PITA Training & Conferences

Paper
Industry
Technical
Association

'PRACTICAL PAPERMAKING CHEMISTRY'

Thursday, 23rd September 2010
at
Aylesford Newsprint

5 Frecheville Court
Bury
Lancashire
BL9 0UF

Tel: 0161-764-5858
Fax: 0161-764-5353
E-mail: info@pita.co.uk

Bringing Science to the Art of Papermaking

Practical Papermaking Chemistry

Aylesford Newsprint - 23rd September 2010

Start	End	Presentation
9:00	9:30	Registration, Coffee & Bacon Sandwiches
		Session One - Chairman: Nigel Jopson / Pira International
	1	Opening Comments Barry Read / PITA
	2	Influence of fibre preparation on papermaking fibre quality Robert Langley / Intertek
	3	Effective flash mixing of chemicals close to PM headbox brings considerable cost savings together with environmental benefits Prof Jari Käyhkö / Lappeenranta Technical University, Finland
11:00	11:30	Tea & Coffee
11:30	13:00	**Session Two - Chairman: Barry Read / PITA**
	4	Strength enhancement of recycled fibre with a new range of chemical additives Paul Dekock / Clariant
	5	Biopolymers At The Wet-end, A New Approach Martin Georgeson / Roquette UK & Regis Houze / Roquette Frères
	6	Foam control in paper systems Phil Cooper / Blackburn Chemicals
13:00	14:30	Extended Lunch
14:30	16:00	**Session Three - Chairman: Graham Moore / Pira International**
	7	Fillers & forming - impact on sheet structure Nigel Jopson / Pira International
	8	Electrochemical method for calcium carbonate & microbial anti-fouling in pulp & paper process Matti Häkkinen / Savcor Forest Oy, Finland
	9	Charge control for improved paper production John Munday / BTG
16:00	16:30	Tea & Coffee
16:30	17:10	**Session Four / Workshop**
	10	The value of retention & dewatering Stuart Thomas / Axchem UK
	11	Closing Comments Barry Read / PITA
17:10	17:30	End of Conference

Robert Langley

Intertek (ITS) Testing Services Ltd
Head of Stock Preparation

Graduated from the London University in 1983 in Chemical Engineering.

Joined the Wiggins Teape Group in 1977 to develop the knowledge of Stock Preparation – Refining and fibre utilisation. During which time, a comprehensive pilot plant system was developed to simulate Mill production systems on which Research and System development was conducted.

1982 – 1987 worked developing IDEM carbonless coatings and coating techniques during which time, installed and supervised the production of a synthetic clay plant.

1987 – 1995 Provided technical support trouble shooting and designing Stock Preparation Systems.

1995 - 2009 responsible for the technical design and development of the ArjoWiggins Stock Preparation systems and technical procurement of pulps.

2009 – Joined Intertek (ITS) testing services providing technical testing and project support in the field of Stock Preparation and Fibre for the Paper Industry.

Contact Details:

ITS Testing Services
Unit 7, St. Georges Industrial Estate
White Lion Road.
Amersham
Buckinghamshire
HP7 9JQ
United Kingdom

Tel. +44 (0) 1494 544819
Fax. +44 (0) 1494 766798
E-mail: robert.langley@intertek.com
www.intertek.com

Intertek

Intertek Paper Technology Services

INFLUENCE OF FIBRE PREPARATION ON FIBRE QUALITY

Robert Langley

Intertek - Paper Technology Services

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-Fibre Structure

- Importance of Fibre Selection and Effect on sheet quality

- Stock Preparation Influences on Fibre Qualities

Promote Discussion !

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Papermaking Fibres

- **Esparto** – Stamp papers
  - **Grass from Tunisia. Very fine, springy, opaque fibres**
- **Hemp / Flax** – Cigarette, Bible, Currency papers
  - **Traditionally textile fibre (rope, canvas, yarn). Very long fibre**
- **Manila** (Abaca) – Strong papers, Packaging
  - **Traditionally rope, textile fibres, Plantation residues**
- **Cotton Linters** – High quality business papers
  - **Oil seed hair, very long fibre,**
- **Straw** – Dense, smooth papers
  - **Grass stem, fine fibres, high level of dirt**
- **Wood** - Multi purpose applications
  - **Hardwood functional, Softwood reinforcement**

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Comparison of Fibre Costs

Fibre Type	Relative Price	Actual Price £/t
Abaca	4.80	1920
Flax / Hemp	4.00	1600
Sisal	3.45	1380
Flax	3.30	1320
Cotton	2.50	1000
Esparto	1.4	560
Straw	1.35	540
Wood pulp	1.00	400
Bamboo	0.96	340

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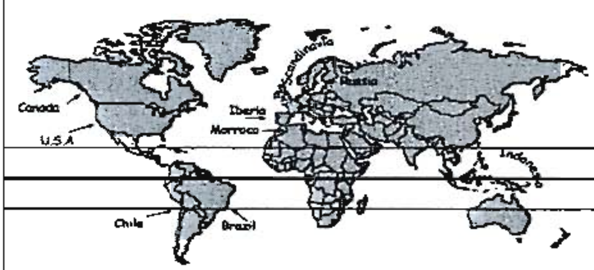
Geographical Sources of Woodpulp



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Softwoods - low fibre density

- **Examples**
  - **Pine** (Scots – Jack – Loblolly - Slash)
  - **Spruce** (Norway – Sitka)
  - **Fir** (Douglas – Balsam – Western)
- **Geography**
  - Generally come from cold climates.
  - Slower the tree growth, stronger the pulp
  - Scandinavia, N. USA, Canada, West Coast USA
- **Rotation Times**

- Scandinavia / Canada	Cold Climate	50/120 yrs
- UK	Mild / Wet	35 yrs
- S. America / SE Asia	Hot	8 – 12 yrs

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Hardwoods - high fibre density

