Multilayer Liner and Machine Technology

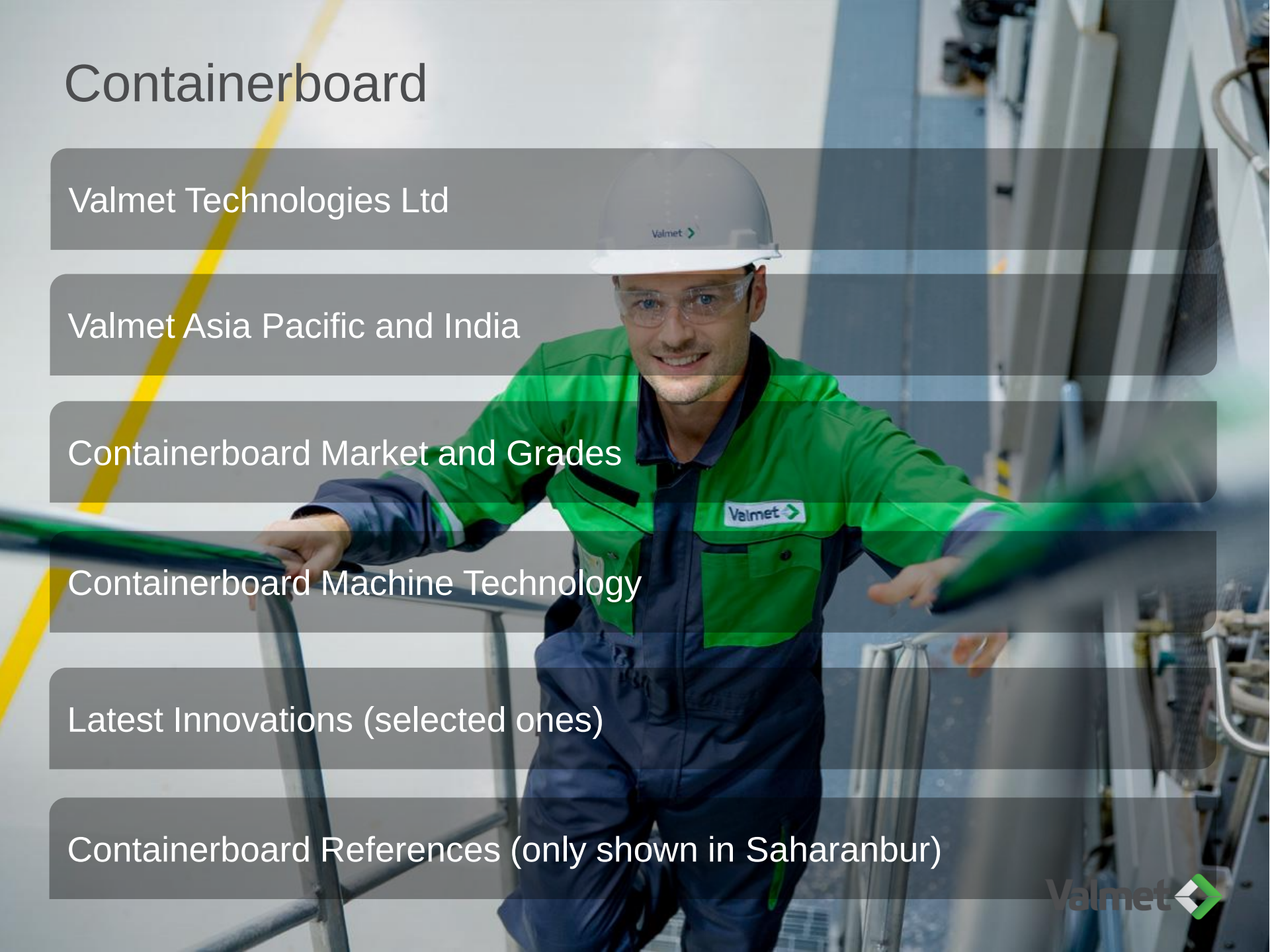
Jari Kataikko

Paper Technology Manager

Board and Paper Mills Business Unit

Valmet

Containerboard



Valmet Technologies Ltd

Valmet Asia Pacific and India

Containerboard Market and Grades

Containerboard Machine Technology

Latest Innovations (selected ones)

Containerboard References (only shown in Saharanbur)

Valmet Technologies Ltd

Progress built on 220 years of industrial history

From cloth making to high-tech processes

1797 Tampereen Verkatehdas
1841 Götaverken
1856 Tampella
1858 Beloit
1860 KMW
1868 Sunds Defibrator

1942
Rauma-Raahe

1951
Valmet

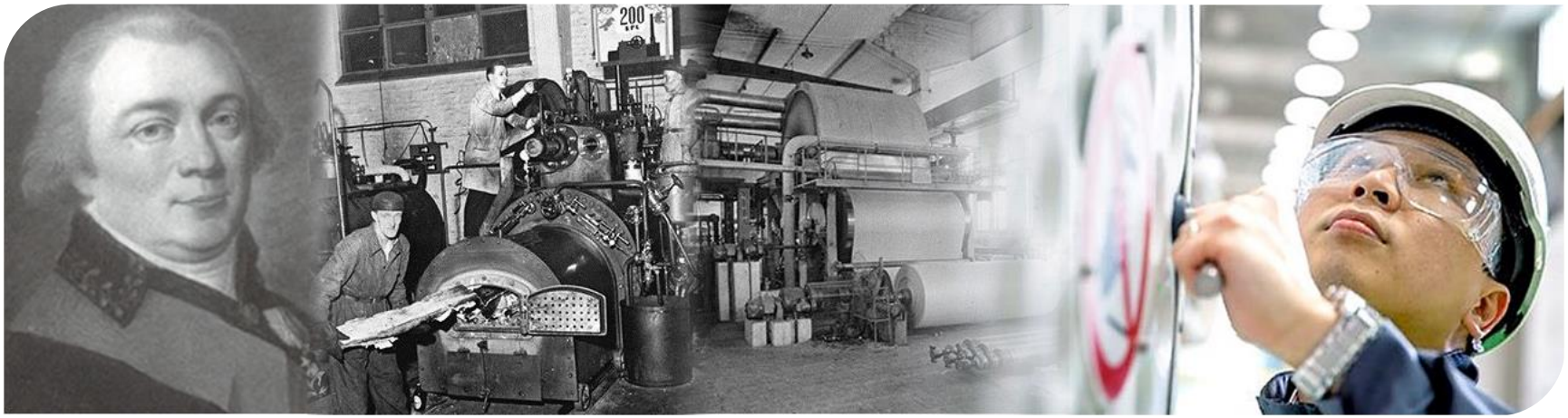
1968–1996
Several M&As:
1986 KMW
1987 Wärtsilä paper finishing machinery
1992 Tampella Papertech

1999
Metso created through merger of Valmet and Rauma

Acquisitions
2000 Beloit Technology
2006 Kvaerner Pulping
Kvaerner Power
2009 Tamfelt

End of 2013
Demerger to Valmet and Metso

2015
Metso Process Automation Systems to Valmet



Valmet

Today Valmet is the market leader serving a global customer base

Unique offering

- Market's widest offering combining process technologies, services and automation
- Research and development spend EUR 64 million in 2017

Market leadership

- Leading market position in all markets
- Pulp #1–2
- Energy #1–3
- Board #1
- Tissue #1
- Paper #1
- Services #1–2
- Automation #1–3

Strong global presence

- 33 countries
- 120 service centers
- 87 sales offices
- 36 production units
- 16 R&D centers
- 12,000 professionals

EMEA	8,000
China	1,700
North America	1,200
Asia-Pacific	700
South America	500

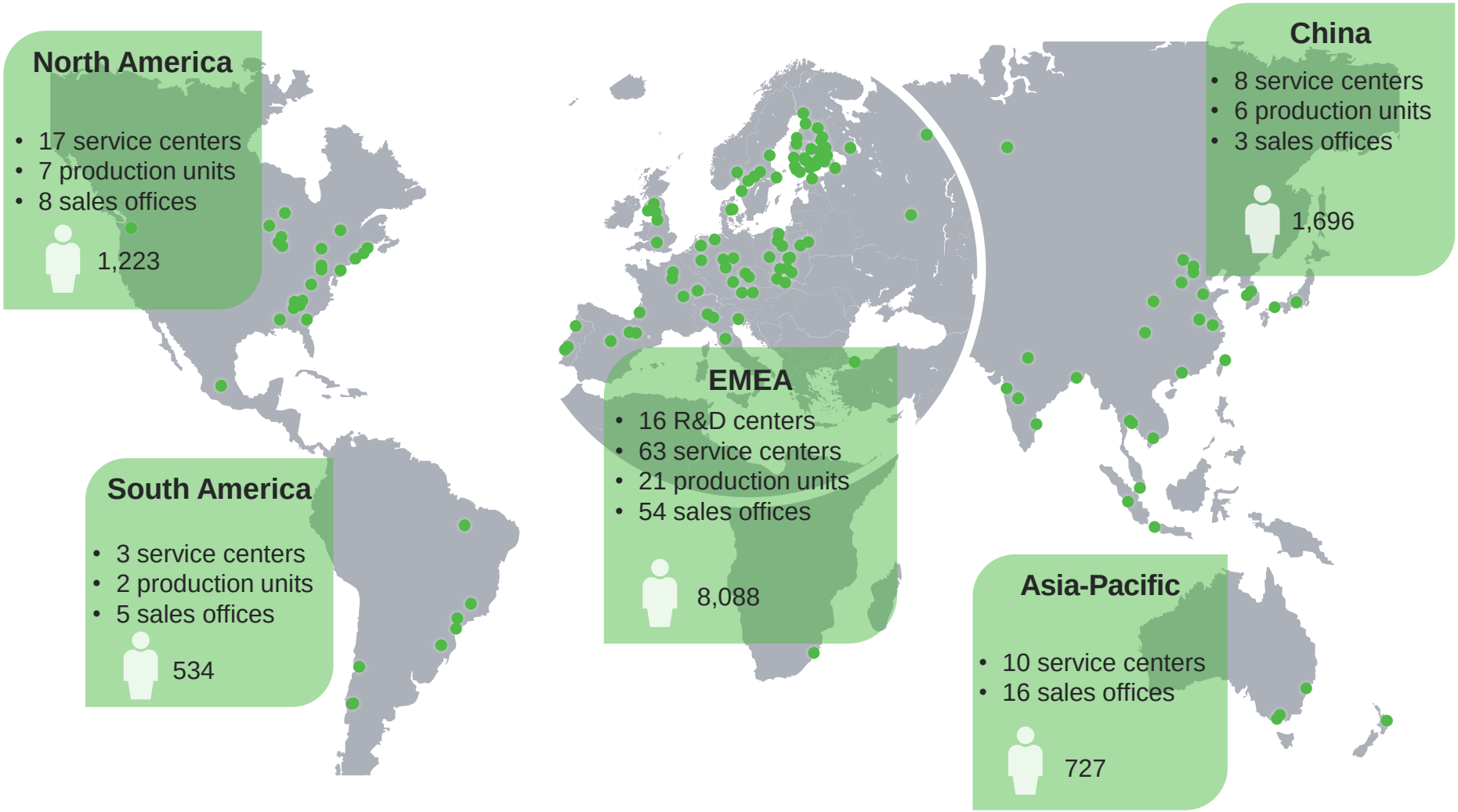
Leader in sustainability

- Sustainability 360º agenda
- Four consecutive years in Dow Jones Sustainability Index
- Three consecutive years in Ethibel Sustainability Index Europe
- A- rating in CDP climate program 2017

Valmet

Strong, global presence is a good platform for growth

Over 120 service centers, 87 sales offices, 36 production units, 16 R&D centers



Employees on December 31, 2017

Valmet

Full scope offering for the pulp and paper industry

Technologies

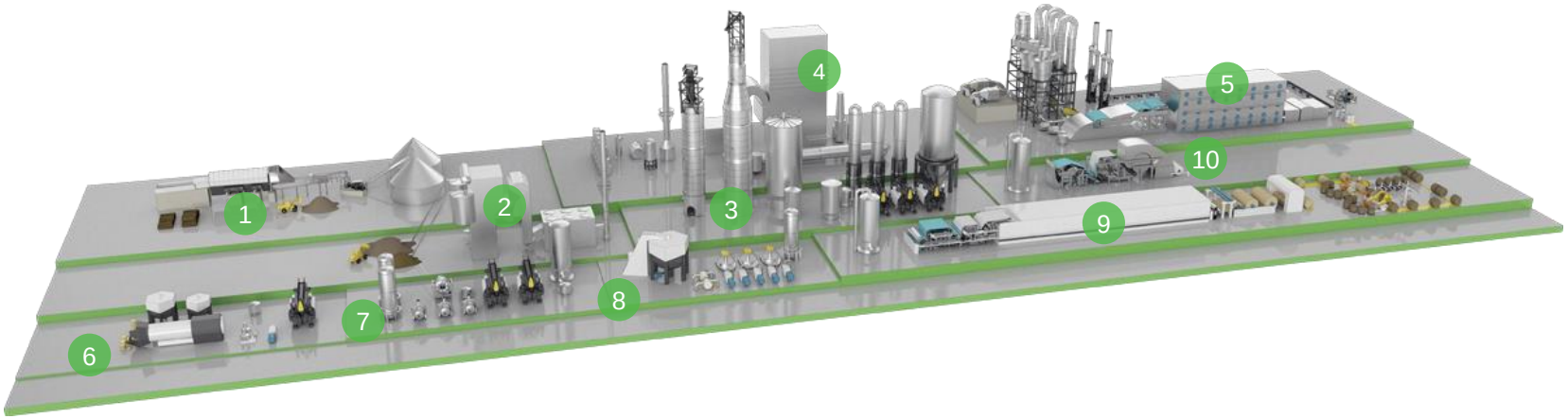
1. Wood handling
2. Heat and power production
3. Chemical pulping
4. Chemical recovery
5. Pulp drying
6. Recycled fiber
7. Mechanical fiber
8. Stock preparation
9. Board and paper making
10. Tissue making

Automation

- Distributed Control System (DCS)
- Performance solutions
- Quality Control System (QCS)
- Profilers
- Analyzers and measurements
- Industrial internet solutions
- Automation services
- Process simulators
- Safety systems and solutions

Services

- Mill and plant improvements
- Spare and wear parts
- Paper machine clothing and filter fabrics
- Roll services
- Services for evaporation plants, power and recovery boilers
- Services for environmental equipment



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Valmet’s customer focused research and development work

Valmet’s R&D focus areas

- Advanced and competitive technologies and services
- Raw material, water and energy efficiency
- Promotion of renewable materials

16
research and development centers

Research **partnerships** with leading global universities and research institutes

EUR **64** million
R&D spend in 2017

1,400
protected inventions

Valmet

Valmet Paper Technology Centers

Creative environment for paper and board development

Paper & Board Technology Center

Jyväskylä, Finland - 2 pilot machines
Järvenpää, Finland – Finishing technology
Inkeroinen, Finland – Fiber technology

- Fully equipped analysis laboratory
- Extensive expert network
- Joint development
- Customer pilot trials
- Training

Valmet in Asia Pacific and India

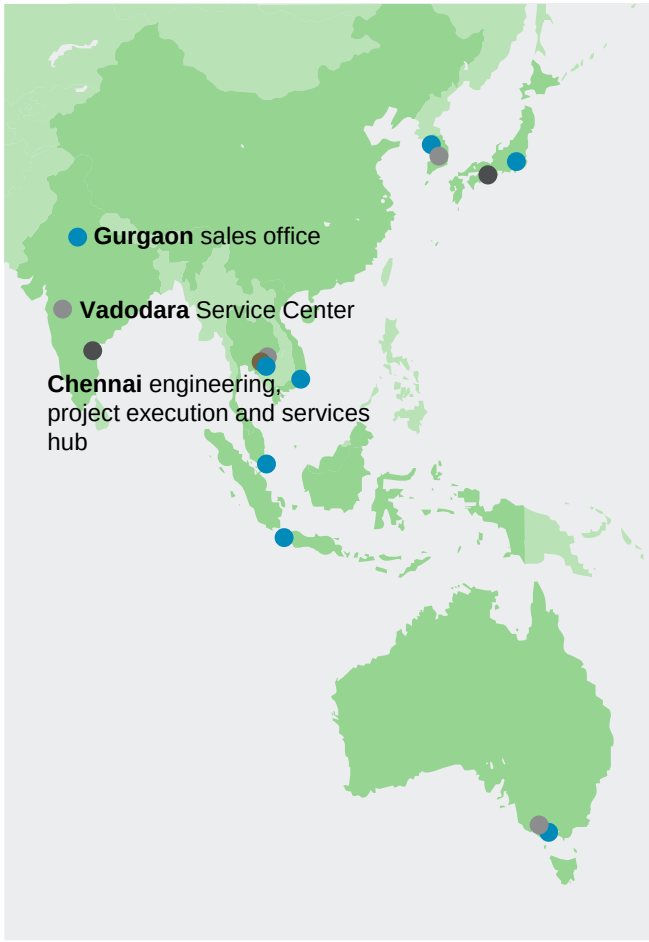
Local presence in Asia Pacific

24 locations, over 750 employees working for automation, pulp, energy and paper industries

