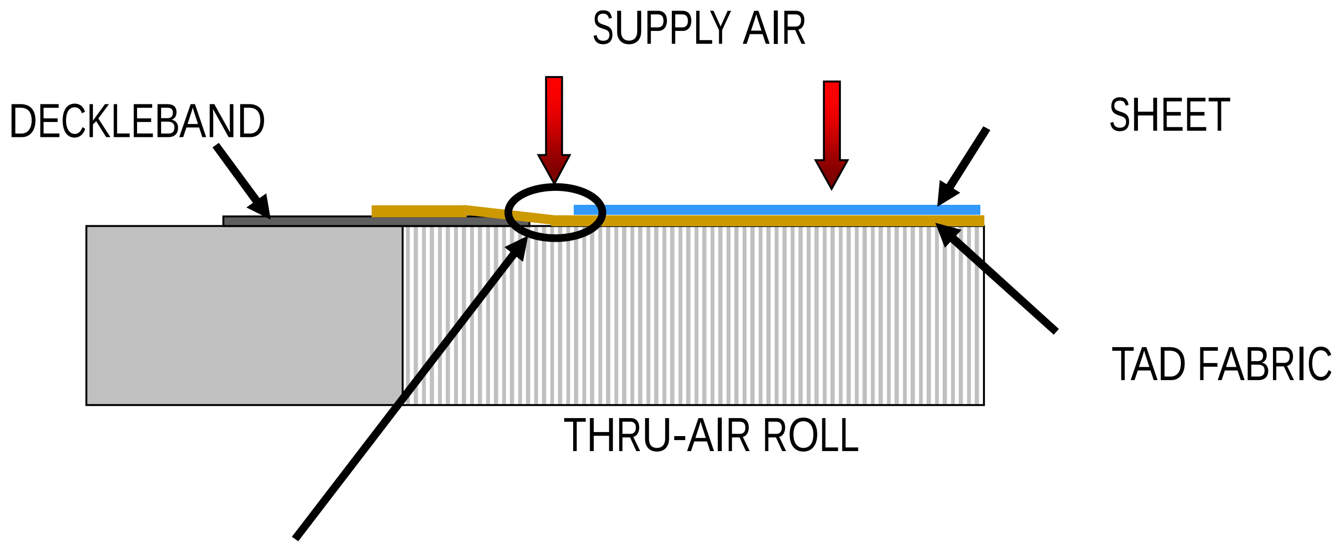
Importance of sheet edge alignment to deckle