- **Main Species**
  - **Maple**
  - **Beech / Oak** (European - American)
  - **Birch** (White)
  - **Eucalyptus** (Globulus – Grandis – Camaldulensis - Acacia)
- **Geography**
  - Generally slower growing than softwoods in temperate climates e.g. Oak
  - Some of 700 species are fast growing in hot climates e.g. Eucalyptus
  - Scandinavia, N. USA, Canada, Iberia, S. America, S.USA, SE Asia
- **Rotation Times**
  - Scandinavia / Canada Cold Climate Birch 58 – 80 yrs
  - Latin America / SE Asia Iberia (Spain / Portugal) Hot Eucalyptus 8 – 12 yrs

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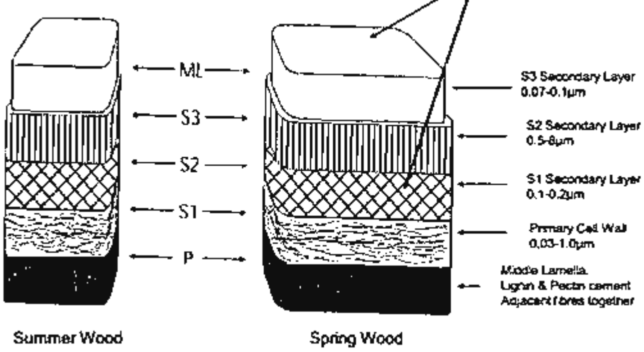
Fibre Angle determines fibre strength
↓ Angle = ↑ Strength
Springwood = ↑ Angle = ↓ Strength

Mature Softwood Fibre



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Fibre Chemical Composition

Cellulose

- Main component of fibre (Carbohydrate). Long straight chain polymer, Glucose
- Material of which fibre is built
- Resistant to most chemicals except strong acids
- Provides principle source fibre – fibre bonding in sheet

Hemi Cellulose

- Second major fibre component. Short polymer glucose / mono saccharides
- Polymer can be removed by mild chemical actions
- Promote development fibre – fibre bonding by fibre hydration

Lignin

- Between / within fibres. Complex structure. Does not readily dissolve but can be made soluble by chemical reactions.
- Prevents fibre – fibre bonds

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Average Composition of Softwood and Hardwood Fibres

Species	Lignin (%)	Cellulose (%)	Hemi Cellulose (%)	Extractives (%)
Hardwood	20	45	30	5
Softwood	28	42	27	3

Variations seen between different Fibre species and Geography / growth patterns of trees.

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Distribution of Chemical components in Wood fibres

Wall Layer	Lignin (%)	Cellulose (%)	Hemi Cellulose (%)
Middle Lamella	90	0	10
Primary Wall	70	10	20
Secondary Wall S1	40	35	25
Secondary Wall S2	15	55	30
Secondary Wall S3	10	55	35

Majority of Lignin removed during digestion from Middle Lamella + Fibre Wall (Primary + Secondary).
Removal dictated by wood species / Geography of growing region / Pulp Company.

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Zeta Potential - Unrefined Stock

(Pulp dispersed in De-ionised Water @ 15 °C)

Charge dictated by Pulp Mill Operations

		Zeta Potential mV	*pH*
Annual	*Esparto SNCPA*	- 10.8	9.16
	Bagasse EPPCO	- 6.35	6.11
	Chinese Linters	+ 1.0	7.0
Hardwood	*Cenibra Euc. Grandis*	- 5.0	6.6
	Cacia Euc. Globulus	- 3.5	5.7
	Ceasa Euc. Globulus	- 2.6	5.85
Softwood	*Sodra Black R Pine/Spruce*	- 6.0	7.0
	Tembec Tarascon	- 3.0	6.0
	Oulu Pine	- 6.0	5.9
Variability	*European Eucalyptus Supplier*	+ 1.0	7.0
		- 5.0	7.0

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Zeta Potential - Mill Stock

Pulp dispersed in Process Water in Pulper – Nominal 20 °c – No chemical modification
30 minutes chest agitation
Refined 1.0 J/m SEL – 3mm Bars

Charge varies as fibre is 'Opened" through refining.

		Zeta Potential mV
Sodra Black R SWD	*0*	*-20.3*
	50	*-14.1*
	100	*-13.7*
	150	*-13.5*
	200	*-12.9*
Cenibra Euc. HWD	*0*	*-17.75*
	50	*-17.5*
	100	*-17.35*
	150	*-15.4*
	200	*-14.6*

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Fibre Characteristics - Hardwood

Country	Major Producers	Species	Attributes	Major Applications
Indonesia	PT Tel	Acacia	High Opacity	Bible paper
	PT Riau Andalan		Low Bulk	Textbook
	PT Kiani Kertas		Very High Population	Financial prospectus
Brazil	Aracruz	Eucalyptus Grandiflora	Bulk	Facial tissue
	Klabin - Riocell		Opacity	Printing papers
	Cenibra		High Population	Filters
	Bahia Sul		Tactile	Specialty products
	Jari		Smoothness	
Canada	AlPac	Aspen	High smoothness	Coated papers
	DMI		Holdout	Coated papers especially gravure
	Domtar			
Canada	Domtar	Maple	High population	Printing / writing grades
	Irving		Thick walls	Resists abuse of refining
Spain	ENCE	Eucalyptus Globulus	Good for recycling	Toweling
Portugal	Portucel			Tissue
Chile	Pheonix			Coated/uncoated printing grades
Thailand	CMPC			
	Santa Fe			
Sweden	Major pulp producers	Birch	Long slender fibres	LWC
Finland			Refines easily	Coated/uncoated printing grades
Canada			Strength	
			Entanglement	

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Fibre Characteristics - Softwood

Country	Major Producers	Species	Attributes	Major Applications
Chile	CMPC	Radiata Pine	Thick walled fibres	Cement reinforcing
	Arauco		Good blend of tear	Packaging papers
			Fold	
			Burst	
			Tensile	
Canada	DMI	White spruce	Thin walled	Printing
	AlPac		Easy refining	Converting papers
			Low coarseness	Smooth surfaces grades
Canada	Domtar	Black spruce	Thin walled	Facial tissue
	Abitibi - Cons		Easy refining	Toweling
			Low coarseness	Printing / writing grades