Valmet

Local presence in India

Serving the pulp, paper and energy industries



Over 140 employees experts in:

- project and process engineering
- plant design
- start up and commissioning services
- global sourcing
- automation
- services

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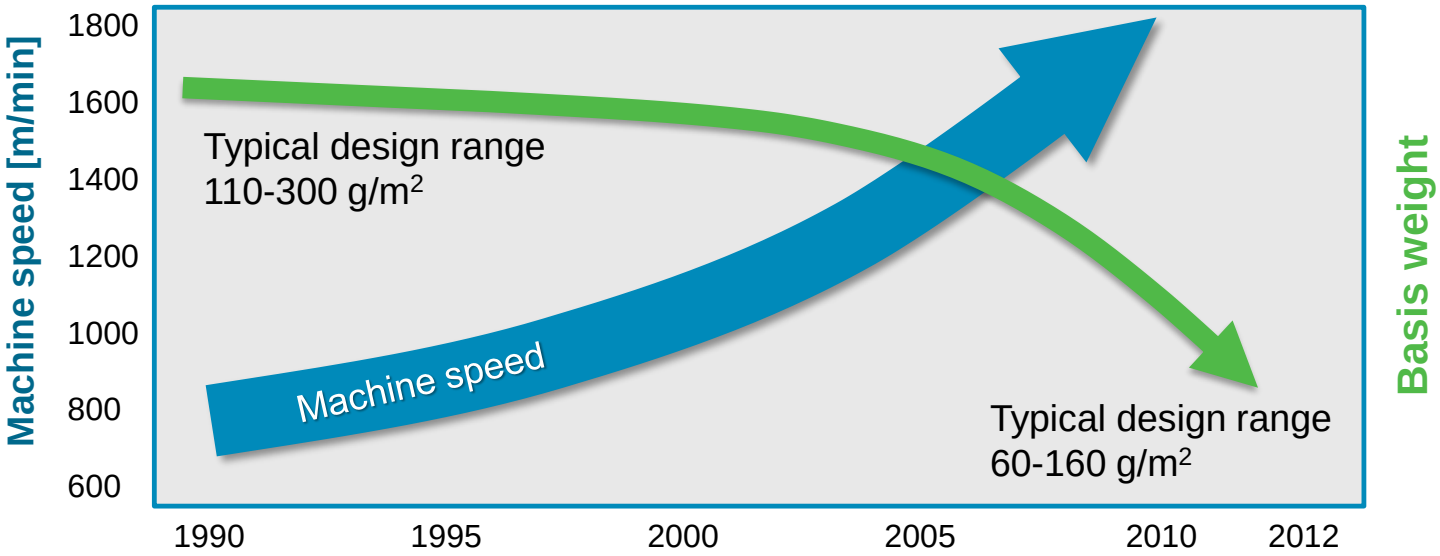
Containerboard Market and grades

New Container board machines

Towards lighter basis weights and higher speeds



- More paper at the same raw material cost and higher speed
- Lower transportation costs
- Economic packaking
- Less packaking waste

Source: Operation speed development, containerboard grades, based on information with sample collection.

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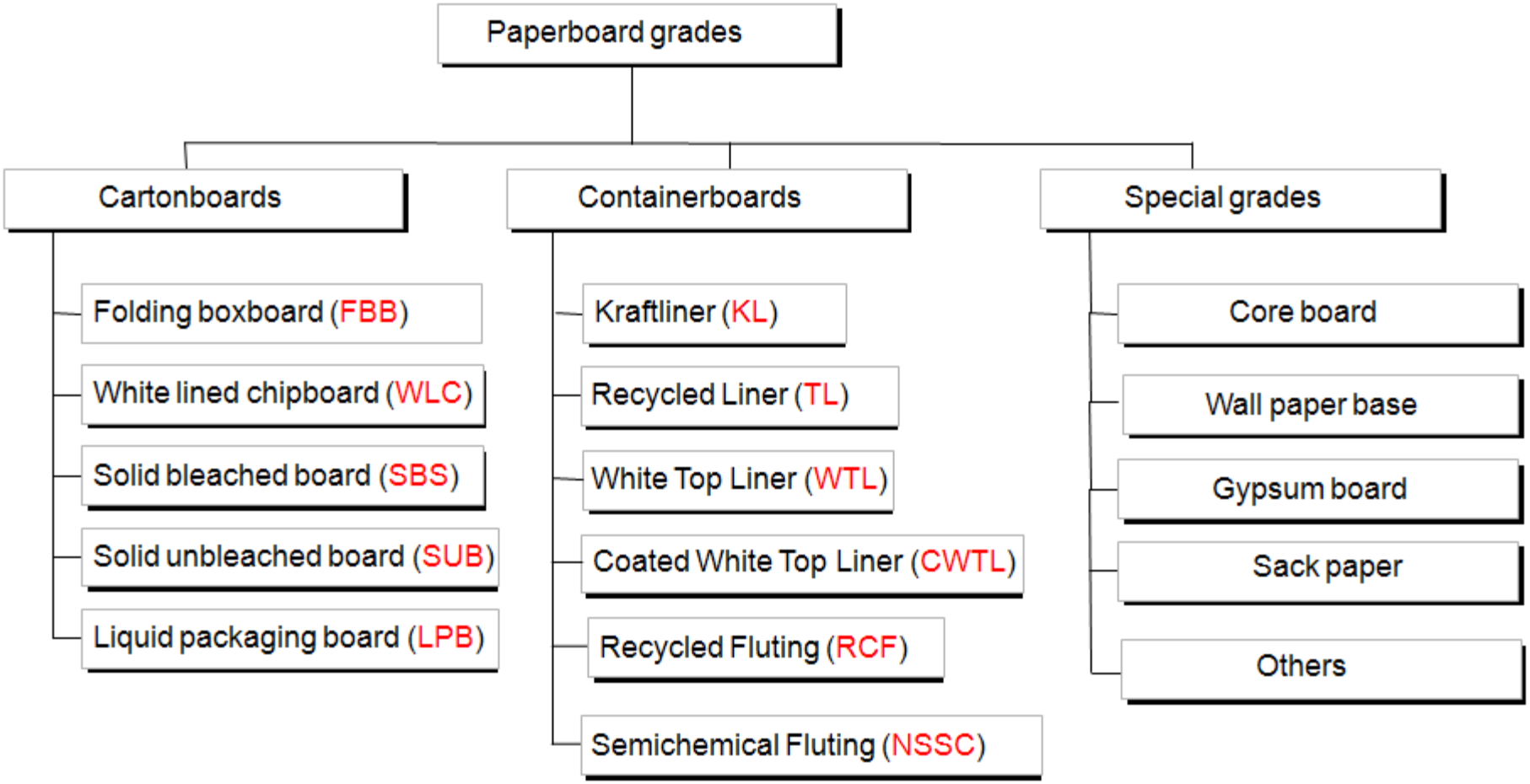
Technology Part focusing on TL and RCF



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Containerboard Machine Technology

Focus: Fluting & Testliner

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High quality containerboard – machine sections effect to board quality parameters

	Furnish	Short sircu-lation	Headbox	Forming	Pressing	Drying	Sizing	Calen-dering
Basis weight profile CD	X	X	XXX	X			X	
Basis weight profile MD		XXX	XX	X			X	
Basis weight profile RES	X	XX	XXX	XX			X	
Moisture CD			XX	XX	XXX	XXX	X	
Moisture MD		X	X	X	XX	XXX	X	
Moisture RES		X	XX	XX	XX	XX		
Thickness CD			XXX	X	XXX			XXX
Thickness MD		XXX	XX	X	XX			XXX
Thickness RES		X	XX	X	XX			XX
Formation	XXX	X	XX	XXX				
Smoothness	X		X	X	XX	X	XX	XXX
Burst strength	XXX		X	XX	X		XX	X
Water absorption	XXX					X	XXX	
CMT, RCT, SCT	XXX		X	XX	X	X	XX	X
Internal bond	XXX		X	XX	X	X	XXX	

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Headbox

Valmet’s OptiFlo headbox product family

The solution for your specific papermaking needs

- Fit for purpose: all applications and paper machine sizes available
- Robust and modular construction, with high quality and cost efficiency

For ultimate quality

OptiFlo Fourdrinier Headbox

OptiFlo Layering Fourdrinier Headbox

OptiFlo Gap Headbox

OptiFlo Layering Gap Headbox

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OptiFlo Fourdrinier ejector type of dilution

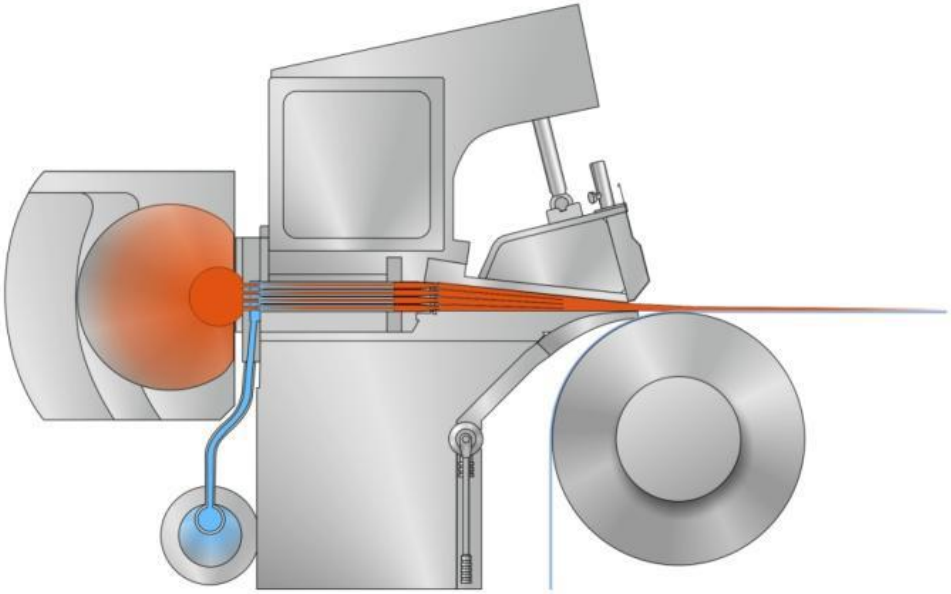
Sets new levels for basis weight CD profiling

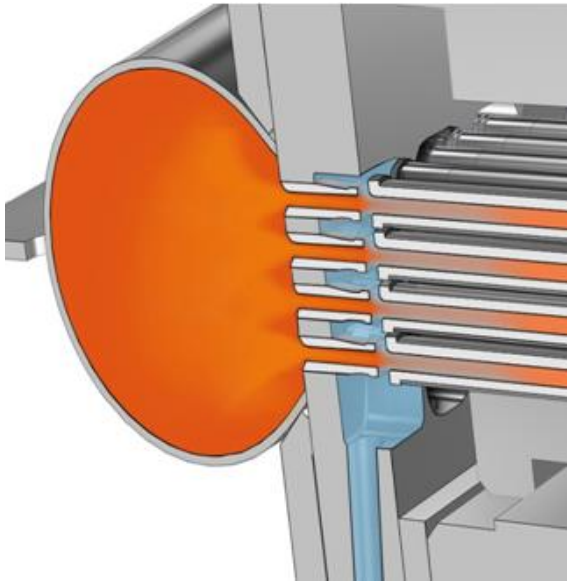
- **Ejector type profiling feed straight to turbulence generator tubes:**

✓ 30% better CD control response accuracy and power

✓ 50% lower dilution line pumping energy consumption

✓ Extreamly compact and clean headbox design





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Forming section

Multi-Fourdrinier ply selection

1-ply	2-ply	3-ply	4-ply	5-ply
Containerboard				
Corrugating medium	Kraftliner	Recycled linerboard (testliner)		
	White top liner	White top liner		
	Recycled linerboard (testliner)			

1-ply	2-ply	3-ply	4-ply	5-ply
Cartonboard				
Solid bleached board		Folding boxboard	White lined chipboard	White lined Chipboard
		Liquid packaging board		
		White lined chipboard		
		Solid bleached board		

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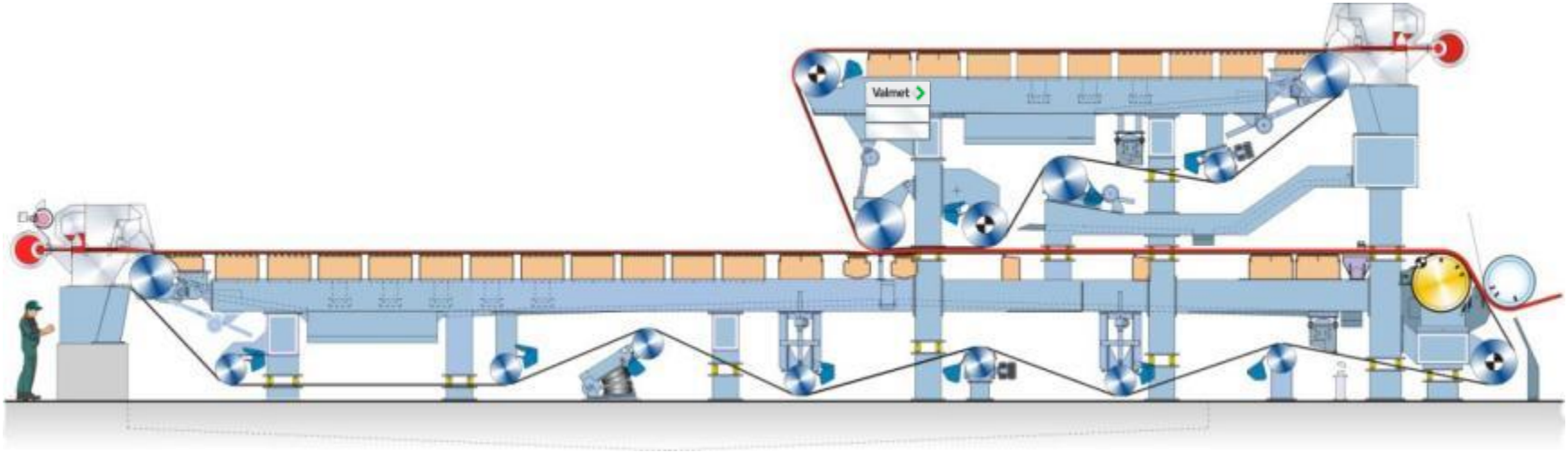
2-ply multi-Fourdrinier, containerboard grades using recycled fibres



- Benefits:
  - Good solution especially for low basis weights
  - High dewatering capacity
  - Economical investment
  - Good strength properties

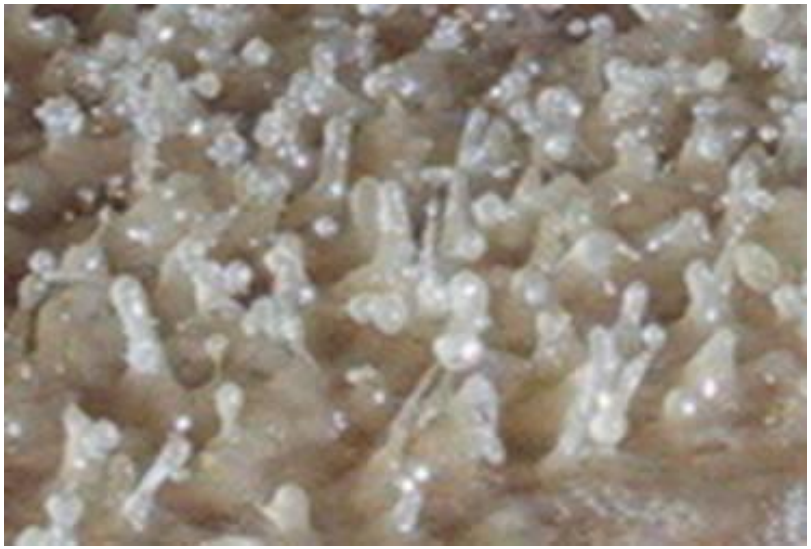
Basic definitions in forming

- Dewatering
  - Drainage capacity
  - Turbulence
  - Table activity
  - Retention
- Formation
  - Flocculation tendency
  - Shear forces
  - Turbulence
  - Table activity
  - Retention

Activity - Magnitude

Low **Medium** **High**

- Effecting factors:
  - Foil angle
  - Foils width
  - Vacuum
  - Wire tension
  - Machine speed
  - Jet to wire speed ratio
  - Headbox consistency



Factors influencing dewatering and formation

- Low headbox consistency
  - flocculation tendency decreases
  - shear strength of fiber network decreases
- More table activity
  - more deflocculated stock
- Increased shear forces
  - more deflocculated stock
- Increased drainage
  - better formation, smaller floc sizes
- Higher freeness
  - usually worse formation (response to table activity decreases)
- Longer fibers
  - more flocculated stock
- Higher fiber coarseness
  - more deflocculated stock