CONFIGURATION 1: TOO FAR = GAP BETWEEN SHEET EDGE AND DECKLEBAND

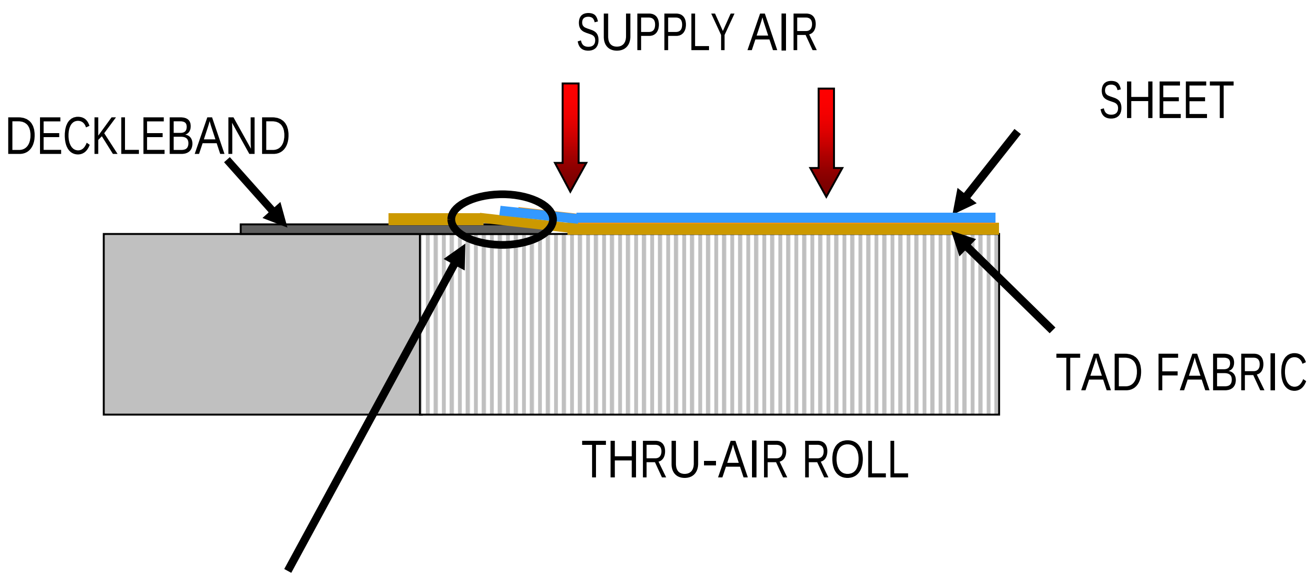


~ 4 x AIR VELOCITY THROUGH GAP

RESULT = **ELEVATED FABRIC TEMPERATURE**

Importance of sheet edge alignment to deckle

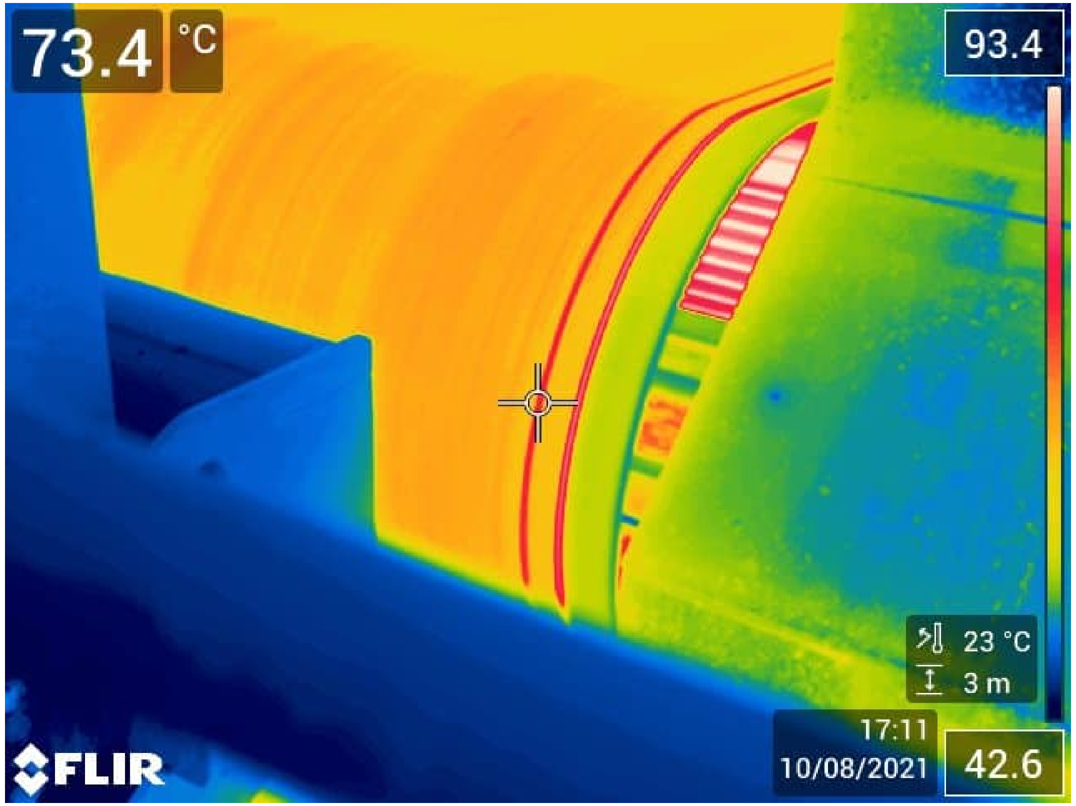
CONFIGURATION 2: TOO CLOSE = OVERLAP OF SHEET ON DECKLEBAND



NO HEAT TRANSFER TO SHEET EDGE = NO DRYING

RESULT = **WET EDGE**

Importance of sheet edge alignment to deckle



Before adjusting 2nd transfer deckle

After adjusting 2nd transfer deckle

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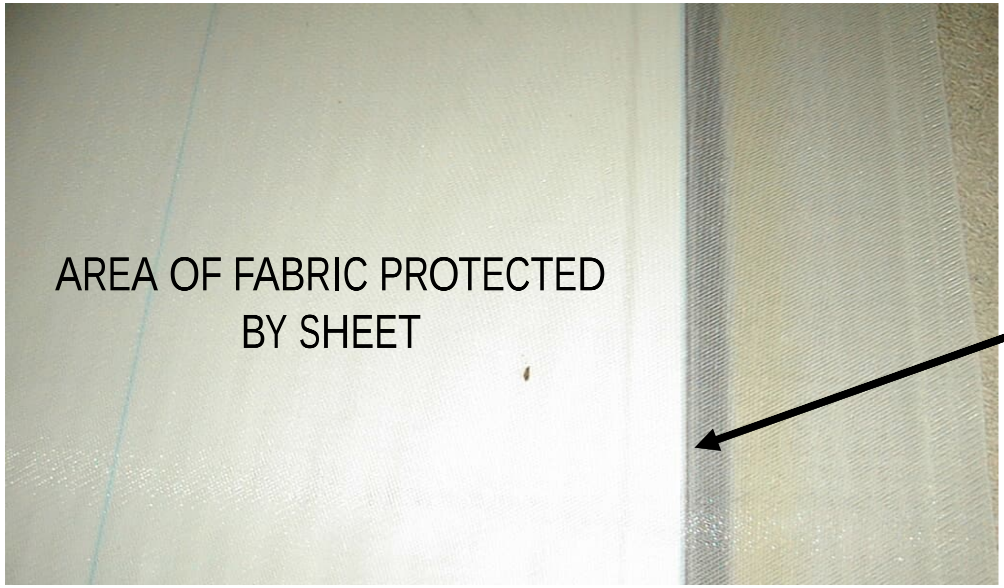
Fabric wear at deckle band edge
Visual indication that fabric wear is occurring

LOCATION OF SHEET EDGE

LOCATION OF DECKLEBAND EDGE



DARK STREAK IN FABRIC
CAUSED BY GAP
BETWEEN SHEET EDGE
AND DECKLEBAND

Most Common Fabric Failures

✓ Hygiene

- Debris fell into the fabric (glue box, pressure roll heads, Yankee heads
- Wear : dirt/resin buildup on elements, deckles, etc

✓ Mechanical

- Loss in dimensional stability
- Seams, Holes, Edge tearing, tear and wear
- Wrong adjustment of stationary elements
- TAD deckle band damaged

✓ Operational

- Excessive load on transfer roll
- Rush transfer without sheet ON
- Excessive shower pressure
- Showers OFF while TAD burners running