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Fibre Characteristics

Hardwood		Fibre Length mm	Coarseness mg / 100m	No. fibres No. / mg
Eucalyptus	Acacia	0.83	6.0	20k
	Grandis	0.77	8.5	16k
	Globulus	0.80	9.7	13k
Birch		1.05	10.0	8k
Maple		0.70	13.3	11k

Softwood	Fibre Length mm	Coarseness mg/100m	No. fibres / gram No
Pine	2.4	11.98	3.5k
Spruce	2.3	13.8	3.2k
Redwood	1.85	21.6	2.5k

Refining Process Considerations:-

Fibre Length	Refiner Hydraulics	Bar dimensions
Fibre Coarseness	How hard to hit	Specific Edge Load / Specific Surface Load
No. Fibres	Fibre pad on bars	Refining consistency

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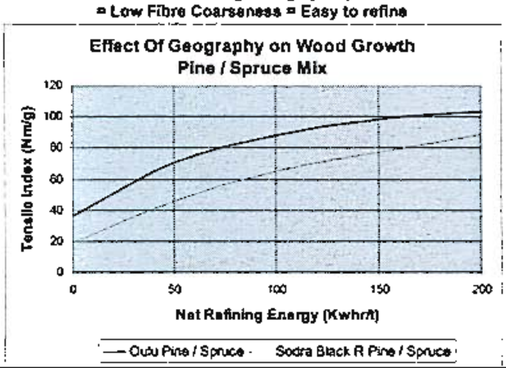
Tree Growing Environment / Geography will influence Length of Annual Growing Season. Temperature / precipitation
Cold climate – short growing cycle per annum
= Low Fibre Coarseness = Easy to refine



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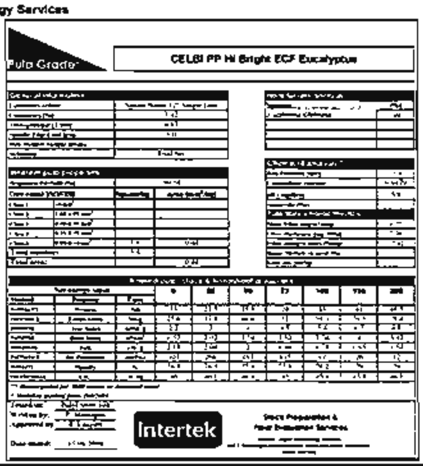
Pulp Evaluation Test Report



- **Define Pulp Qualities / Papermaking Potentials**
- **Furnish Construction through modelling for Quality / Cost**

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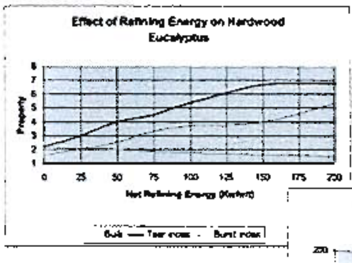
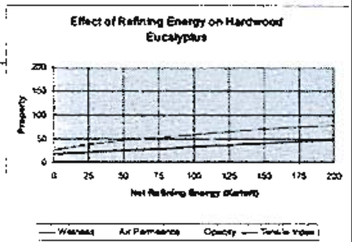
General Influences of Refining on sheet qualities





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Refining Process

Bar geometry – bar angle / No. sectors / bar orientation etc….
Refiner rotational speed
Disc vs Conical refining
Single / Multi pass refining
Stock consistency
Ph environment
Slushing

………………………………………!!

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Refining Theory

Intertek Paper Technology Services **Refining Theory**

The Severity of Bar to Fibre Impact

Specific Edge Load (SEL).

This relates the net power applied by the refiner motor to the edge length of refiner bars that cross in a unit of time

$$\frac{\textbf{Gross Power – No-Load Power}}{\textbf{Bar Cutting Edge Length}}$$

Units = j/m

Gross Power

Total power absorbed by the refiner motor
Units = Kw

No-Load Power

Power absorbed by the refiner motor
At the point which the bars are driven together (rotor – stator)
just before the power is seen to increase.

Intertek Paper Technology Services **Refining Theory**

The Number of Bar to Fibre Impacts

Net Energy Input (NEI).

This relates the net power applied by the refiner to the mass throughput of dry fibre through the refiner.

$$\frac{\textbf{Gross Power – No-Load Power}}{\textbf{Refiner Through-put dry Fibre}}$$

Units = Kwhr/t

Gross Power

Total power absorbed by the refiner motor
Units = Kw

Units = Kw

No-Load Power

Power absorbed by the refiner motor
At the point which the bars are driven together (rotor – stator)
just before the power is seen to increase.

Intertek Paper Technology Services **Refining Theory**

The Nature of the Bar to Fibre Contact

Specific Surface Load (SSL)

This relates the Specific Edge Load (Severity of Impacts) by the refiner bars to the bar widths at the point of bar crossing.

$$\frac{\textbf{Specific Edge Load}}{\textbf{Bar Impact Length}}$$ Units = j/m²

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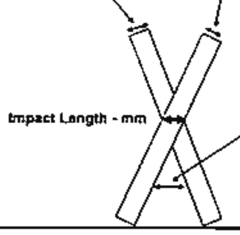
Refining Theory

Bar Impact Length:

$$\frac{\text{Width Rotor Bar x Width Stator Bar}}{2} \Big/ \frac{1}{\text{Cos } \frac{\text{Bar Angle}}{2}}$$

Units = mm



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Influence of Refining Intensity (SEL) / Net Energy on Bleached Hardwood Eucalyptus Globulus

Fibre	Eucalyptus Grandis
Refining	No chemical modification – Ph 7 - 20°C
	4.0% Consistency
	5mm bars → 1.5mm bars
	2.0 → 0.1 j/m SEL
	Constant bar angle 5 degrees
	Constant sector angle 30 degrees