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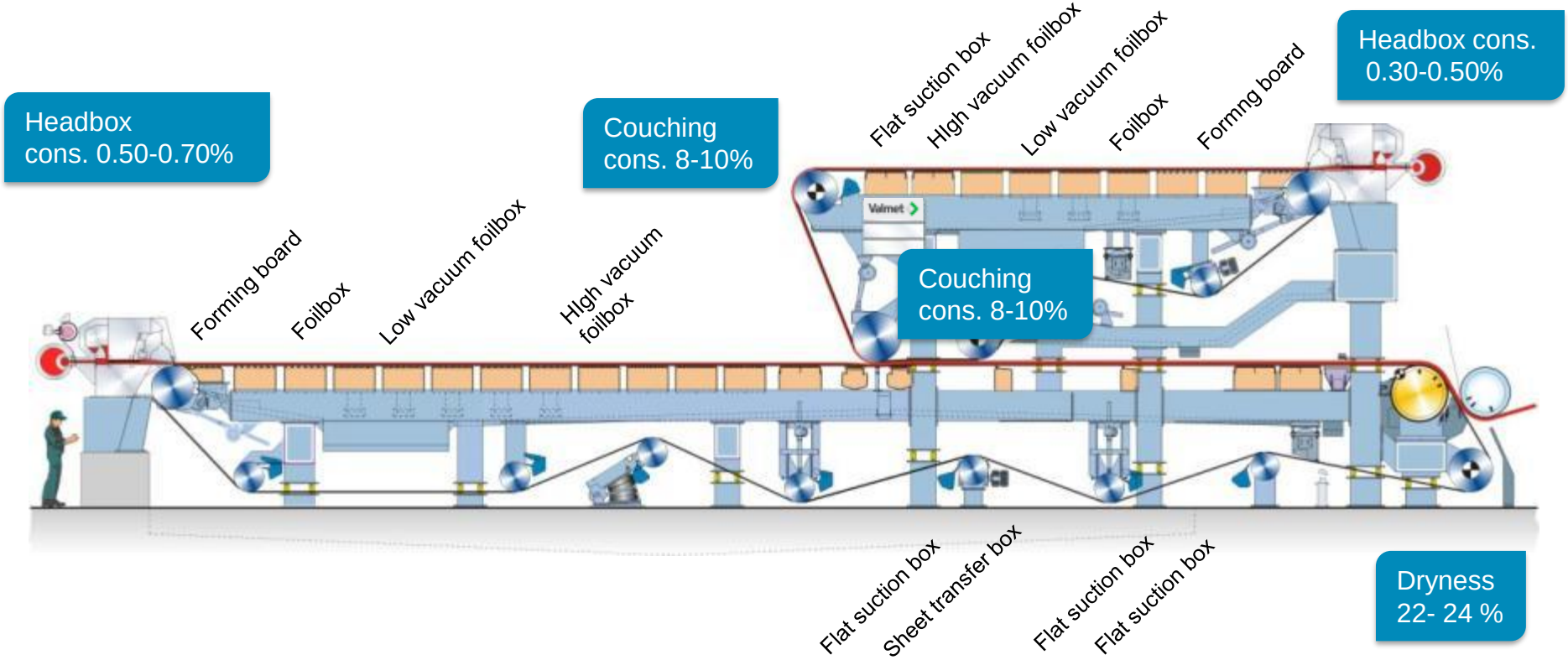
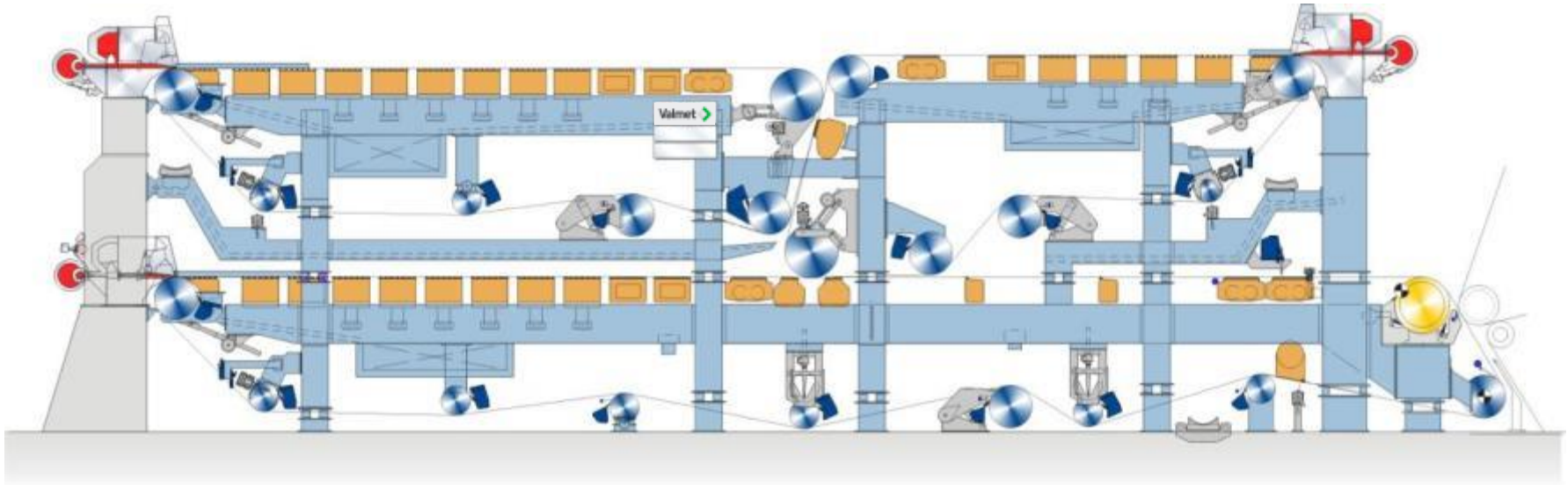
2-ply forming section with on-top-Fourdrinier

Containerboard machine, consistencies



3-ply multi-Fourdrinier, containerboard grades using kraftpulp, OCC and/or virgin fibers



- Benefits:
  - Compact design
  - High dewatering capacity
  - Optimum furnish selection for each ply
  - Good surface brightness (layer purity/coverage)
  - Delivers gentle dewatering and the highest strength

Press section

High quality containerboard

Effect of press section

	Furnish	Short sircu-lation	Headbox	Forming	Pressing	Drying	Sizing	Calen-dering
Basis weight profile CD	X	X	XXX	X			X	
Basis weight profile MD		XXX	XX	X			X	
Basis weight profile RES	X	XX	XXX	XX			X	
Moisture CD			XX	XX	**XXX**	XXX	X	
Moisture MD		X	X	X	**XX**	XXX	X	
Moisture RES		X	XX	XX	**XX**	XX		
Thickness CD			XXX	X	**XXX**			XXX
Thickness MD		XXX	XX	X	**XX**			XXX
Thickness RES		X	XX	X	**XX**			XX
Formation	XXX	X	XX	XXX				
Smoothness	X		X	X	**XX**	X	XX	XXX
Burst strength	XXX		X	XX	**X**		XX	X
Water absorption	XXX					X	XXX	
CMT, RCT, SCT	XXX		X	XX	**X**	X	XX	X
Internal bond	XXX		X	XX	**X**	X	XXX	

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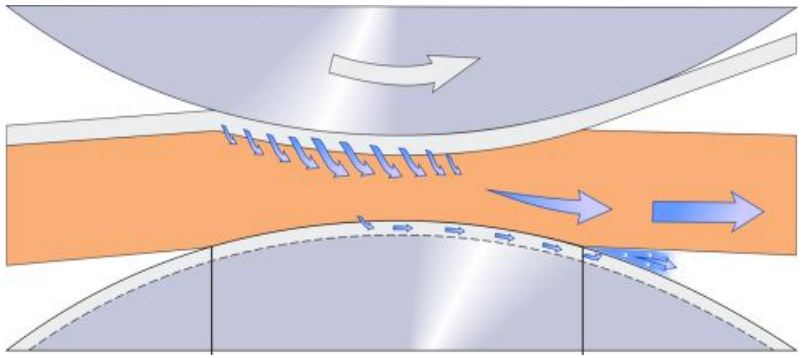
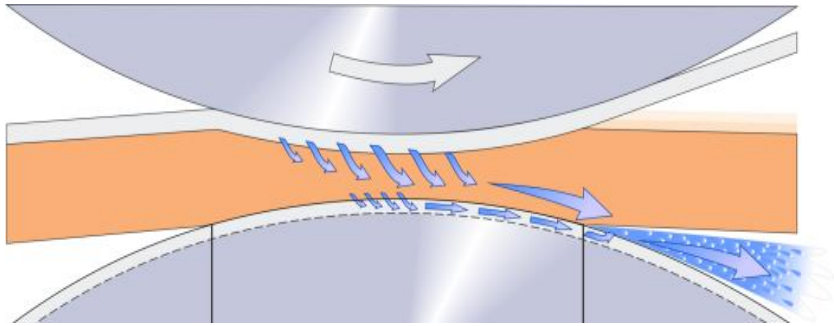
Press section dewatering



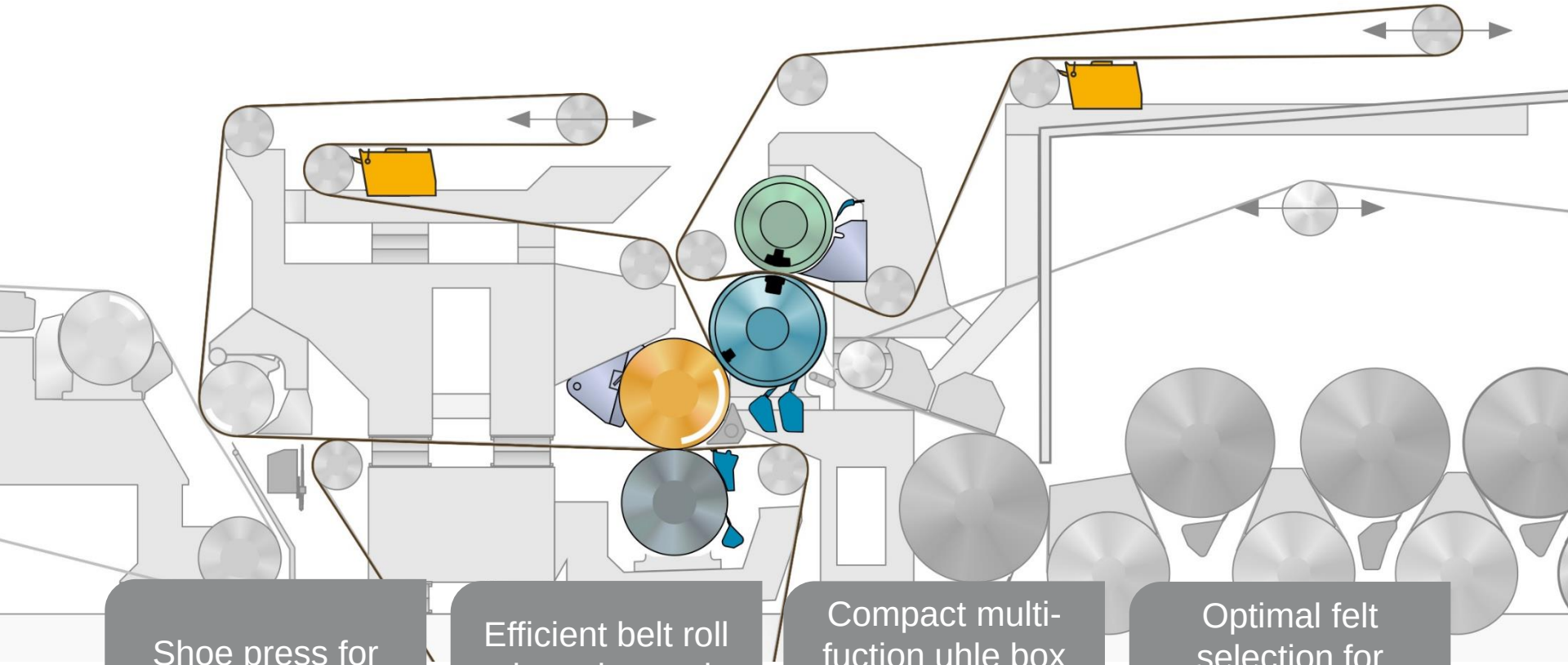
- UB dewatering
  - Water pressed from sheet to felt
  - Felt carries the water to the uhle box where it is removed by vacuum
  - Open, heavy weight felts
  - Slow machines (pulp, packaging)
  - NA



- Nip dewatering
  - Water pressed from sheet through the felt to roll grooves or holes
  - Water removes out of the roll with the help of centrifugal force
  - Dense and/or light weight felts
  - Higher speed machines (P&W, tissue, higher speed packaging)
  - EMEA, China

OptiPress Center

High dewatering capacity



Shoe press for excellent dryness

Efficient belt roll doctoring and savealls

Compact multi-fuction uhle box for optimized felt dewatering

Optimal felt selection for secured water removal

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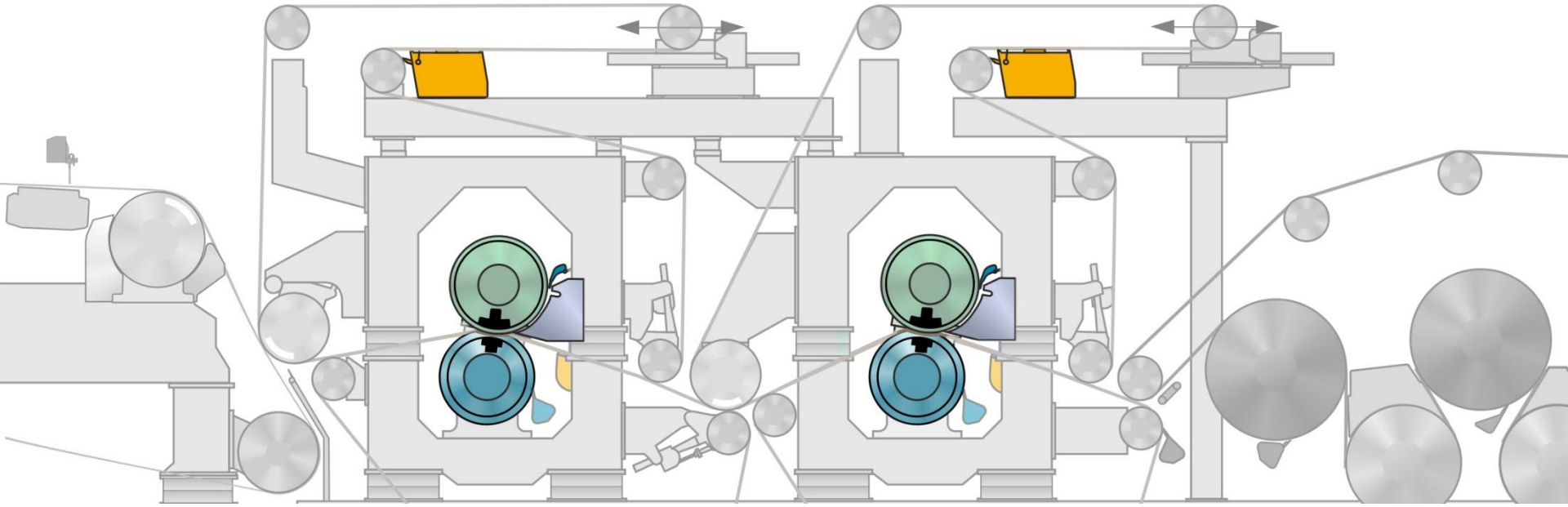
OptiPress Linear

High dewatering capacity



Two shoe presses for high dryness

Four felts for excellent water removal and dryness

Compact multi-fuctional uhle box for optimized felt dewatering

Efficient belt roll doctoring and savealls

Valmet

Board pressing concepts

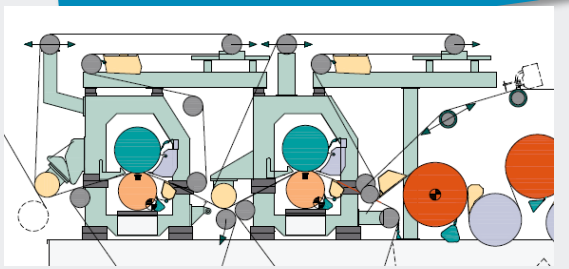
With OCM technology (no cantilevering)

Basis weight

Machine speed

Typical design range 110-300 g/m^2 (22-61 lb/1000 ft^2)

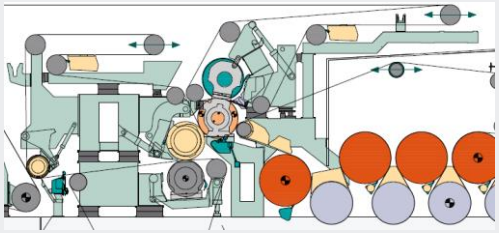
Typical design range 60-160 g/m^2 (12-33 lb/1000 ft^2)