✓ Hydrolysis

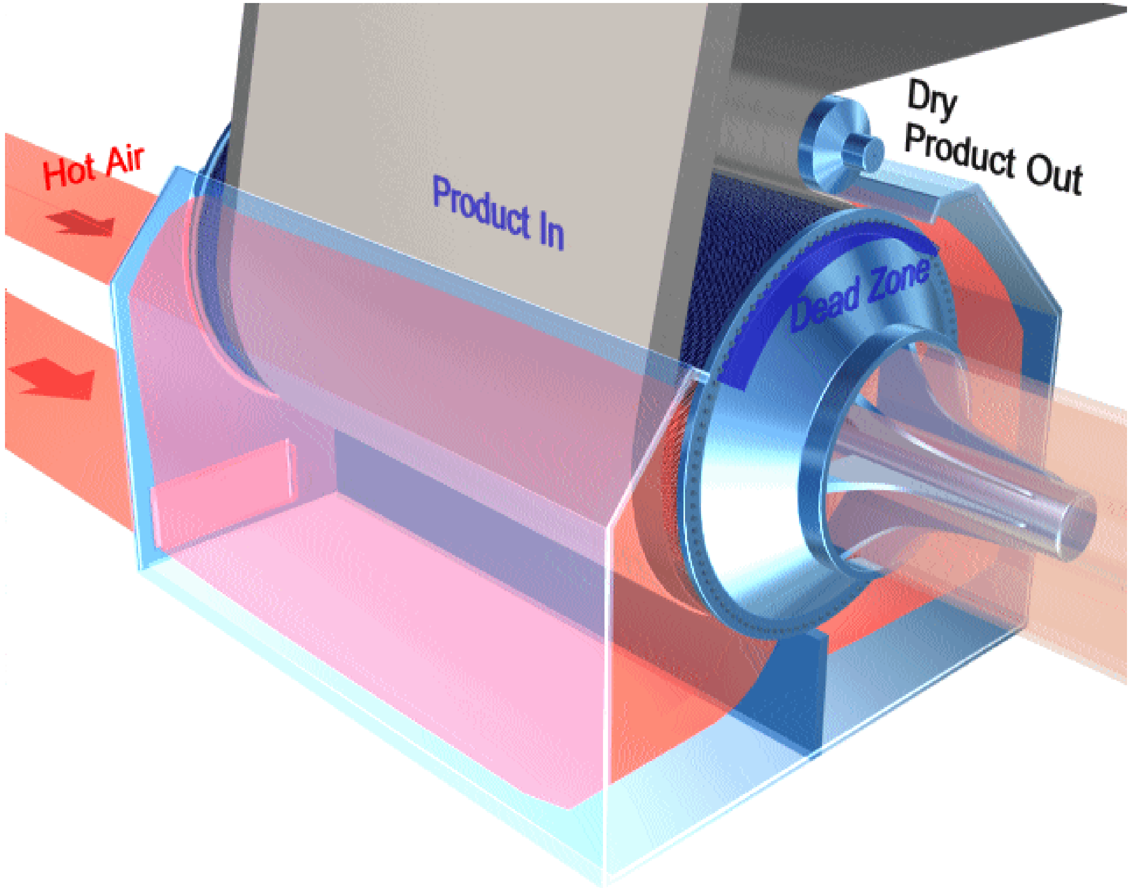
- Degradation of the molecular structure due to temperature.

TAD Drying

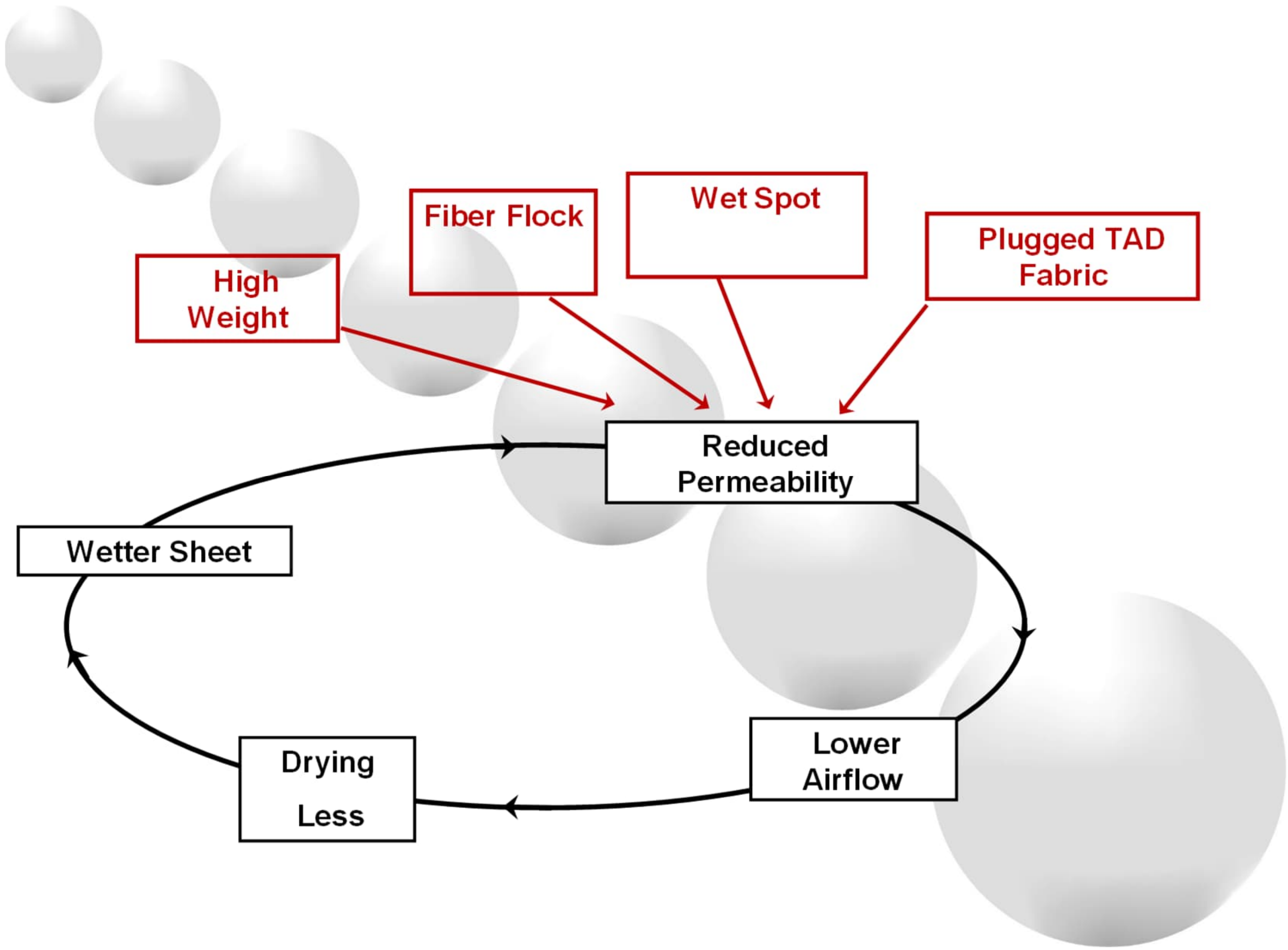
CRITICAL FACTORS:

1. NON-UNIFORM DRYING - TEMPERATURE, FLOW DISTRIBUTION

2. NON-UNIFORM DRYING - BASIS WEIGHT, MOISTURE, FABRIC CONTAMINATION



TAD Drying Uniformity / Snowball effect



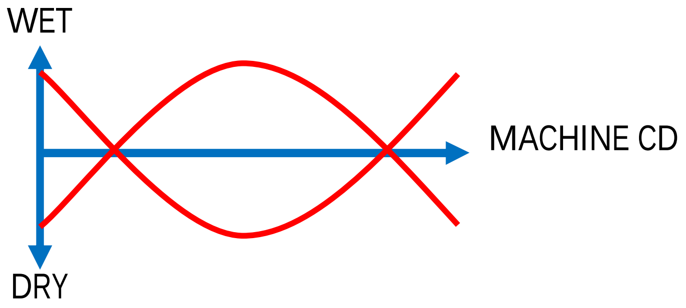
- Air takes the path of least resistance
- If the path is less permeable – for any reason – the air will go around and reduce drying in that location.
- The adjacent areas thus get drier, and more permeable promoting even more air flow leading to the snowball effect.

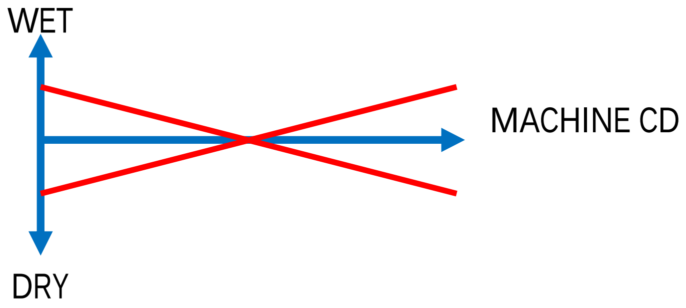
TAD Drying

Non-Uniform Drying

POOR LOCAL CD MOISTURE PROFILES ARE NOT INHERENT TO TAD

❖ POTENTIAL PROFILES

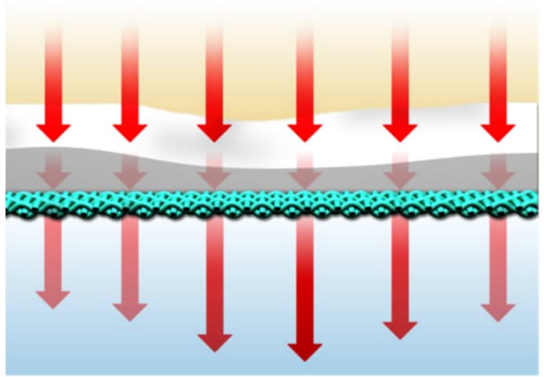




✓ USUALLY DETECTED AND REMEDIED AT STARTUP

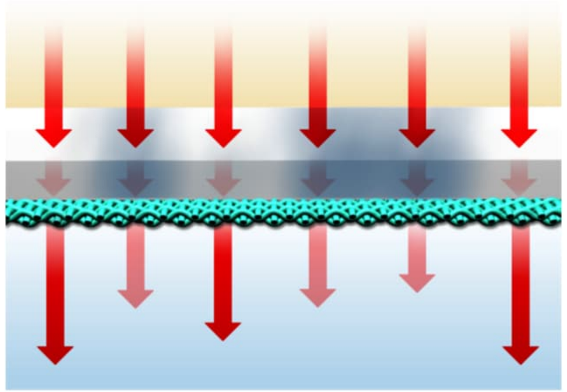
TAD Drying
Non-Uniform Drying

BASIS WEIGHT



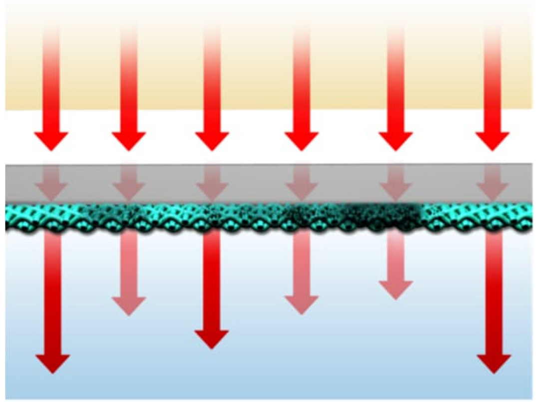
Excess drying in low BW areas!

INLET TAD DRYNESS



Reduced drying in wet areas!

FABBRIC CONTAMINATION



Reduced flow / less drying through contaminated areas!

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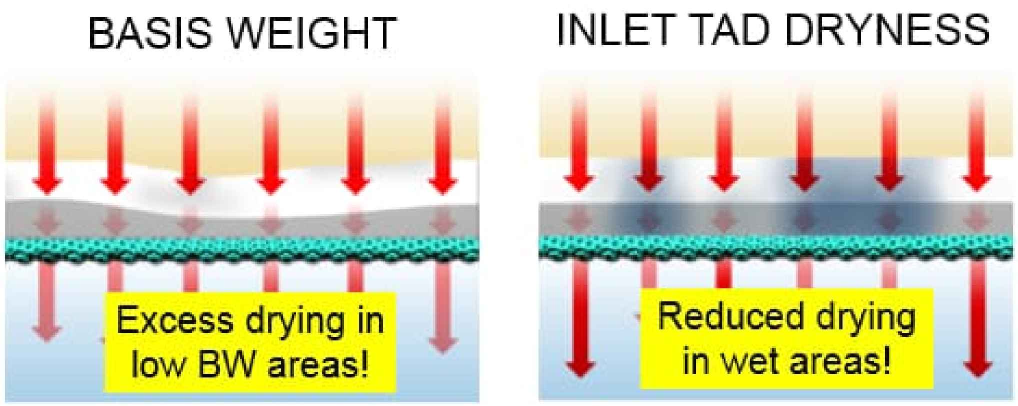
TAD Drying