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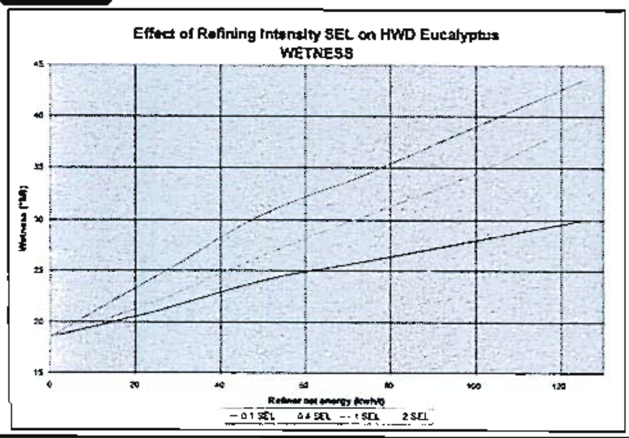
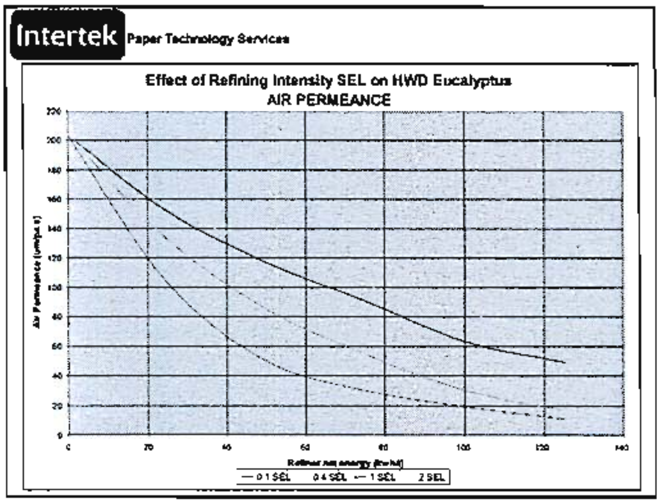
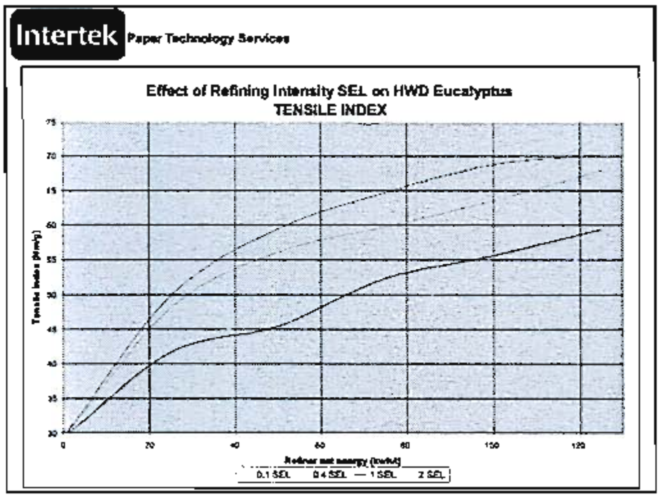
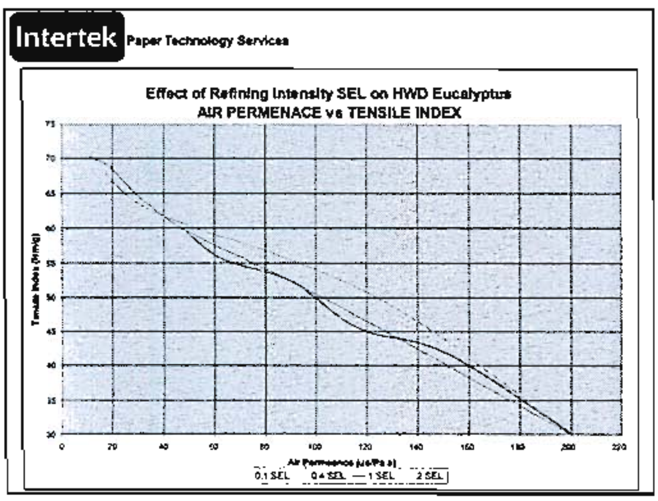



Intertek Paper Technology Services
Effect of Refining Intensity SEL on HWD Eucalyptus
AIR PERMEANCE
0.1 SEL
0.4 SEL
1 SEL
2 SEL


Intertek Paper Technology Services
Effect of Refining Intensity SEL on HWD Eucalyptus
TENSILE INDEX
0.1 SEL
0.4 SEL
1 SEL
2 SEL


Intertek Paper Technology Services
Effect of Refining Intensity SEL on HWD Eucalyptus
AIR PERMENACE vs TENSILE INDEX
0.1 SEL
0.4 SEL
1 SEL
2 SEL

Intertek Paper Technology Services

Influence of Refiner Bar Surface Area (SSL) / Net Energy on Bleached Hardwood Eucalyptus Globulus

Fibre	Eucalyptus Grandis
Refining	No chemical modification – Ph 7 - 20°C
	4.0% Consistency
	5mm bars → 1.5mm bars
	80 → 667 j/m² SEL
	Constant bar angle 5 degrees
	Constant sector angle 30 degrees

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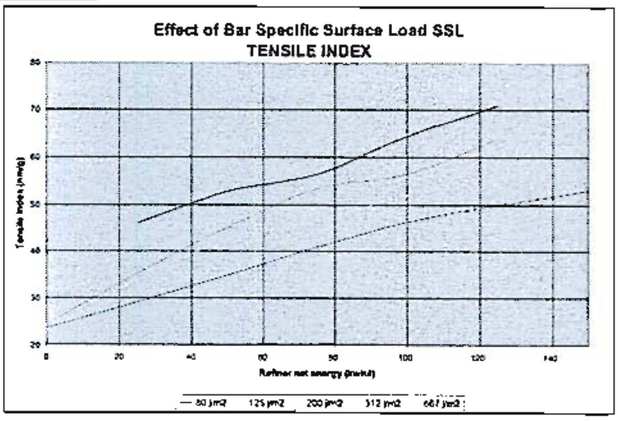

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Summary
Refiner SEL - SSL on Bleached Hardwood Eucalyptus Globulus