OptiPress Linear

≤ 1200 m/min (4000 fpm)

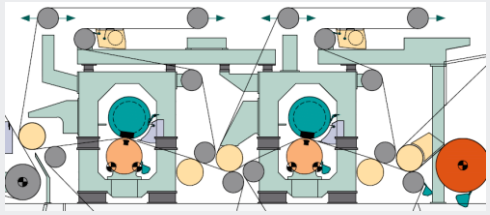
Oper. 1050-1150 m/min (3440- 3770 fpm)



OptiPress Center

≤ 1600 m/min (5250 fpm)

Oper. 1250-1600 m/min (4100-5250 fpm)



OptiPress Linear

≤ 1730 m/min (5675 fpm)

Oper. 1250-1600 m/min (4100-5250 fpm)

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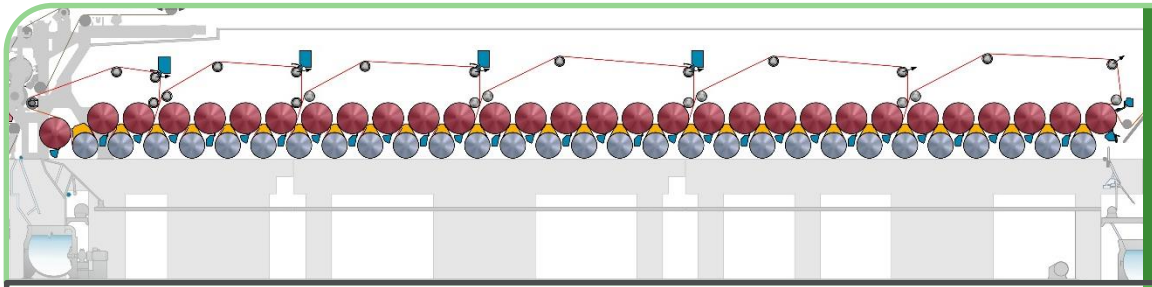
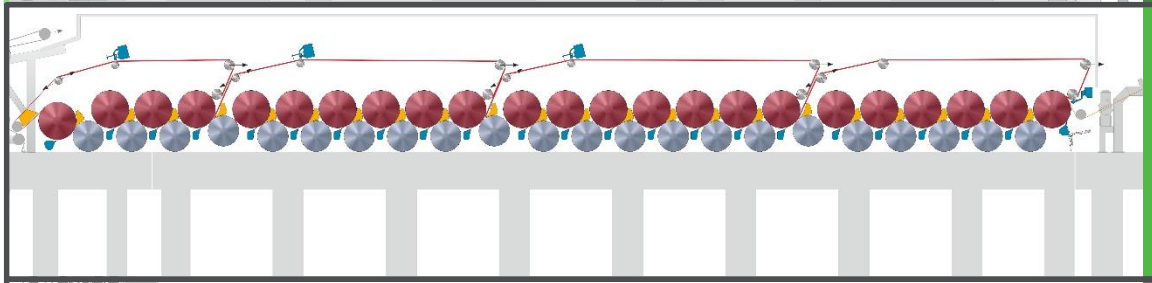
Drying section

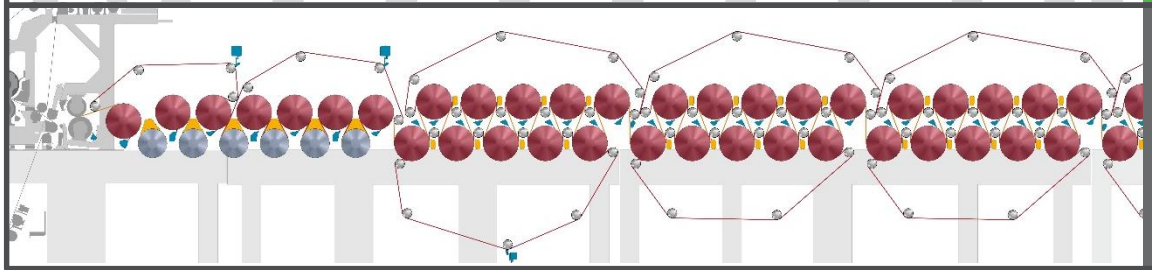
OptiRun main concepts



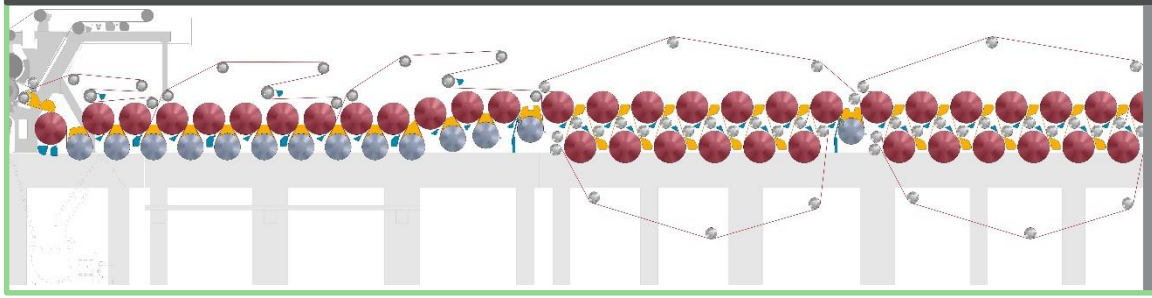
OptiRun Single
single-fabric
dryer section



OptiRun Single
compact single-fabric
dryer section



OptiRun Hybrid
hybrid dryer section with
single-fabric and
double-fabric groups



OptiRun Hybrid
hybrid dryer section with single-
fabric and compact
double-fabric groups

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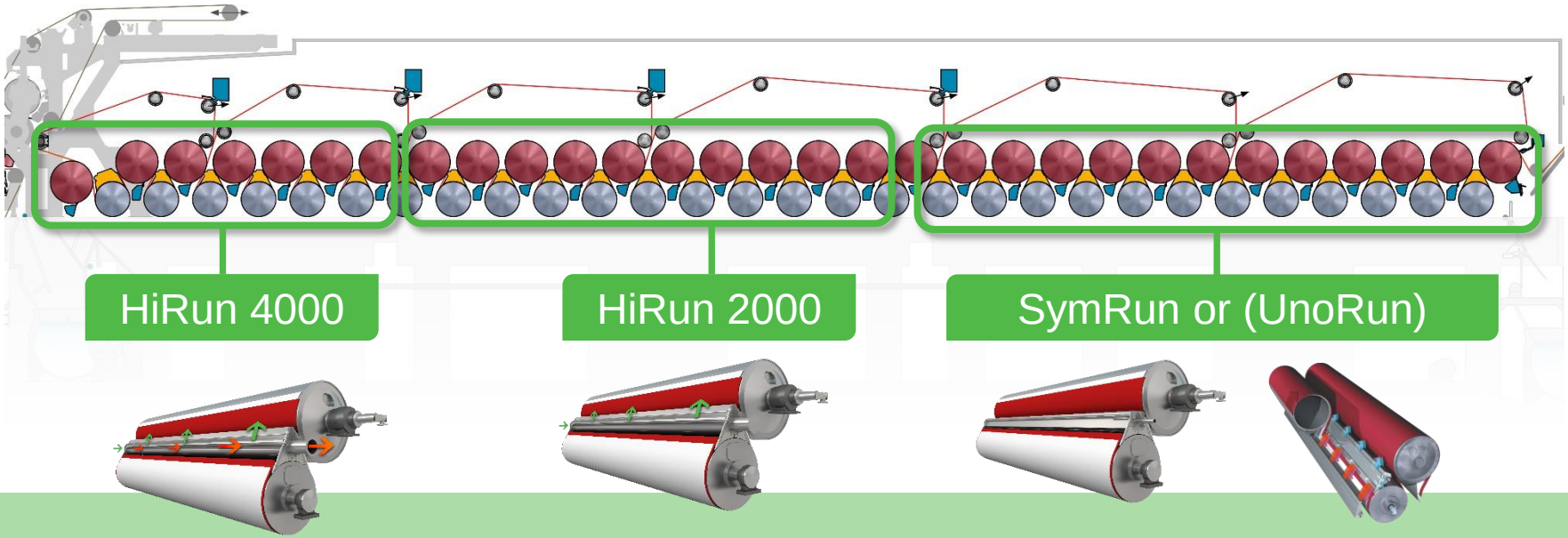
Runnability systems for high-speed machines



- Excellent sheet runnability
- Effective tail threading
- Less breaks
- Draw reduction from press section

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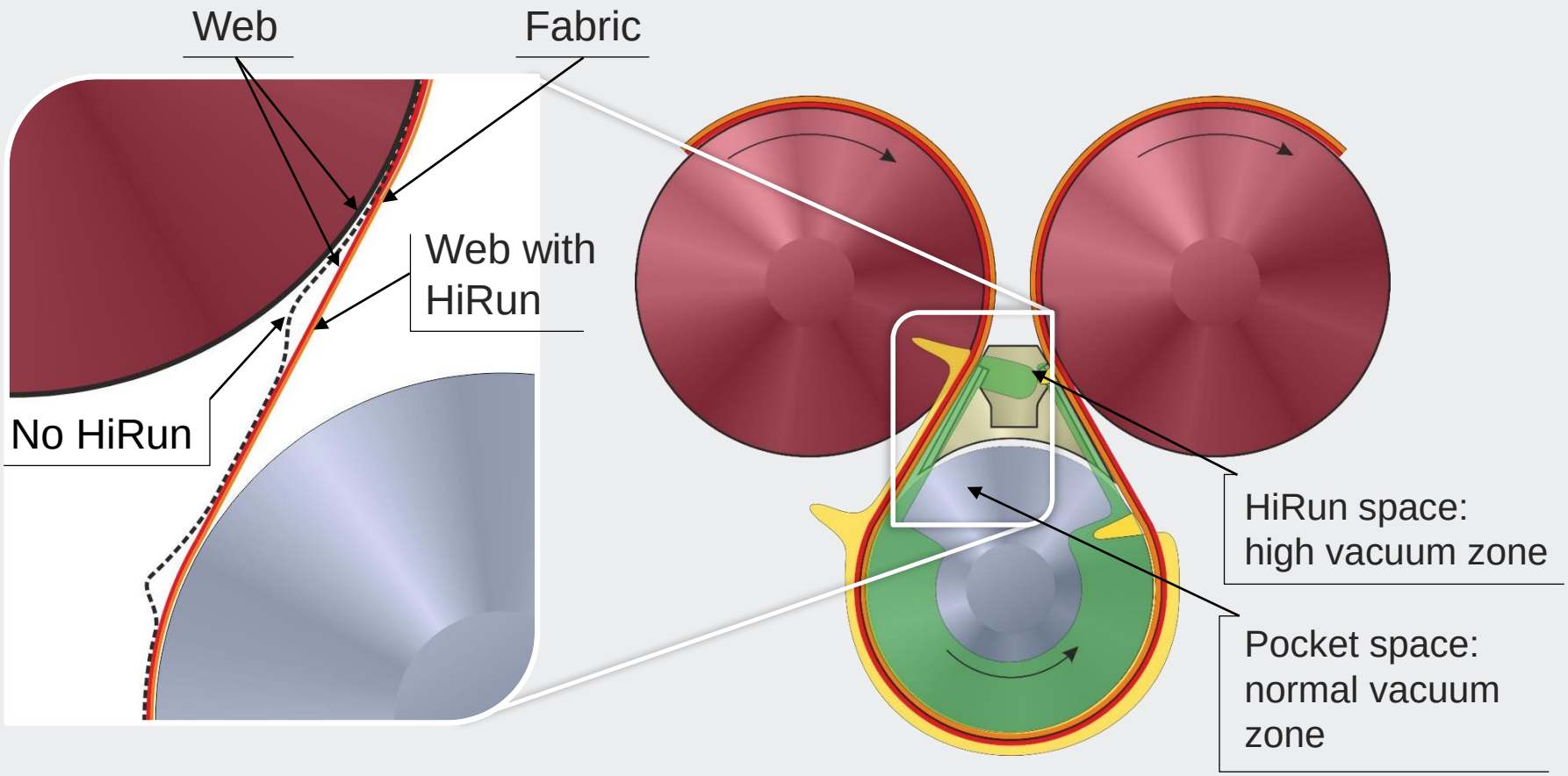
Operation principle of HiRun runnability system



Maximal web stability

Surface sizing

OptiSizer product family

Size application solutions for specific papermaking needs

- Fit for purpose: all application methods and paper machine sizes available
- Robust and modular construction,

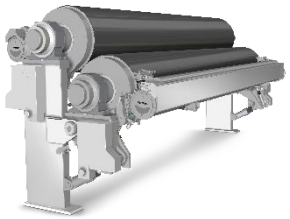
OptiSizer Pond
Pond application

OptiSizer Film
Film application

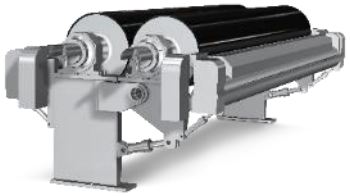
OptiSizer Spray
Spray on web application

OptiSizer Combi
Combined film, pond or spray application

New design



OptiSizer Spray
Sizer with spray on roll application



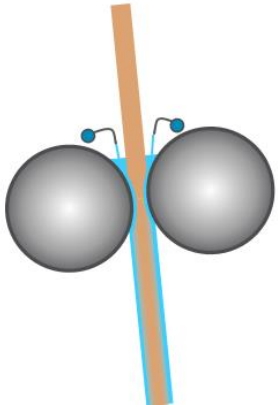
OptiSizer Hard
Sizer with spray application on hard rolls