Non-Uniform Drying



	Sheet Dryness In	Basis Weight	Sheet Dryness Out
	%	g/m^2	%
BASE CASE	25%	20	80%
5% DECREASE INLET DRYNESS	23.7%	20	69%
5% INCREASE BASIS WEIGHT	25%	21	73%
COMBINED EFFECT	**23.7%**	**21**	**63%**

TAD Drying
Non-Uniform Drying

BASIS WEIGHT OR INLET TAD MOISTURE:

- ✓ HEADBOX
- ✓ VACUUM BOXES
- ✓ FABRICS

FORMING OR TAD FABRIC CONTAMINATION:

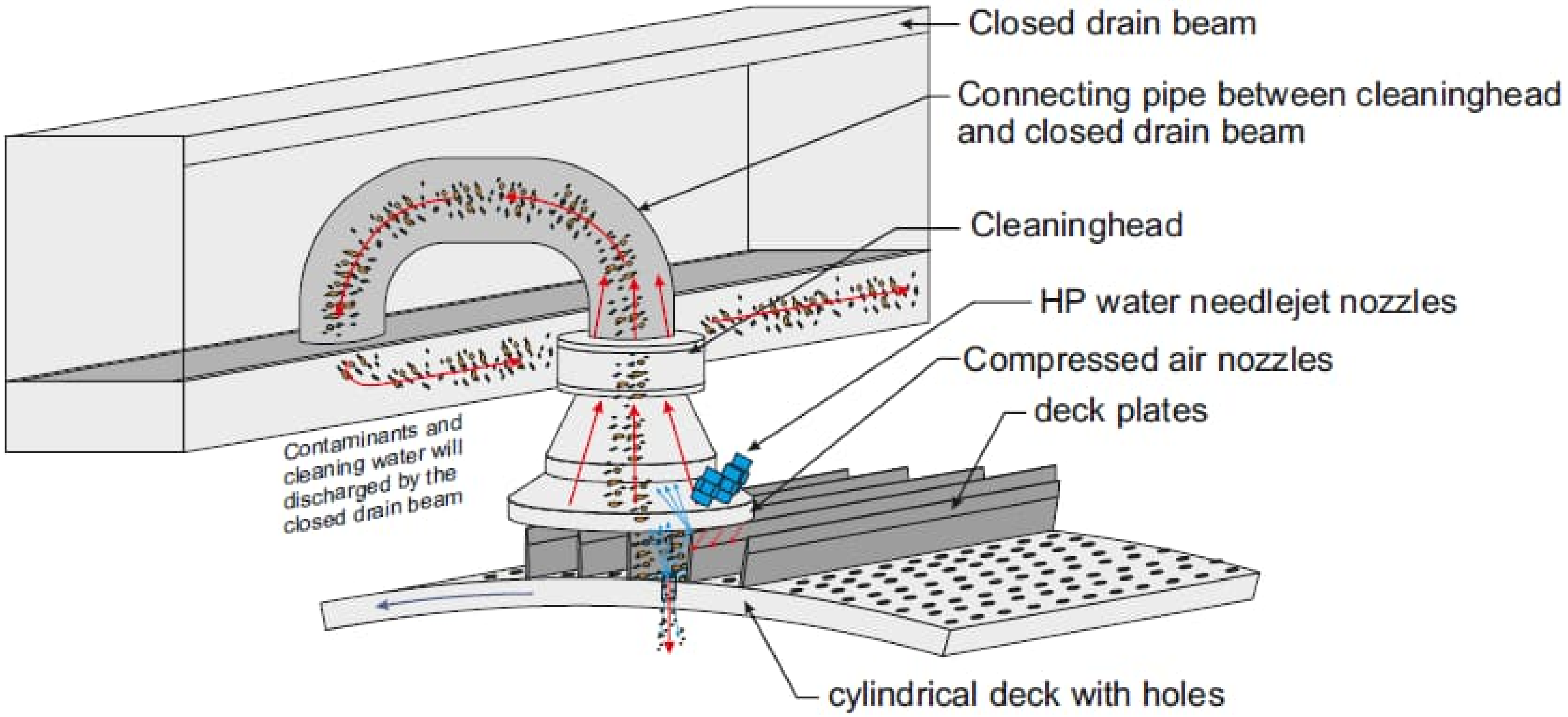
- ✓ SHOWERS
- ✓ DAMAGED FABRIC

TAD SHELL CONTAMINATION