Specific Edge Load

- Low refining Intensity favours fibre development and refining efficiency
- Optimum 0.1j/m for Eucalyptus Globulus but coarseness dependant (Eg Birch, higher intensity required)
- SEL does not change property / property balance but influences efficiency (energy)
- Achieved by narrow barred / groove fillings limited by fibre dimensions

Specific Surface Load

- Low bar surface load promotes fibre development and refining efficiency
- SSL can influence property / property balance
- Achieved by optimising narrow bars / groove dimensions whilst utilising low refiner power

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Influence of Refining Intensity (SEL) / Net Energy on Bleached Softwood Pine / Spruce

Fibre	Sodra Black R
Refining	No chemical modification – Ph 7 - 20°C 4.0% Consistency 5mm bars → 2mm bars SEL3.0 → 0.5 j/m SEL Constant bar angle 5 degrees Constant sector angle 30 degrees

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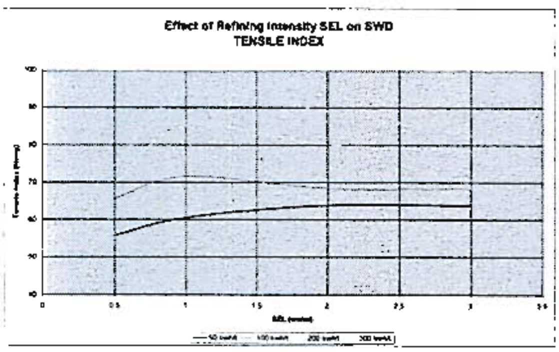

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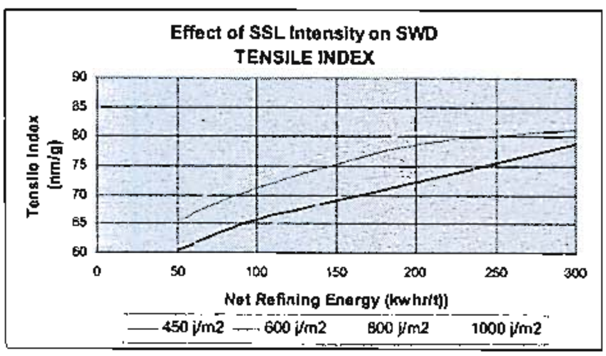

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Summary
Refiner SEL - SSL on Bleached Softwood Pine / Spruce

Specific Edge Load
- Higher refining intensity favours fibre development and refining efficiency
- A minimum intensity occurs when intensity is too low to overcome fibre strength
- Fibre length and coarseness drives refining requirements
- SEL does not change property / property balance but influences efficiency (energy)

Specific Surface Load
- Higher bar surface loads required to promote fibre development.
- A minimum / maximum surface loads exist, fibre dependant
- SSL can influence property / property balance

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Summary

- For each paper grade, careful selection of fibre is required, (Tree species / geographical origin / pulp grade – COST!).

- To maximise each fibres potential, an understanding of the Papermaking Potenti from evaluation / modelling is required.

- The refining process requires careful consideration (Bar design etc) ensuring maximum efficiency and fibre potential.

- The refining process "changes" fibre state - directly offering advantages for the Papermaker (Quality) – indirectly challenges in managing the Process (Chemistry)

Thank you for your attention!

Jari Käyhkö Dr. (Sci.).

Lappeenranta University of Technology
Research Director

Jari studied paper technology in Helsinki University of Technology and graduated in 1994. After that he started in the Lappeenranta University of Technology as a researcher and completed his thesis "The influence of process condition on the deresination efficiency in mechanical pulp washing" in 2002. In 2003 Jari moved to Savonlinna working as a professor (pro tem) and started to build a new Pulp and Paper oriented research unit called FiberLaboratory. Nowadays in the FiberLaboratory is working 20 people and Jari's main task is to lead research work related to the paper making. Studies in that field are mainly concentrated to the wet end of paper machine and the most important research area is the feeding of paper chemicals.

Contact Details:

Lappeenranta University of Technology
Department of Chemical Technology/ FiberLaboratory
Vipusenkatu 10
57200 Savonlinna
Finland

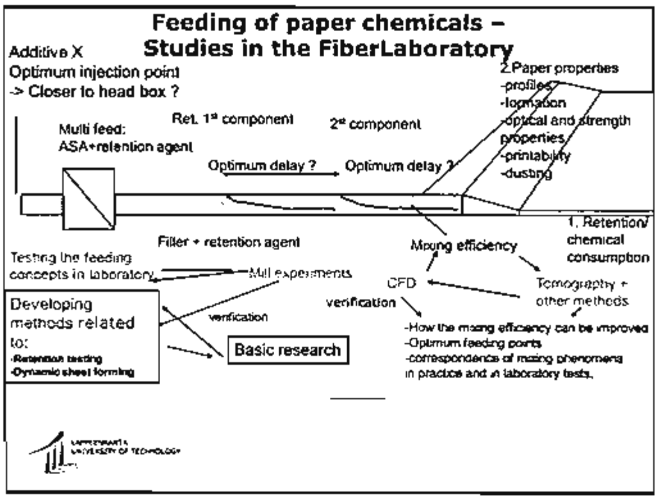
Tel: +358 400 77 11 57
E-mail: Jari.Kayhko@lut.fi

FIBERLABORATORY

Lappeenranta University of Technology, Savonlinna

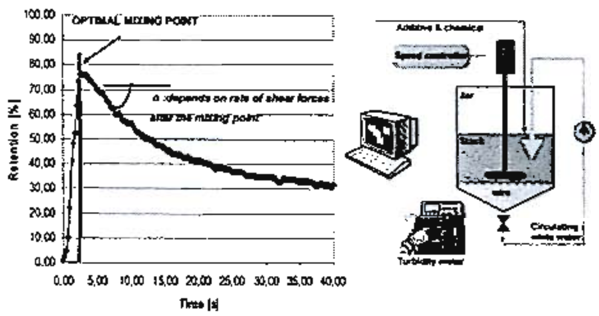
- FiberLaboratory is a local unit of Lappeenranta University of Technology (LUT)/Department of Chemical Technology
- Operation was started up in new building in the end of year 2005
- Main function is pulp and paper technology related research work, which is co-operated between machine suppliers, chemical suppliers and pulp and paper mills.