New design

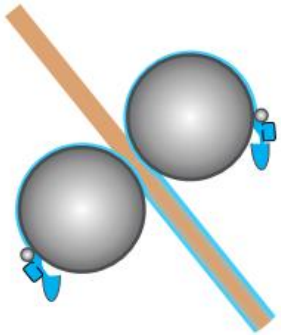
Valmet

Surface sizing development

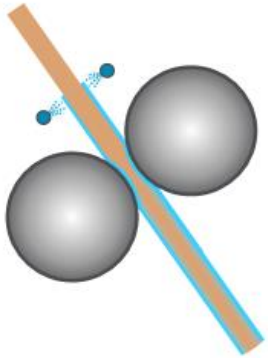
Pond sizing



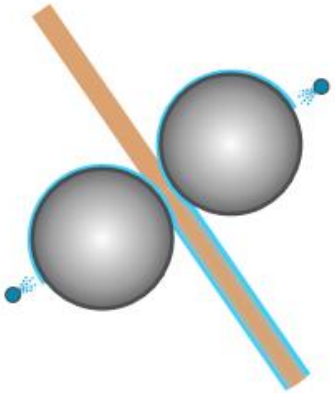
Film sizing



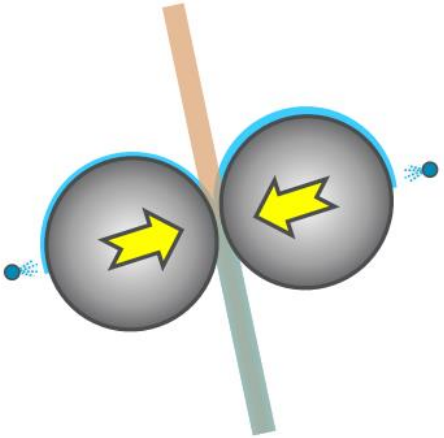
Spray on web



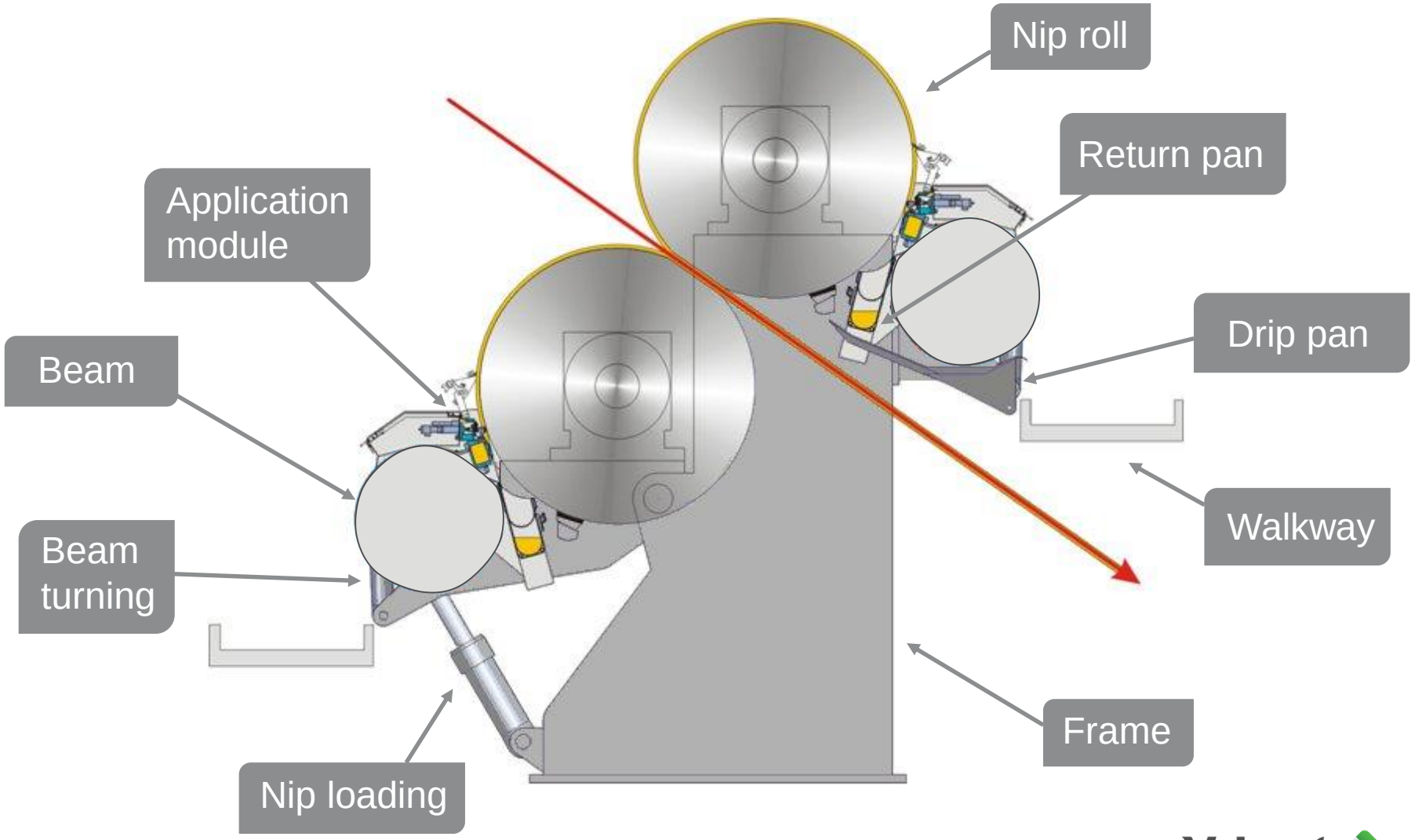
Spray on roll



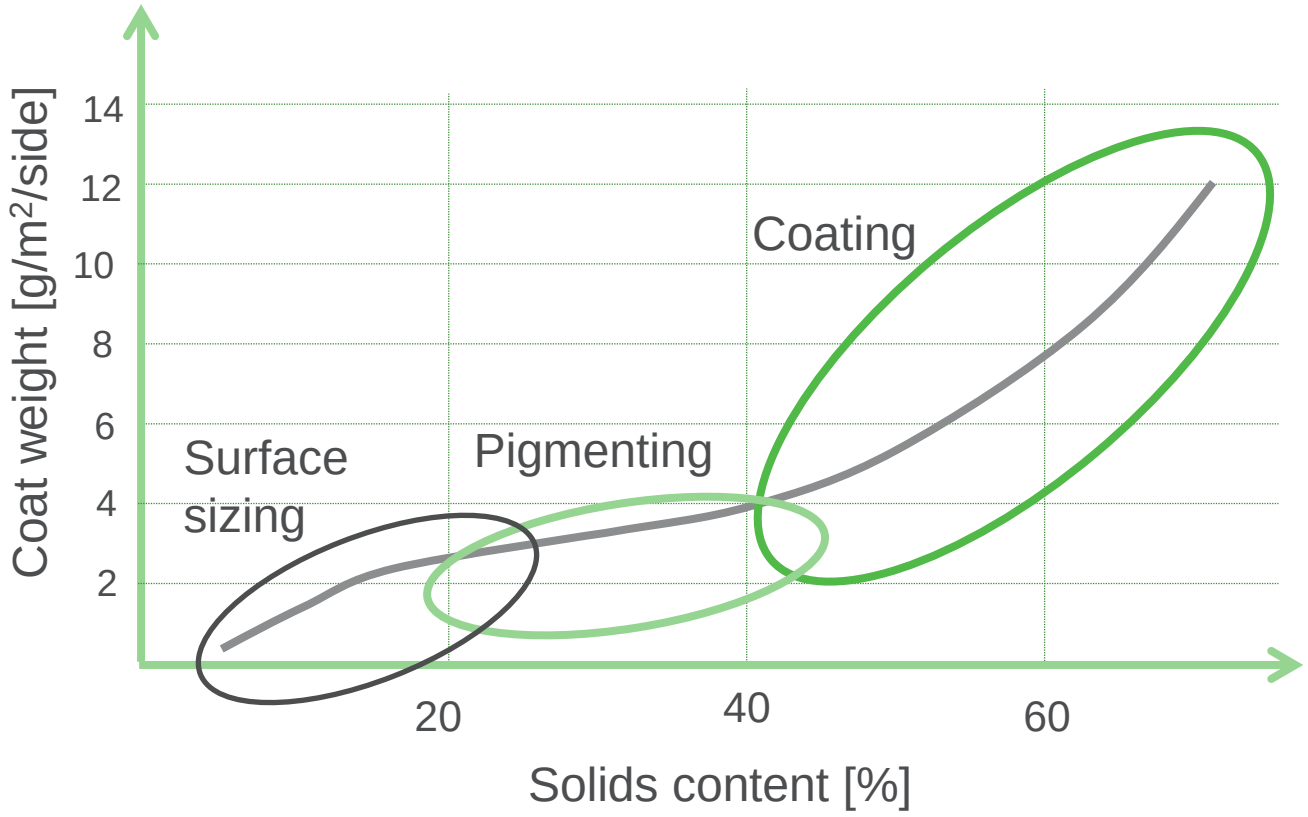
Spray on hard rolls + high nip load



OptiSizer Film – main components



Wide application area



- Also possible to have a multi-purpose sizer with coating and surface size application

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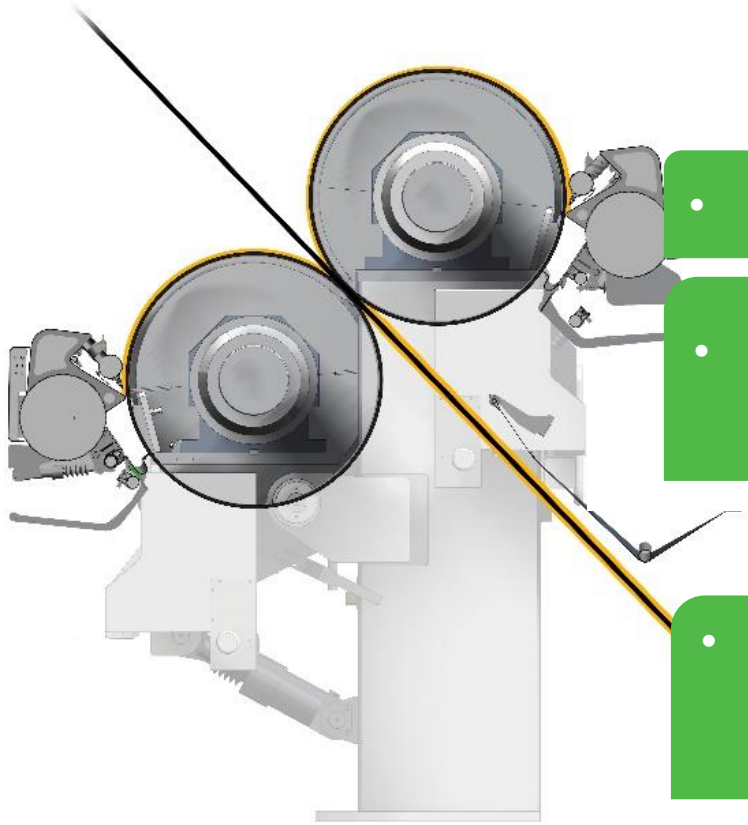
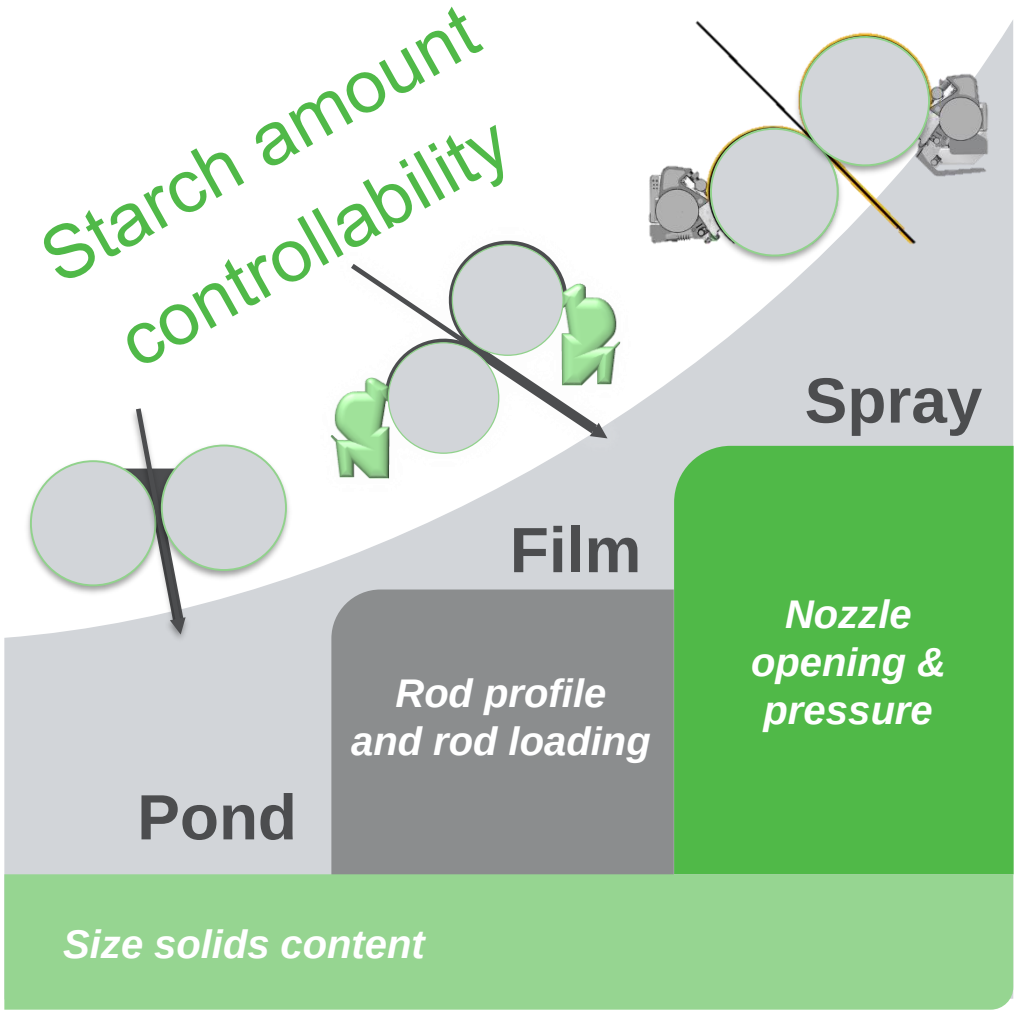
Optisizer Spray application principles



- Contactless application of starch
- No return circulation or washing of the web
- Efficient mist recovery, encapsulated construction and edge sealing

Comparison of control parameters

Accurately controlled size amount is important



- Spray
  - Accurate control of wet film by adjusting feeding pressure
  - Fast response to changes in solid content due to low volume system
- Film
  - Reasonable control possibilities
- Pond
  - Size solids content is the only control parameter

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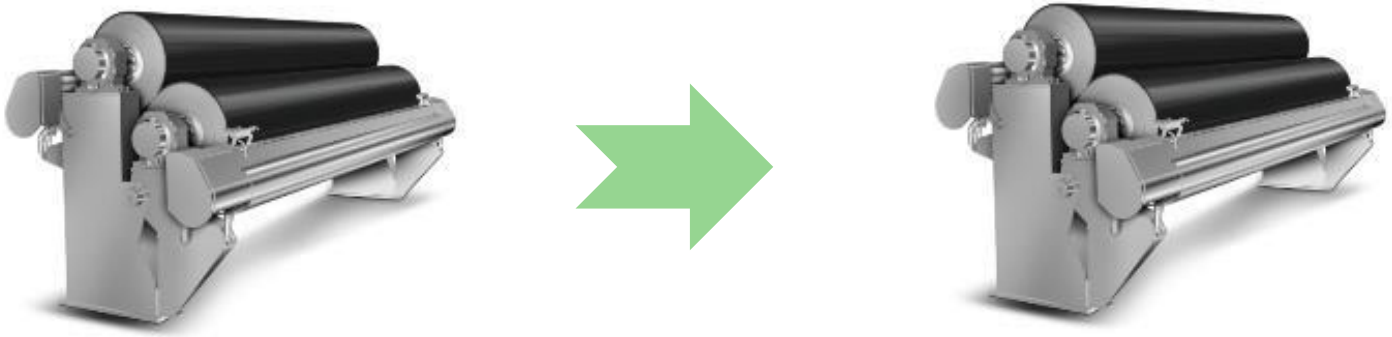
OptiSizer Film vs Spray for Rec. Containerboards



OptiSizer Film - Sizer with film application

- State-of-the-art size press
- Limited strength for high basis weight
- Low starch solid and higher steam consumption
- Cleanliness issues with recycled fibers
- Rolls cover and consumable costs relatively high
- Need a web break to change rod and rod bed.

OptiSizer Spray - Sizer with film with spray application

- Revolutionary sizing process
- Adjustable strength properties for recycled board
- High starch solid (12 – 14%), lower steam consumption, higher production
- Clean starch circulation with non-contact application
- Minimal consumables and long roll lifetimes
- Nozzle module could be change during the turn-up

Valmet

Valmet automation solutions and services (MCS ,QCS, DCS)

Remote online monitoring in addition to site support

Valmet Performance Center access to the expertise you need

Remote monitoring and optimization

On-demand expert support

Data discovery and analysis process

Performance Centers for:

Latest Innovations

Latest Technology for Board making

OptiFlo layering Headbox

Unique technology that uses a thin layer of water as a headbox wedge to minimize flow disturbances between stock layers which allows the forming section to consolidate the stratified paper structure.

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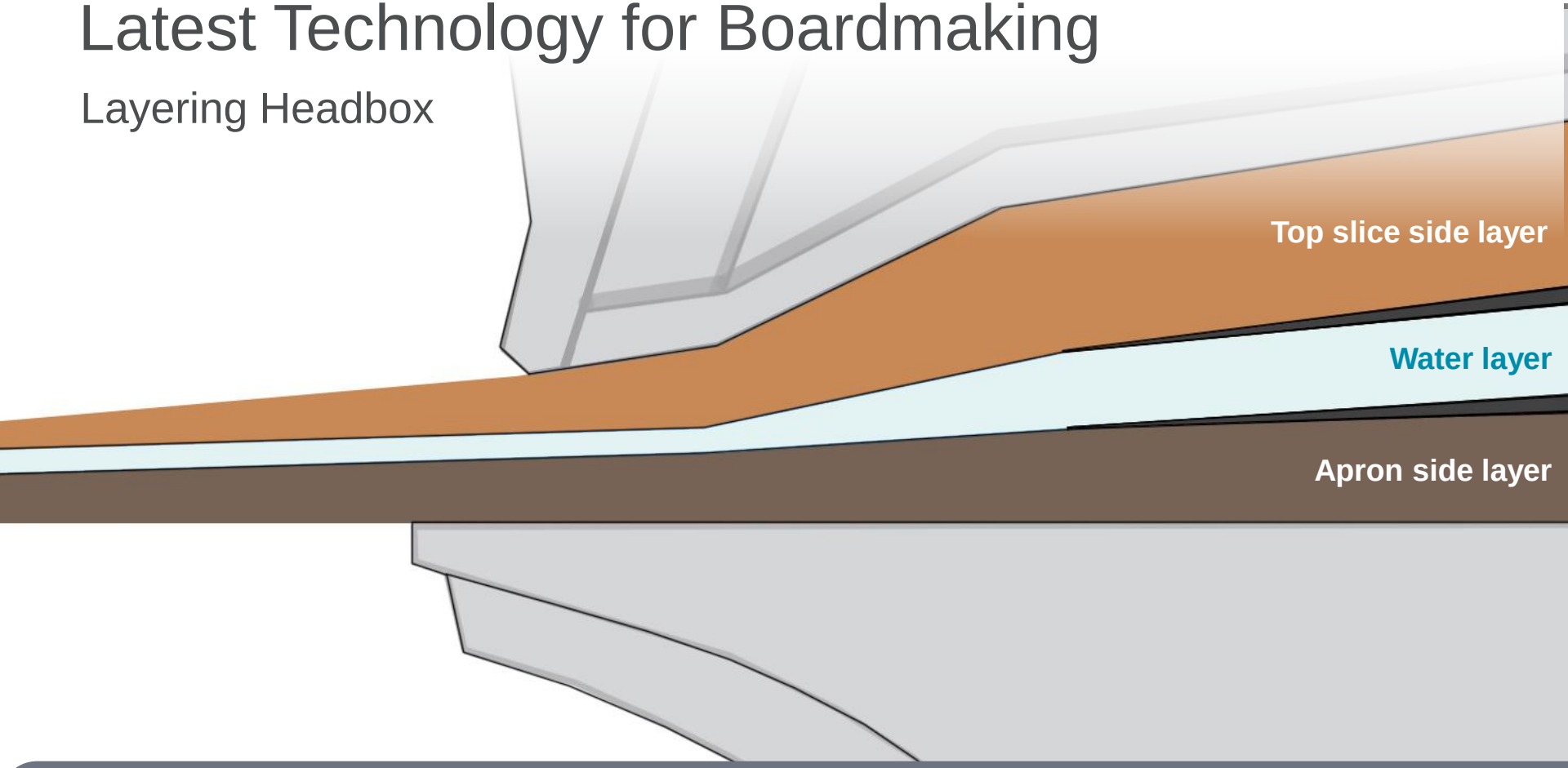
Latest Technology for Boardmaking