- ✓ CAUSES SHADOWING IN THE SHEET
- ✓ UNEVEN/LESS EFFECTIVE DRYING
- ✓ INCREASED SHEET BREAKS

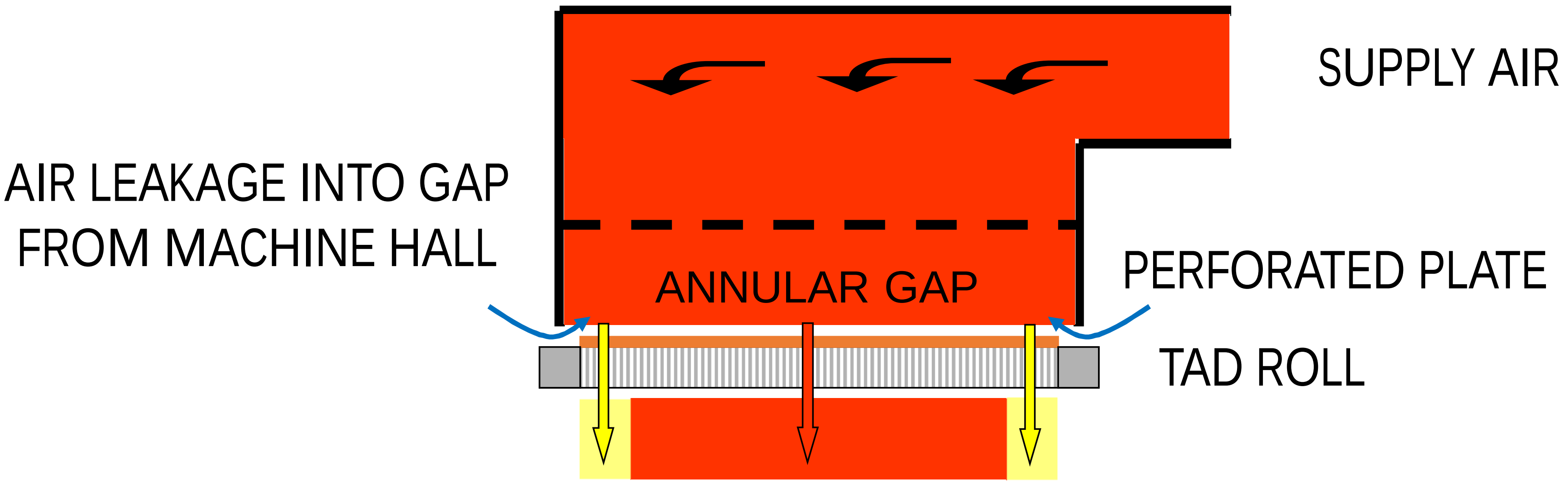
SHELL CONTAMINATION

ON THE RUN AUTOMATED CLEANER



TAD Drying

Non-Uniform Drying – Negative Gap Pressure



COOL AIR FROM MACHINE HALL MIXES WITH HOT SUPPLY AIR, COOLING AIR THAT PASSES THROUGH THE EDGES RESULTING IN WET EDGES

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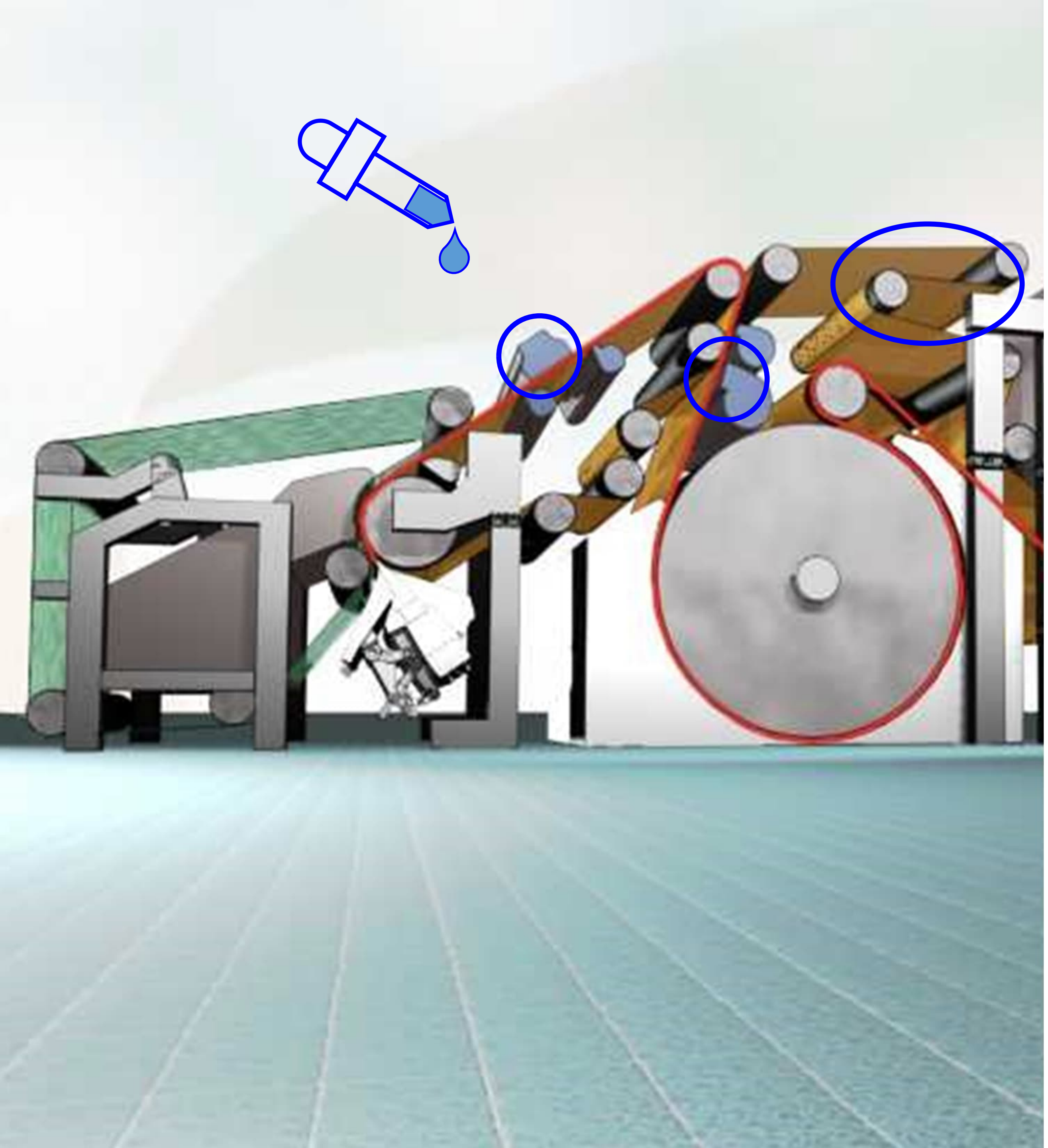