Lappeenranta University of Technology



WETEND technologies

Retention reaction between filler and CPAM measured with Retention Process Analyser



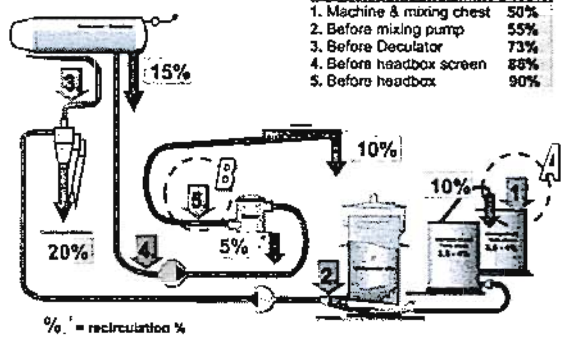
WETEND technologies

Flash mixing of papermaking additives

Conventional methods: Single pass % of additives to headbox vrs. dosage point

Addition point and single pass%:

1. Machine & mixing chest 50%
2. Before mixing pump 55%
3. Before Deculator 73%
4. Before headbox screen 88%
5. Before headbox 90%

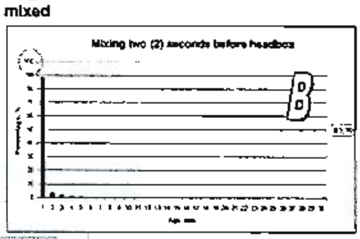


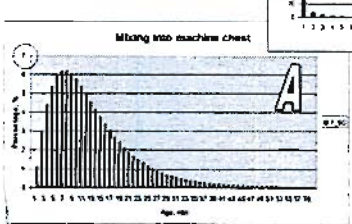
WETEND technologies

Flash mixing of papermaking additives

Age distribution of additive, when mixed
A: Into machine chest
B: Two (2) seconds from headbox

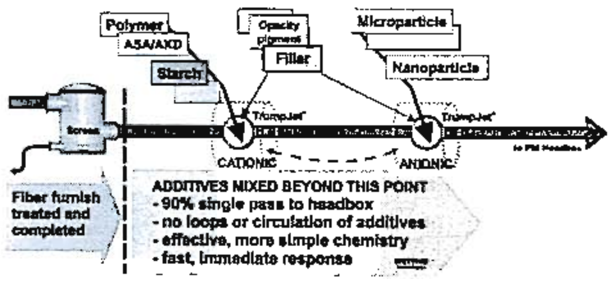
Retention of additive 90%





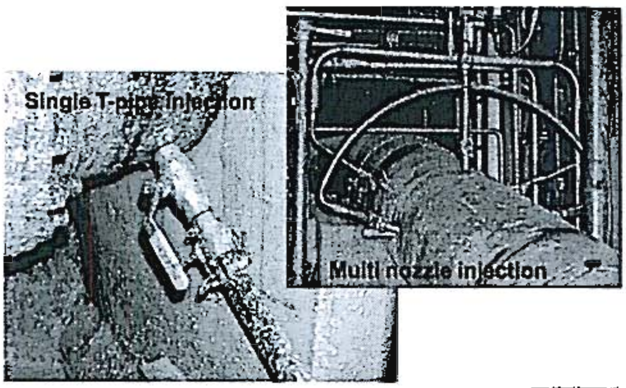
WETEND technologies

Flash Mixing of papermaking additives close to headbox with TrumpJet mixing stations –



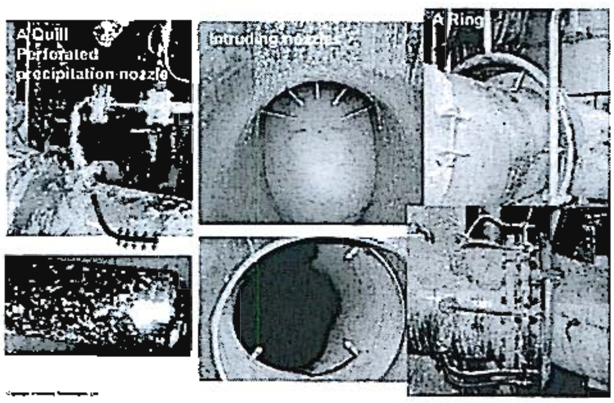
WETEND technologies

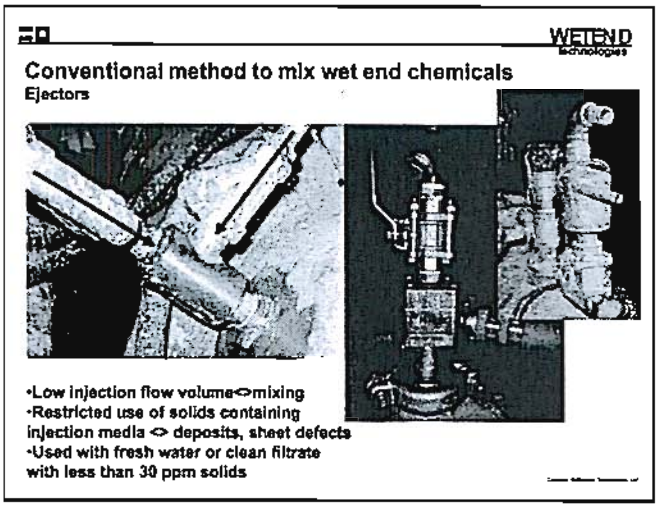
Conventional method to mix wet end chemicals