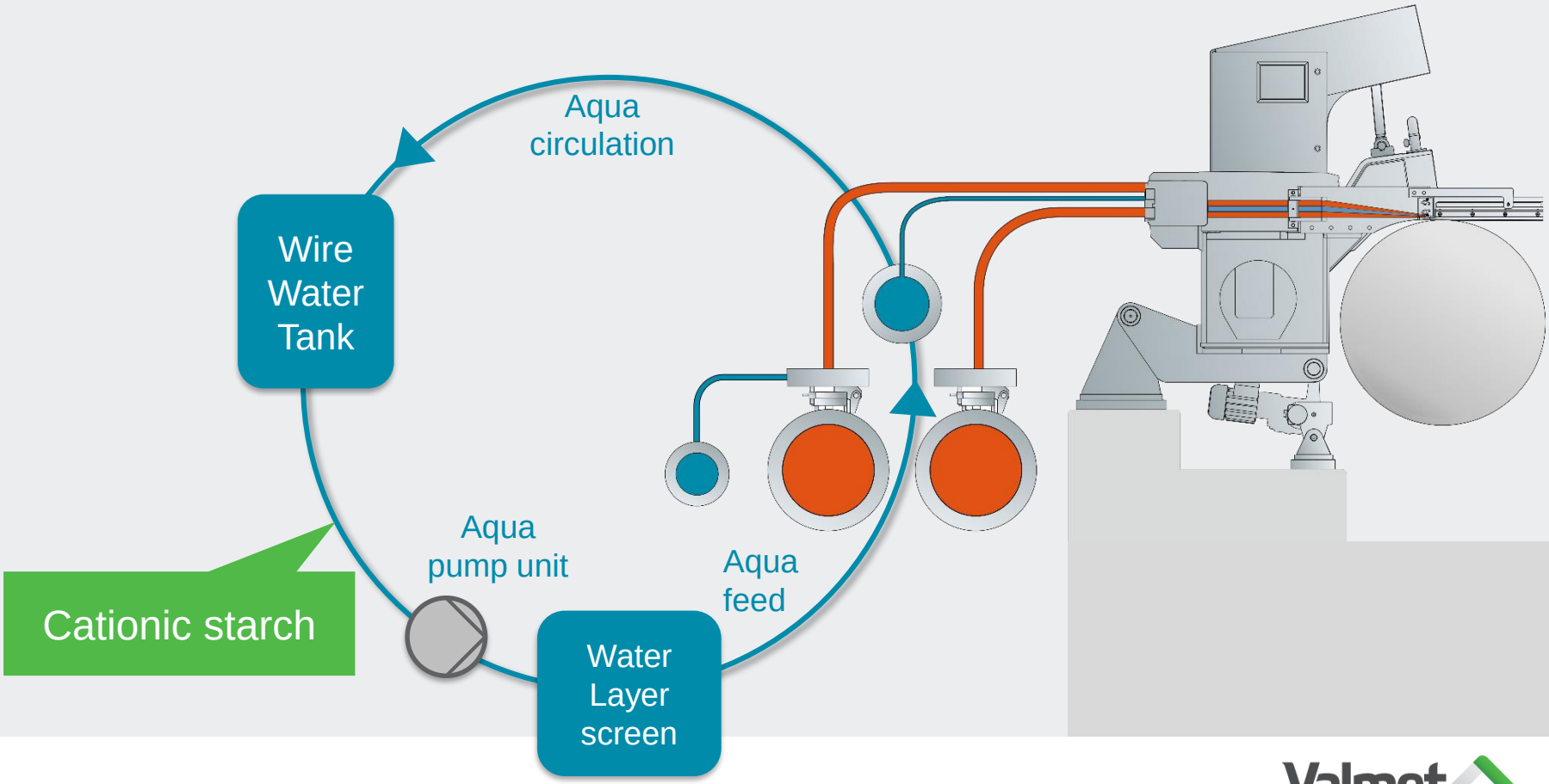
Layering Headbox



Unique technology that uses a thin layer of water as a headbox wedge to minimize flow disturbances between stock layers which allows the forming section to consolidate the stratified paper structure.

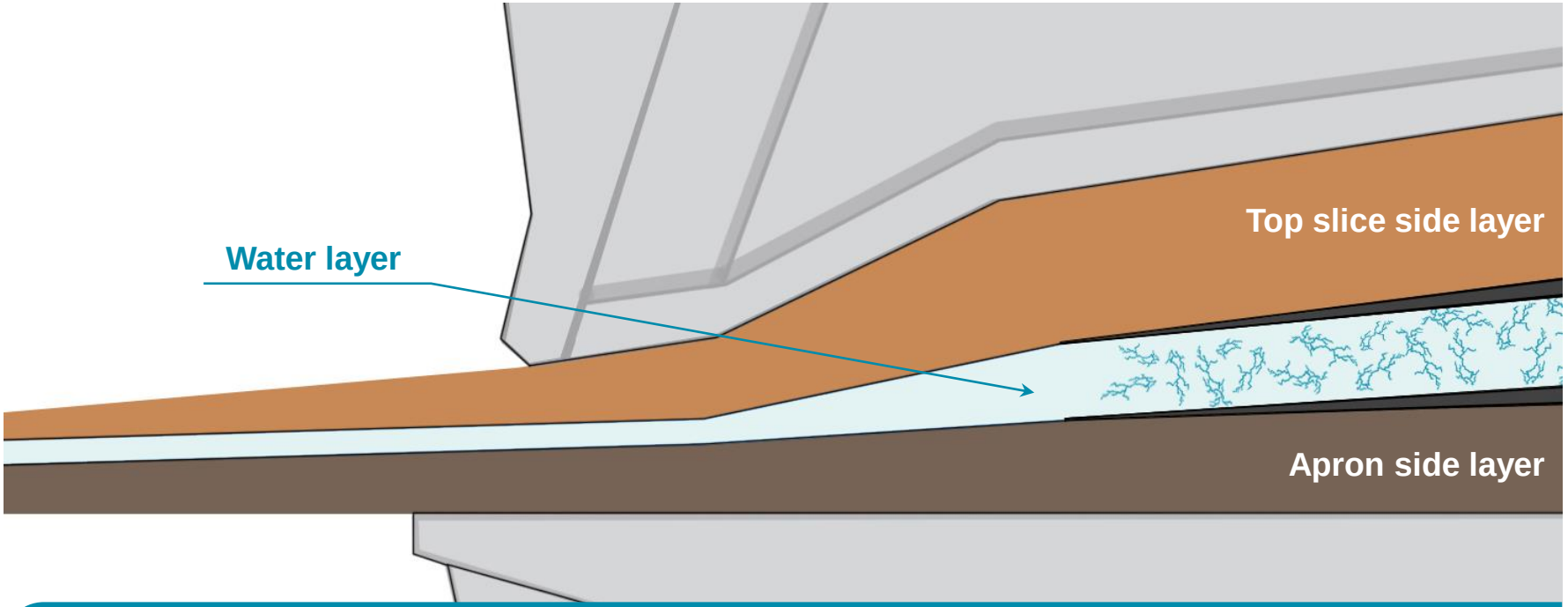
Water Layering Technology Opportunities

Optimal and Flexible Dosaging



Water Layering Technology Opportunities

Additional Features

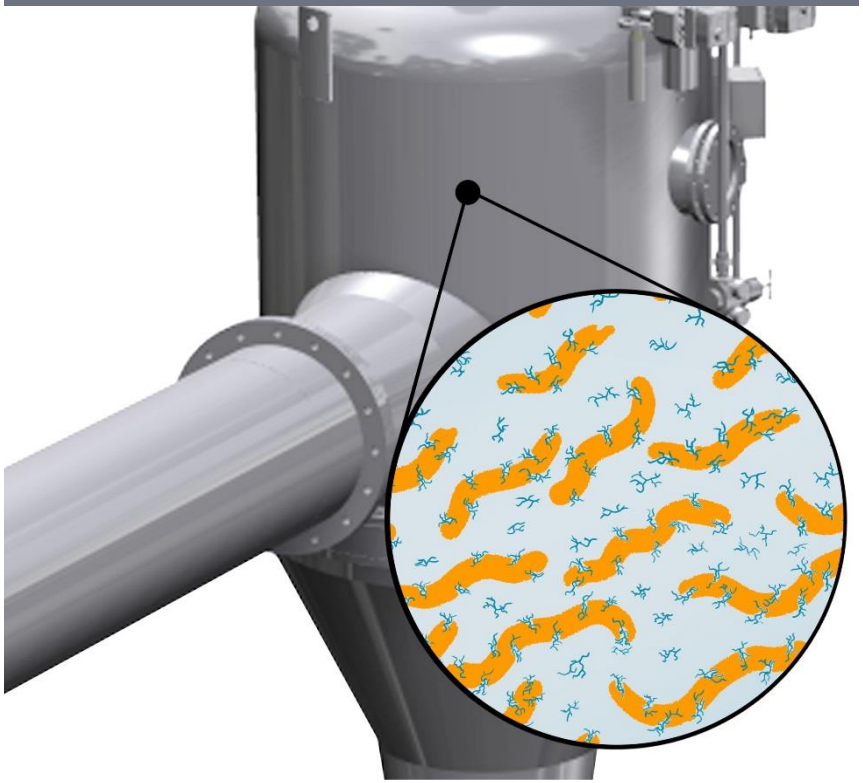


New layering technology provides possibilities to adjust quality and strength properties. Cost savings can be achieved by using different furnish qualities, cheaper raw materials, and functional wet end additives between the layers.

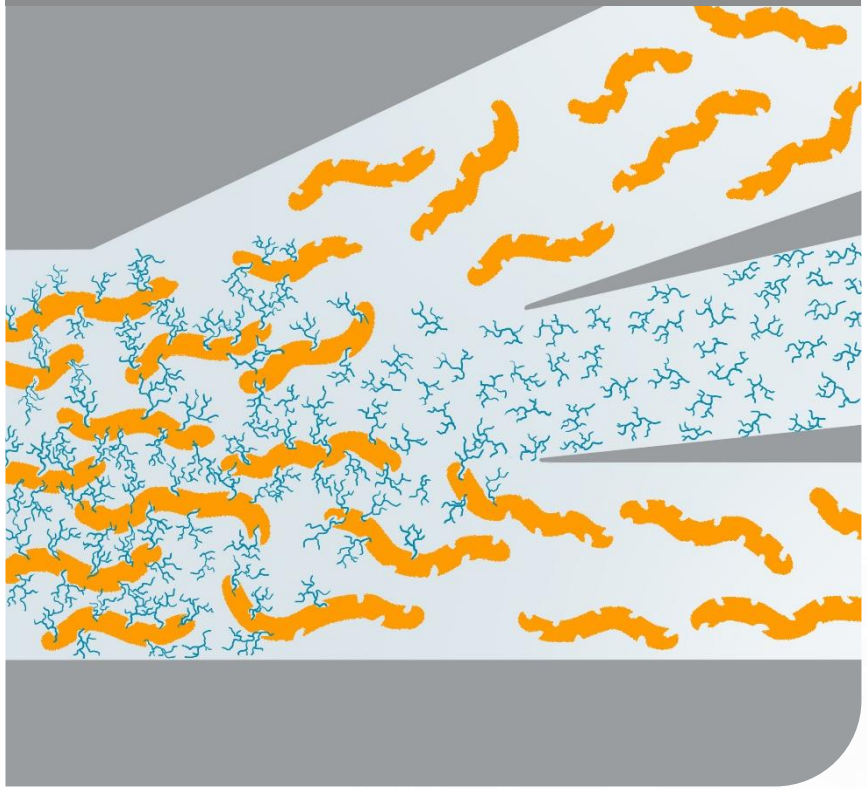
Using headbox for optimal chemical dosaging

Improved strength: Optimal feeding point for active starch interaction

Conventional
starch configuration

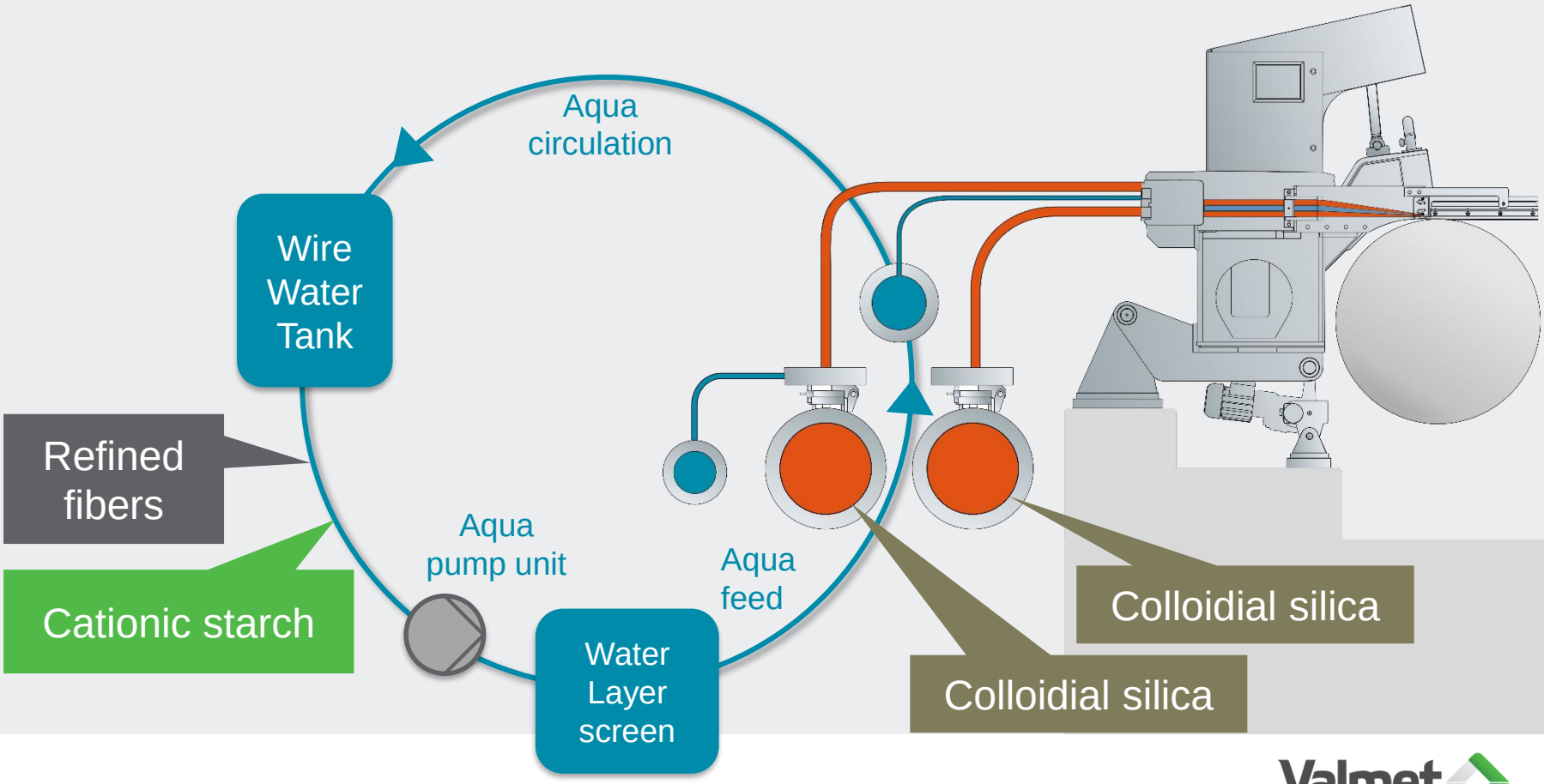


Starch configuration
with Aqua technology



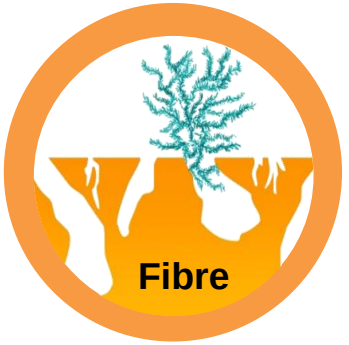
Water Layering Technology Opportunities

Optimal and flexible dosaging → what else can we do?