- Steam box
- Molding box
- Cleaning Station
- Doctoring
- Condensation

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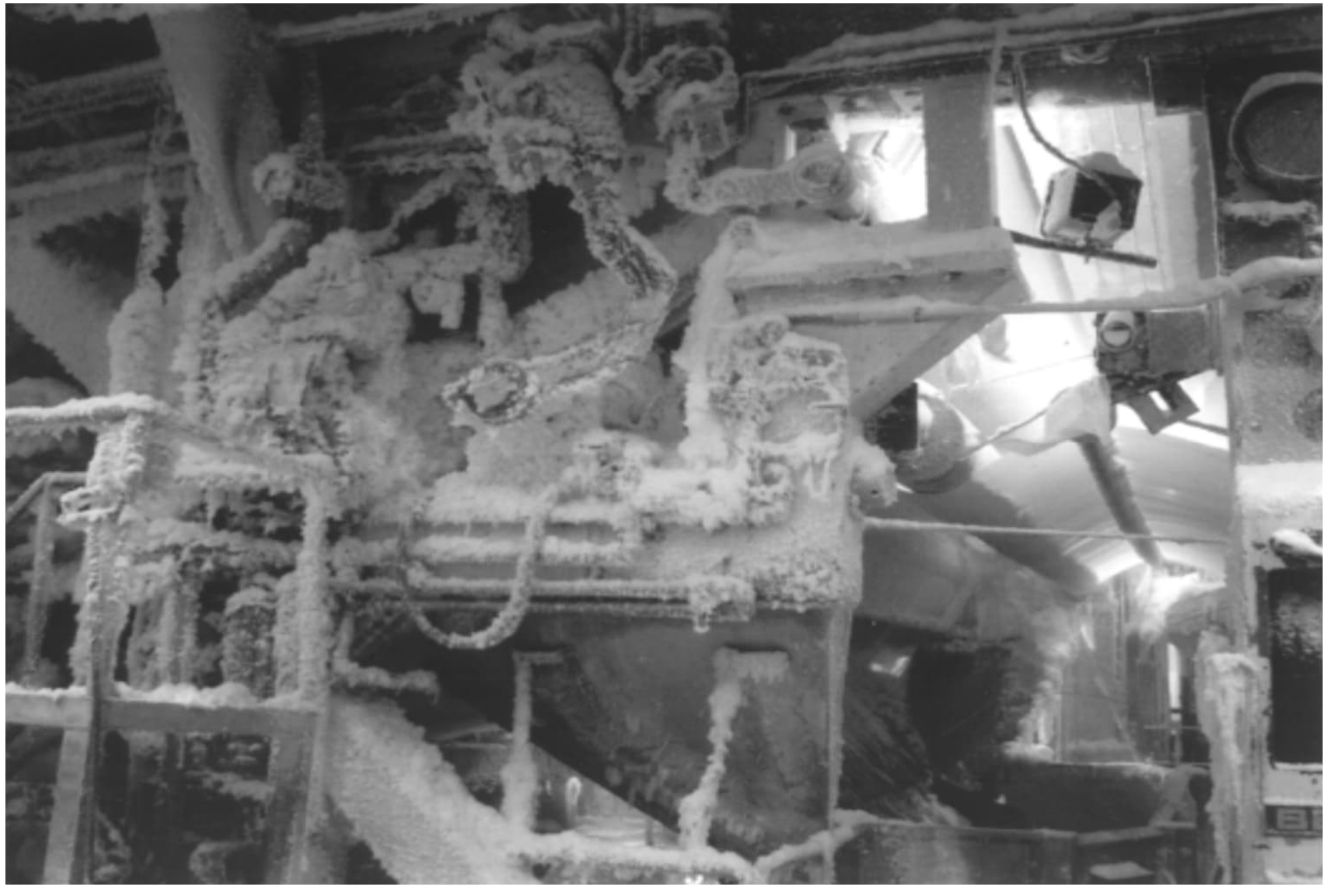
Hygiene is the key to GREAT production

- Avoid spraying directly onto the sheet or splashing the sheet as this action:
  - Will create more mess in the TAD section
  - Parts of the sheet will be missing exposing the TAD fabric to full heat from the TAD hoods
  - reduced fabric life
  - Sheet can build-up on the TAD hood skirts and/or in the gap between the TAD hoods and TAD rolls, rubbing against the sheet creating marks/holes in the paper or the in the worst cast punch a hole in the TAD fabric
  - Excessively wet sheet and large holes can damage the ceramic crepe blade and/or create plugging at the blade
- Control the direction of the water from the hose
- Only hit the target areas, avoid wafting the hose all over the place, more water does not necessarily = better cleaning
- Clean from both sides of the machine
- If you unload a roll doctor to wash behind the doctor blade, remember to reload the doctor
- Roll up the hoses when finished to avoid a tripping hazard
- Do not spray/wash the surface/shell of the hot TAD drums – excessive temperature differences between the HONEYCOMB® shell and the heads can damage the shell structure. The use of automated TAD shell cleaners are recommended for processes that produce excess build up of fiber on the TAD deck.

TAPPI

Why is Dust a Problem?