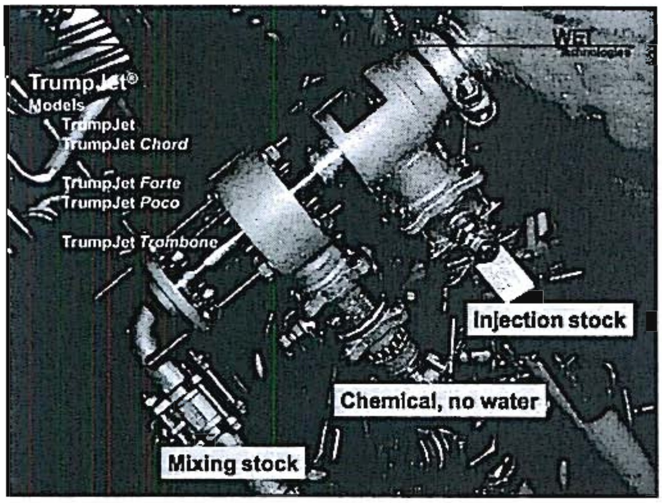


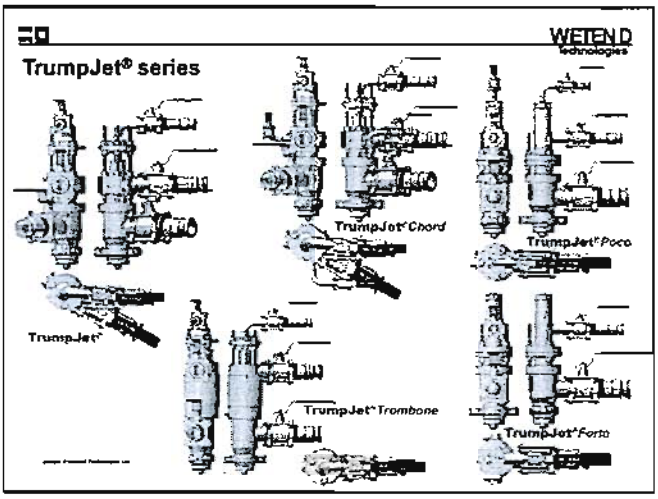
WETEND technologies

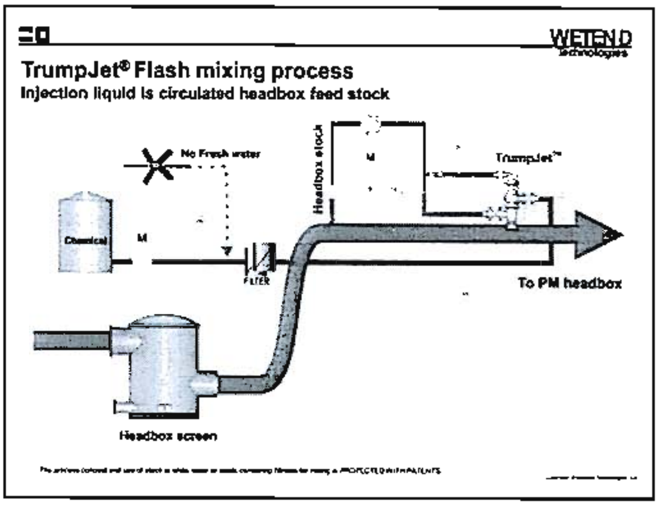
Conventional methods to mix wet end chemicals

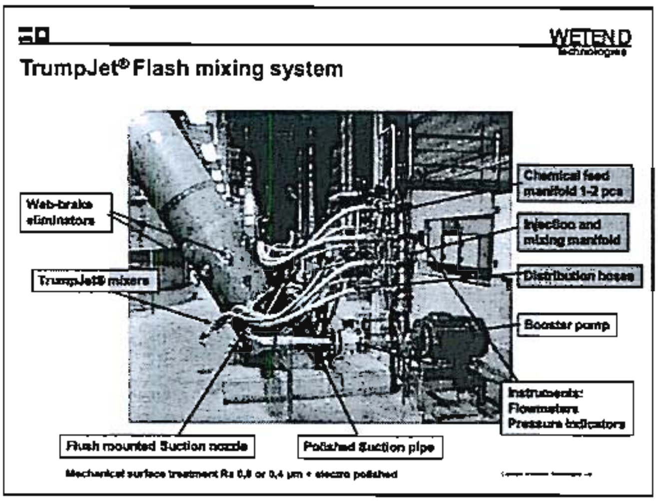


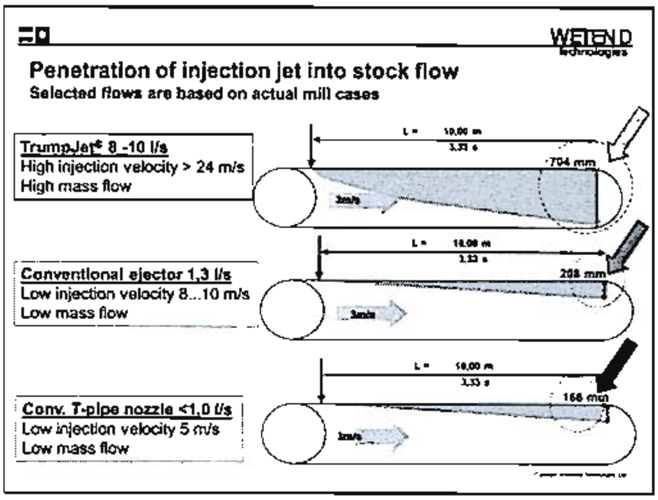

WETEND technologies
Conventional method to mix wet end chemicals
Ejectors
•Low injection flow volume<>mixing
•Restricted use of solids containing injection media <> deposits, sheet defects
•Used with fresh water or clean filtrate with less than 30 ppm solids