Water Layering Technology

Optimal and flexible dosaging for improved quality

Cationic starch + **Colloidical silica** + **Refined fibers** = 

- Dry strength additive
- Retention helper

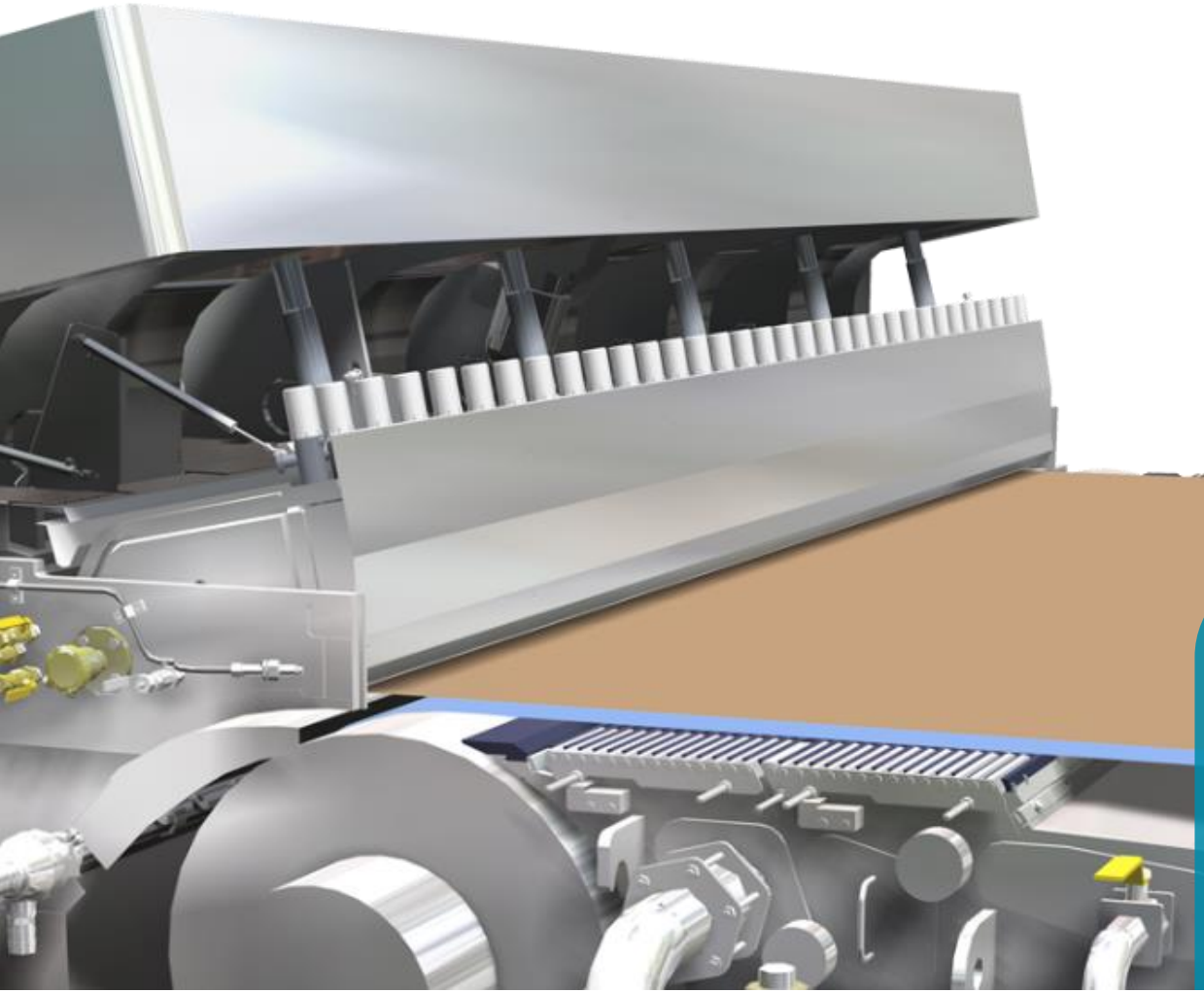
- To maximize starch content in paper
- To help on drainage

- To maximize bonding ability between layers
- To further improve starch retention paper

- Best possible strength-drainage-retention combination

Excellent layer purity

Vacuum Assisted Forming Board with OptiFlo



Technology features:

- Stabilizes jet landing
- prevents stock jump

Benefits:

- Improve layer coverage
- High initial dewatering capacity
- Controlled fiber mat formation

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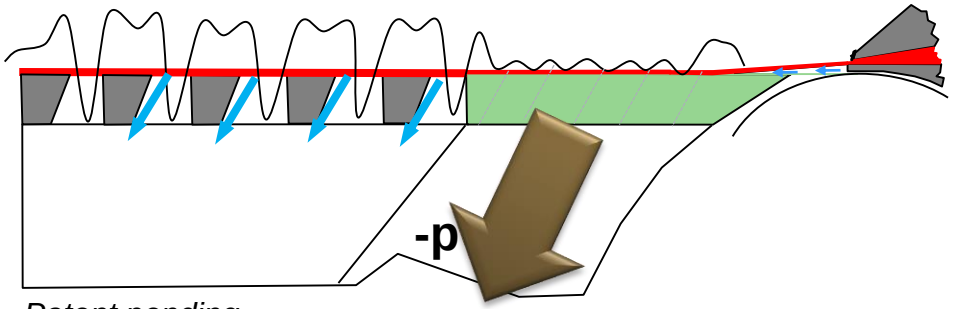
VacuBalance vacuum-assisted forming board

Comparison with traditional forming board

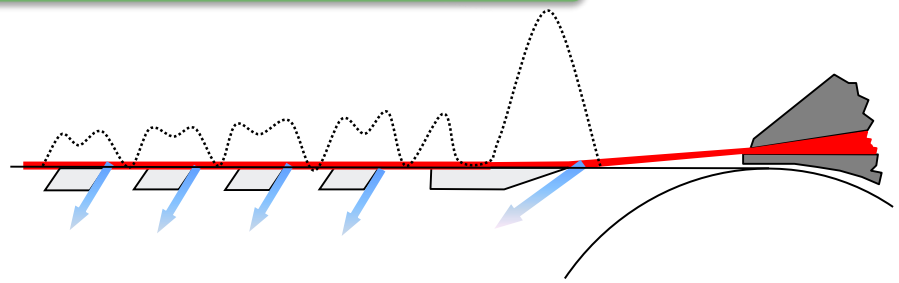
VacuBalance vacuum-assisted forming board



Patent pending

- Minimized pulsation
- Minimized stock jump
- Very high dewatering capacity
- Very wide operation window
- Excellent for layering

Conventional forming board



- Sensitive for stock jump
- Heavy pulsation
- Low dewatering capacity
- Fixed operation window
- Not suitable for layering

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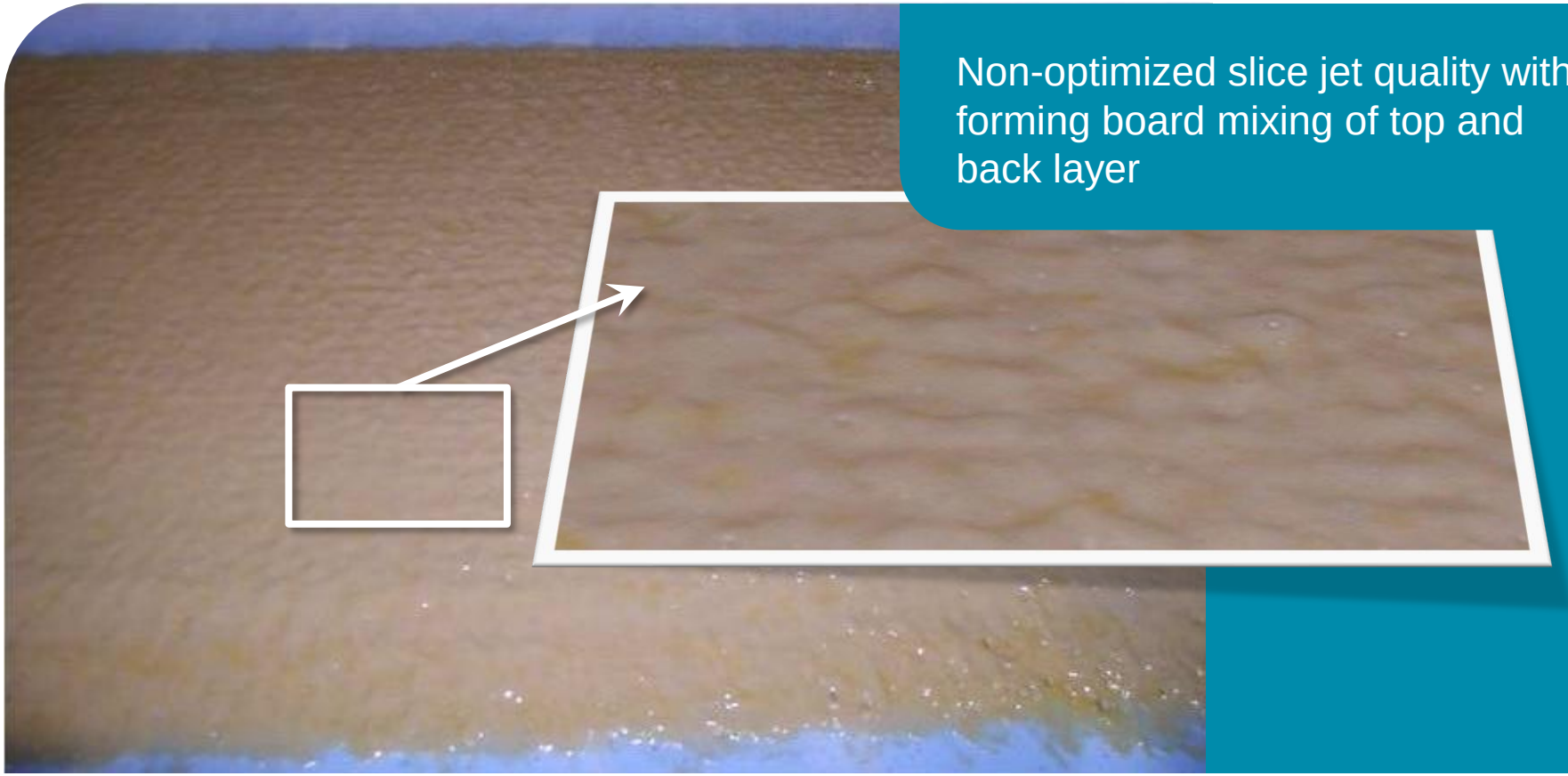
Effect of headbox & former on layer purity

Conventional headbox and non-suitable forming board



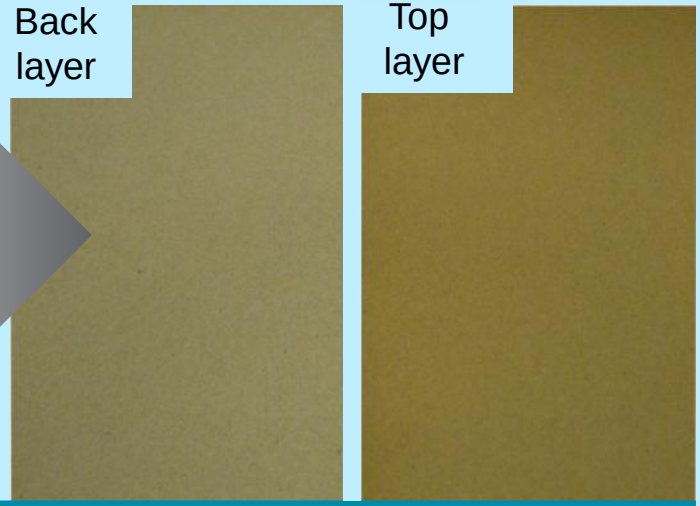
Non-optimized slice jet quality with forming board mixing of top and back layer

Effect of headbox & former on layer purity

Water Layering and Vacuum assisted forming board technologies

Solution

Result



Water Layering Technology together with Vacuum assisted forming board produces smooth forming table activity without mixing of layers.

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30% less starch needed with new Aqua layering technology

- Flexibility
- Aqua has a rapid starch feeding response, unlike conventional technology with a long delay time
- With Aqua layering technology, strength targets are achieved with almost 30% lower starch dosing
- Aqua layering enables totally new ways to utilize raw materials, like refined OCC, refined broke, selected fiber fractions or even reject.

This gives revolutionary improvement possibilities

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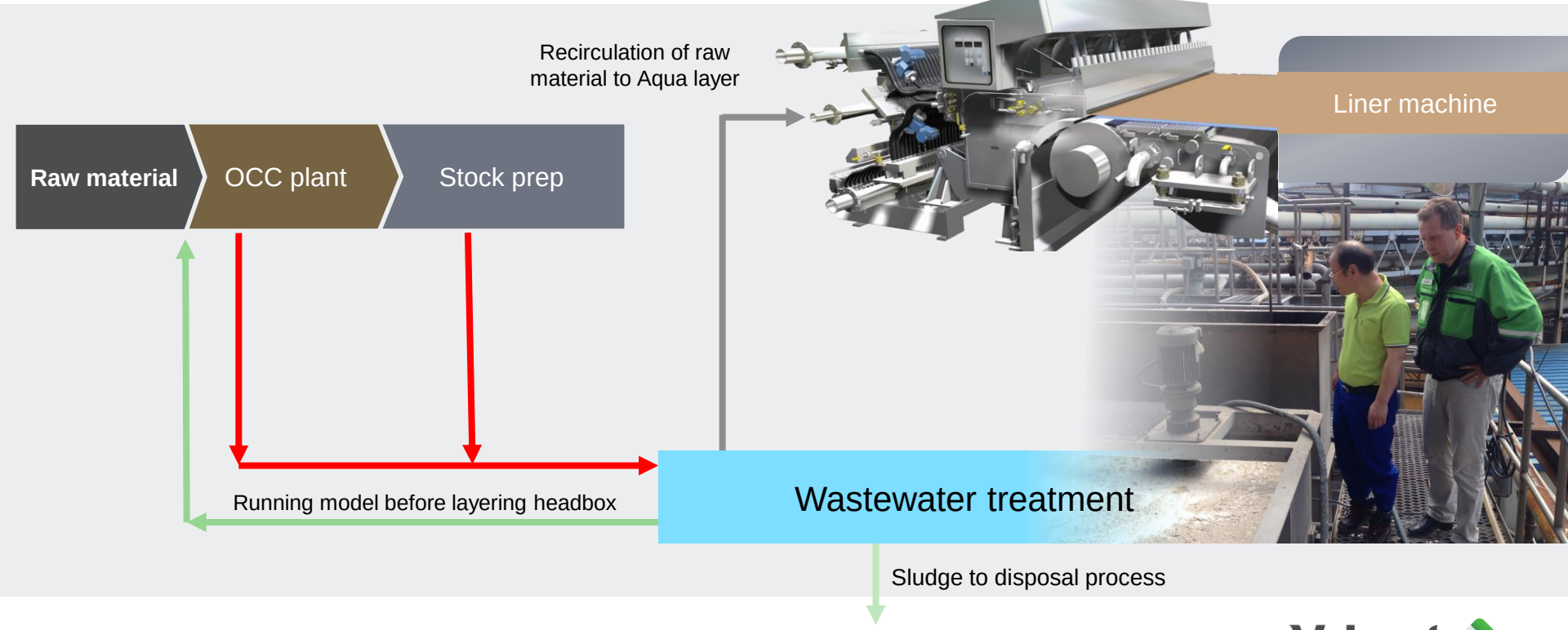
Reference case: revolutionary example:

Signinificant cost savings and method of optimizing mill performance

- Reject from WWTP chemical flotation is returned directly to the Aqua layer
- This has offered totally new optimization possibilities on the furnish side
- Next phase is to utilize fines and fiber from white water



Optisizer Hard

OptiSizer product family

Size application solutions for specific papermaking needs

- Fit for purpose: all application methods and paper machine sizes available
- Robust and modular construction,

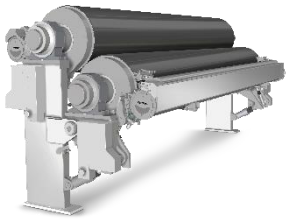
OptiSizer Pond
Pond application

OptiSizer Film
Film application

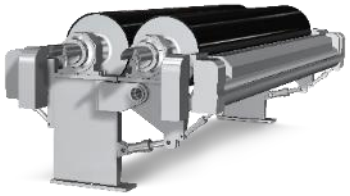
OptiSizer Spray
Spray on web application