- HEALTH RISKS
- WOKING CONDITIONS
- FIRE RISKS
- MACHINE EFFICIENCY
- MAINTENANCE AND CLEANING

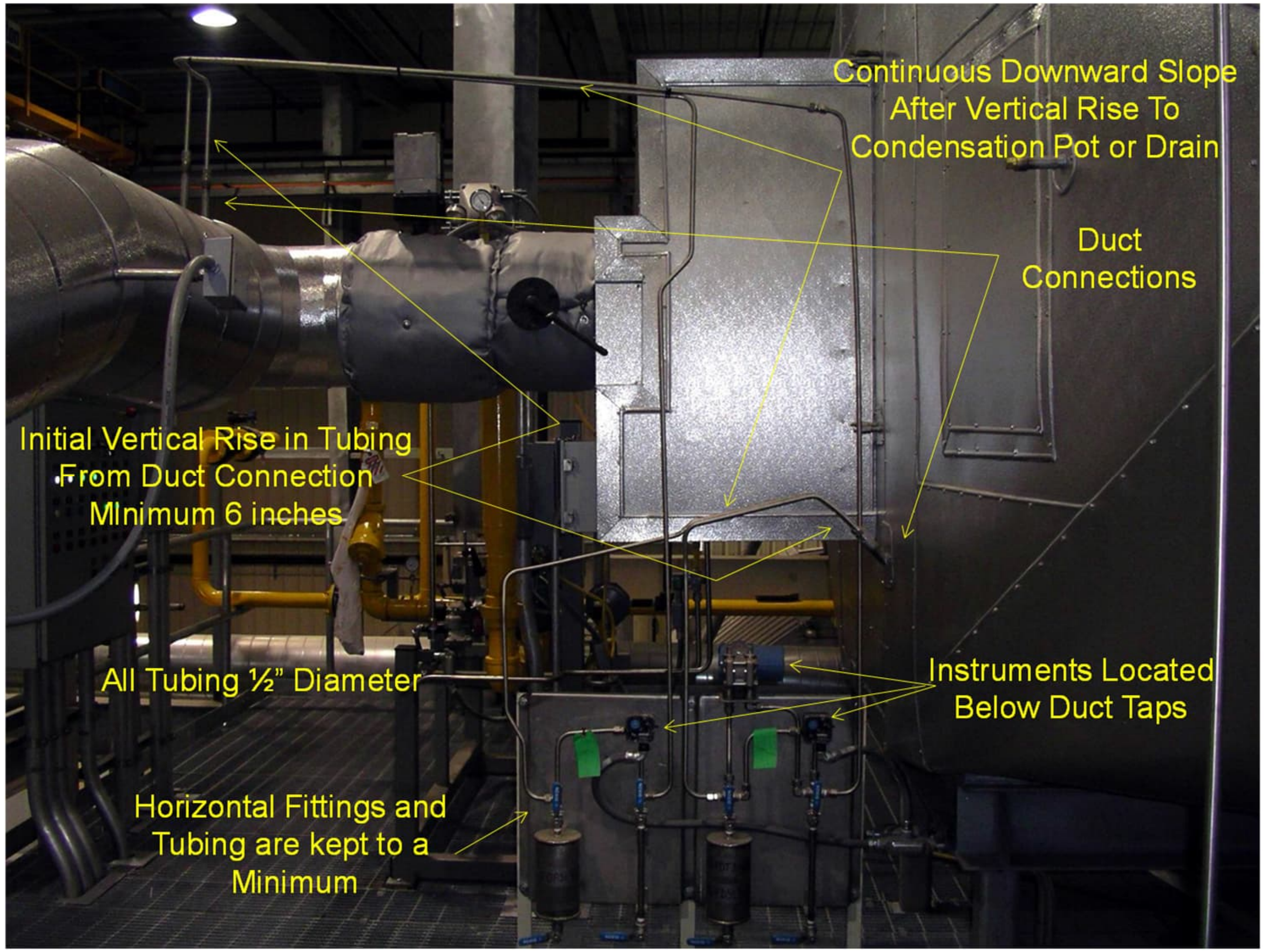
TAPPI

Dust Fire Hazard

- Mill personal Safety
- Loss of production
- Damage to building
- Damage to equipment
- Higher insurance costs

TAPPI

Maintenance Plan
Example: Pressure Taps



- Condensate in lines prevents proper operation
- Instruments are part of burner safety system
- Routine inspection and maintenance may prevent unexpected burner trip outs

Sheet Transfer to Yankee

- EXIT TAD MOISTURE PROFILE
  - MOISTURE PEAK TO PEAK IS MORE DETRIMENTAL THAN 2-σ
  - SHEET EDGES ARE MORE SENSITIVE
- TAD FABRIC WEAR
  - CONTACT AREA
  - SURFACE SMOOTHNESS
  - SEAM
- YANKEE COATING

Fabric Wrinkles

ABRUPT FABRIC EXPOSURE TO HIGH HEAT FLUX

- WARM-UP e.g. < 2°C/min
- Sheet OFF
- Blackouts
- Wet-end sheet breaks
- Cleaning station e.g. Uhle box ON/OFF, Showers ON/OFF, Fabric release nozzle plugging

TAD Run-ability
Dry-End

- SHEET RELEASE AT CREPE DOCTOR
  - TYPE OF BLADES
  - GEOMETRY
- IMPACTED BY TRANSFER TO THE YANKEE
- COATING PERFORMANCE
  - FUNCTION OF MANY VARIABLES
- DRY-END
  - FOILS CONFIGURATION AND OPERATION
  - AIR BALANCE (pulper, air showers)
- ACCURATE CONTROL OF REELING PARAMETERS

TAD Safety

MACHINE SAFETY

- ✓HOT SURFACES
- ✓NIPS
- ✓ROTATING/MOVING COMPONENTS

EQUIPMENT SAFETY

- ✓BURNER INTERLOCKS
- ✓DO NOT SPAY COLD WATER ON HOT ROLL

TAD Case Study

Problem Definition:

- For some time mill “A” has been struggling with the tending side wet edge.
- Up to now such operation was mitigated by over-drying the entire web on the Yankee dryer, plus operating the machine at lower speed.
- Noteworthy, the wet edge in the web appeared gradually over time and it is getting worse with each day.
- As of today the problem has escalated to a point that the edge fibers were picked at the transfer point between the press and the Yankee cylinder, consequently causing frequent sheet breaks at the Dry End of the Machine.
- Using the process parameters, plus assumptions and the learnings from this course, please identify possible reasons for the tending side wet edge.

TAPPI

TAD Case Study

Known Process parameters:

Basis Weight = 22 gsm [13.5#/3000sqft]
TAD speed = 1100 mpm [3608 fpm]
%M out of TAD 2 = 85%
TAD 2 hood T = 160°C [320°F]
TAD 1 Hood T = 230°C [446 °F]
Width of wet edge =~ 6 mm [1/4 inch]
Location = Tending side

Tissue machine consists of:

1. Two-layer headbox with dilution control
2. C-Former with steam profiling capability, and TS & DS edge trimming stations
3. Two 16ft TAD with fabric cleaning station
4. Moisture scanner
5. 16ft Yankee cylinder with hood
6. Soft Nip Calender
7. BW and Moisture scanner
8. Water jet slitters
9. Reel

Assumptions:

Incoming product, moisture and BW into TAD are uniform across the product width

Thank you

PRESENTED BY

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