OptiSizer Combi
Combined film, pond or spray application

New design



OptiSizer Spray
Sizer with spray on roll application



OptiSizer Hard
Sizer with spray application on hard rolls

New design

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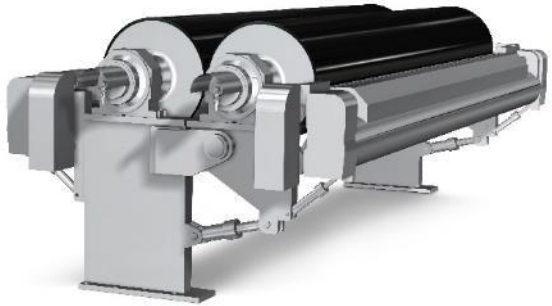
OptiSizer Hard - benefits



OptiSizer Film - Sizer with film application

- State-of-the-art size press
- Limited strength for high basis weight
- Issues with runnability and sheet breaks
- Cleanliness issues with recycled fibers
- Rolls cover and consumable costs relatively high

OptiSizer Hard - Sizer with hard nip rolls and spray application

- Revolutionary sizing process
- Excellent strength properties for recycled board
- Uncompromised runnability
- Lower web tension
- Clean starch circulation with non-contact application
- Minimal consumables and long roll lifetimes

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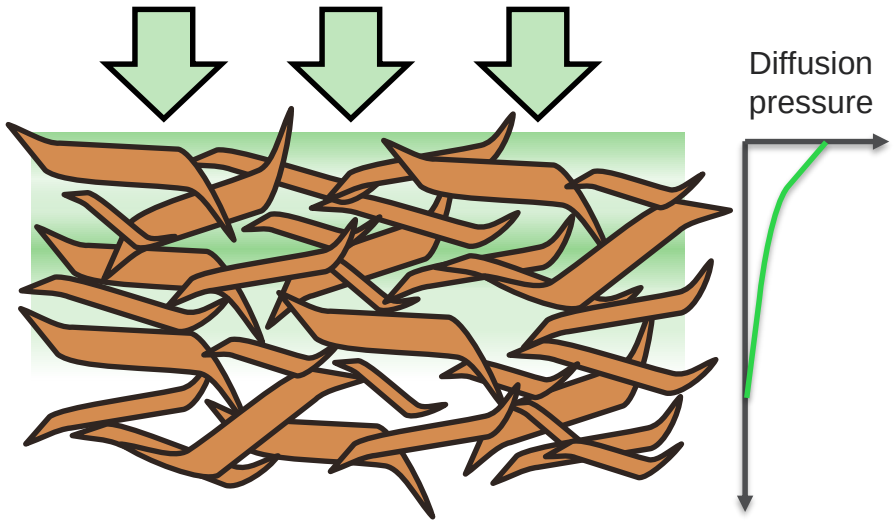
High nip pressure increases strength

Sheet wetting = good penetration ≠ good strength

Low pressure

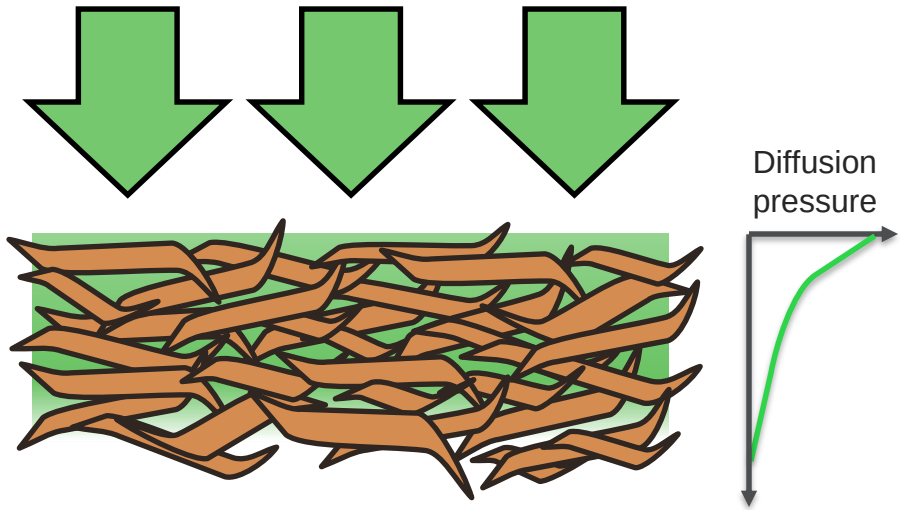


- Fiber to fiber distance relatively large
  - Large porous volume
  - Small pressure for liquid diffusion

→ **Starch in pores,** not in fiber junctions

→ Penetration of starch is small

High pressure



- Fiber to fiber distance relatively small
  - Small porous volume
  - Large pressure for liquid diffusion

→ More starch **in fiber junction points**

→ Better starch penetration

Improves surface strength

Improves surface and internal strengths

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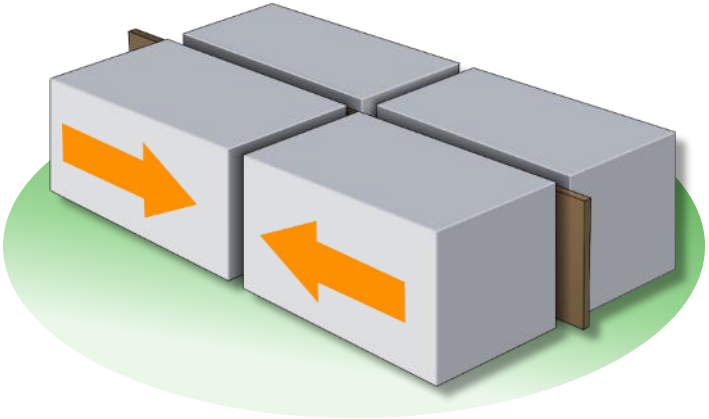
SCT strength tests internal strength of paperboard

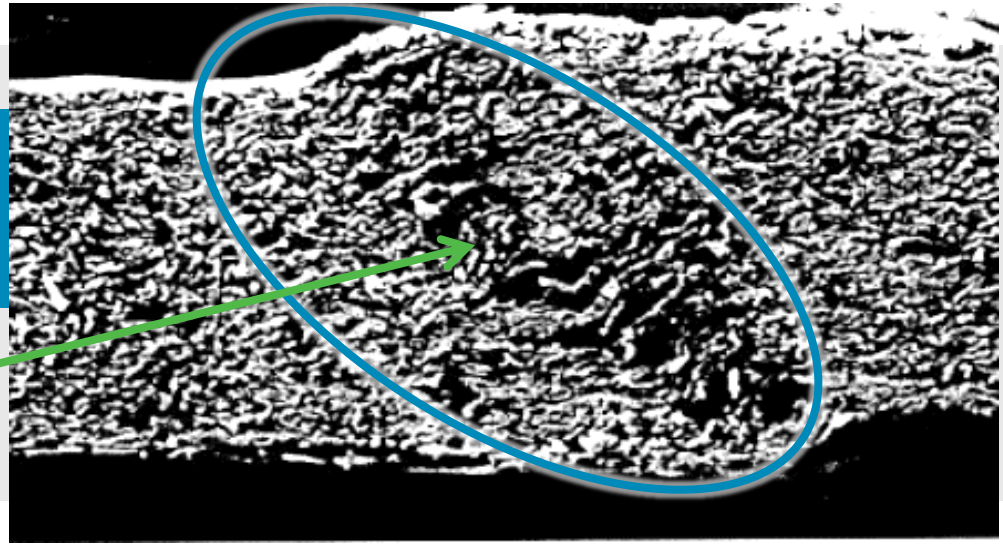
- SCT testing applies compressive stress across the sheet thickness
- For good burst results, internal strength needs to be improved

→ Better starch penetration needed



SCT testing

Paperboard after compressive failure



Source (paperboard specimen photo): http://www.rbi.gatech.edu/sites/default/files/documents/Predicting%20Box%20Compression%20Strength_3.pdf

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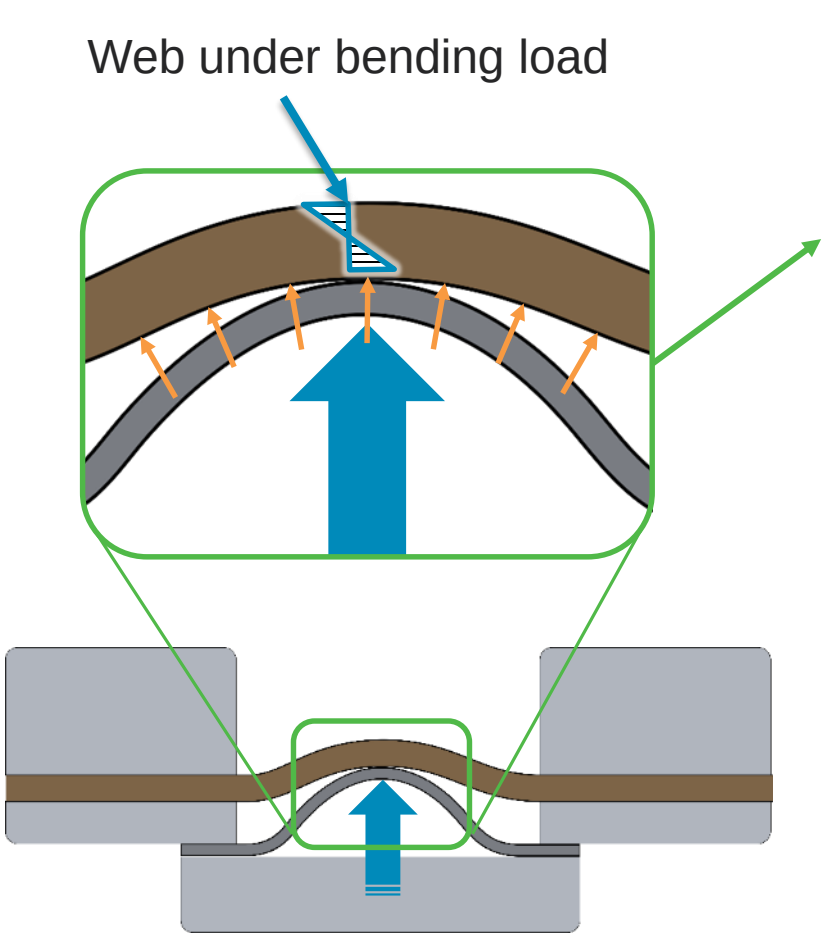
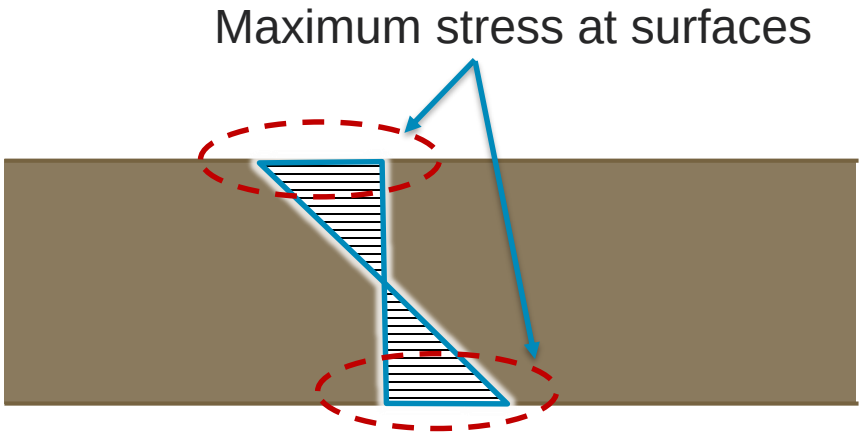
Burst tests surface strength of paperboard





- Burst testing
  - Maximum stress at the surfaces
  - Compression stress at the bottom
  - Tensile/pulling strength at the top

→ For good burst results, surface strength need to be improved

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Comparison of sizer concepts

Pond sizer [Pros]	Optisizer Film [Pros]	Optisizer Hard + Spray [Pros]
+ **Good strength properties**	+ No need for overdrying	+ No need for overdrying
+ Good evenness of size	+ Good size coverage	+ Small starch recirculation
+ Simple design	+ Controllable size amount	+ Controllable size amount
+ Only wear parts roll covers	+ Large viscosity window	+ No wear of rods / rod beds
	+ Higher solids possible (typical 10 – 15 %)	+ **Excellent strength properties**
		+ Hard roll covers → long running times
		+ Lower web tension levels
Pond sizer [Con]	**Optisizer Film [Con]**	**Optisizer Hard + Spray [Con]**
- **Web wrinkling and tension problems → poor runnability, sheet break sensitivity**	- Rod & cover wear with recycled base	- For high solids contents and added sizing agents there is risk of spray nozzle blocking and spray beam contamination
- For pond stability, starch viscosity/solids limited	- Rod blocking with contaminants	- High size viscosities (> 50 mPa*s) not possible
- High wetting → large steam consumption	- Large amount of starch recirculation	- Challenges if color dyes are used in size press due to spray evenness if small wet film is desired
- High size recirculation → starch contamination	- **Strengths for high BW**	- Remainder film lost in doctoring (not recirculated)
- Overdrying for profiles		

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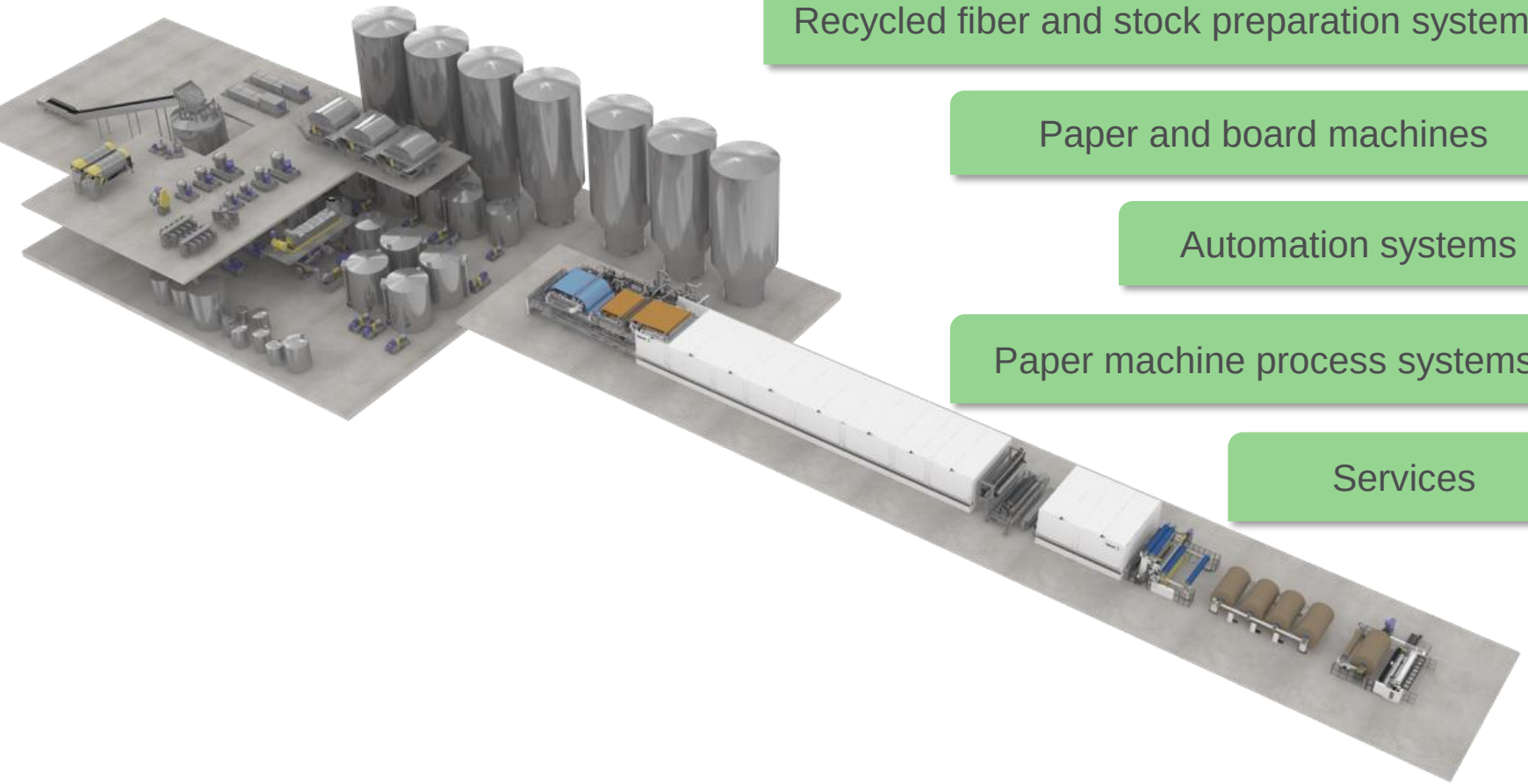
Thank You



- Recycled fiber and stock preparation systems
- Paper and board machines
- Automation systems
- Paper machine process systems
- Services

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