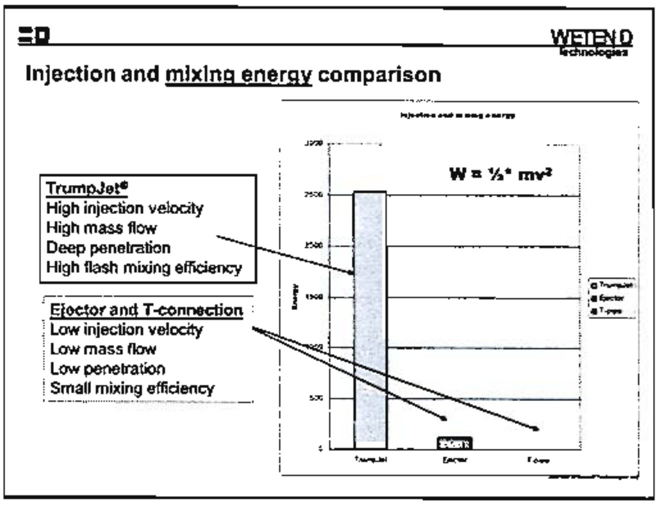

WET technologies
TrumpJet®
Models
TrumpJet
TrumpJet Chord
TrumpJet Forte
TrumpJet Poco
TrumpJet Trombone
Injection stock
Chemical, no water
Mixing stock

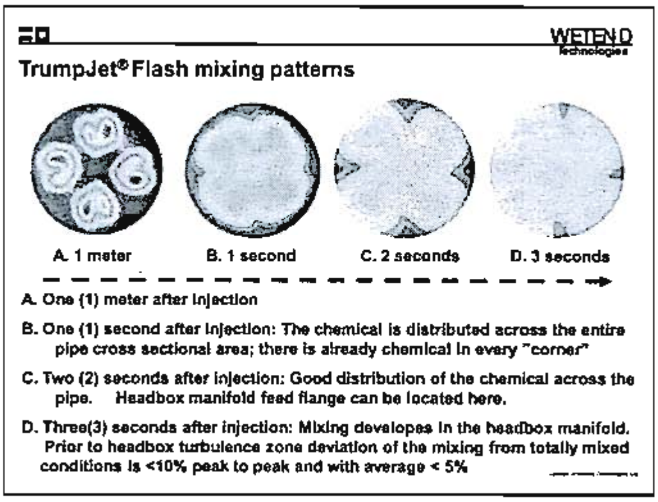

WETEND technologies
TrumpJet® series
TrumpJet®
TrumpJet® Chord
TrumpJet® Poco
TrumpJet® Trombone
TrumpJet® Forte

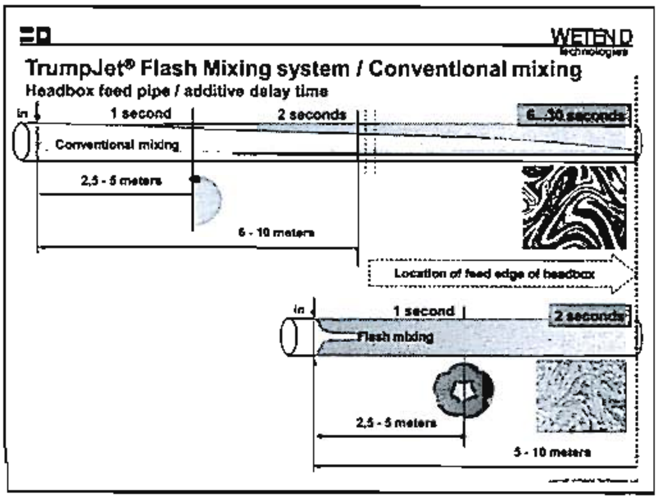

WETEND technologies
TrumpJet® Flash mixing process
Injection liquid is circulated headbox feed stock
No Fresh water
Headbox stock
TrumpJet™
Chemical
M
To PM headbox
Headbox screen

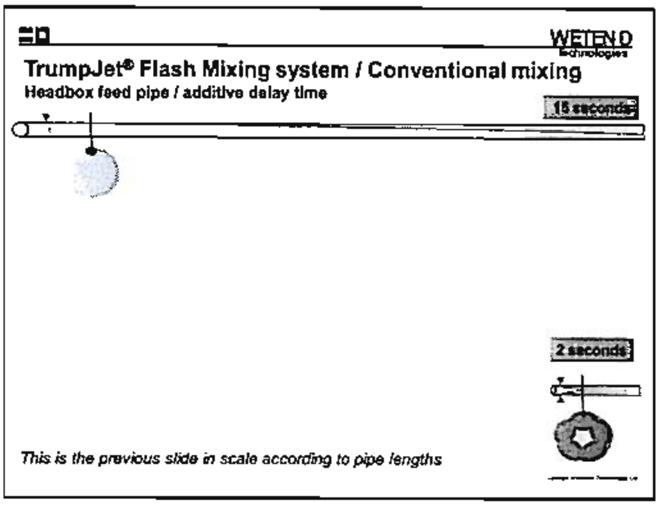

WETEND technologies
TrumpJet® Flash mixing system
Web-brake eliminators
TrumpJet® mixers
Chemical feed manifold 1-2 pcs
Injection and mixing manifold
Distribution hoses
Booster pump
Instruments:
Flowmeters
Pressure indicators
Flush mounted Suction nozzle
Polished Suction pipe
Mechanical surface treatment Ra 0,8 or 0,4 µm + electro polished

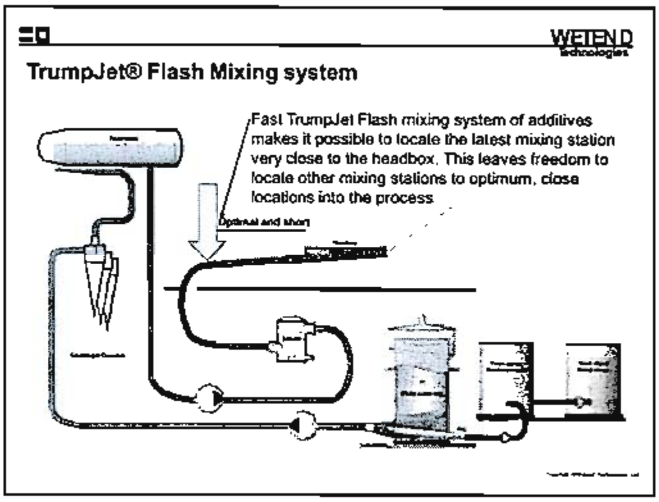

WETEND technologies
Penetration of injection jet into stock flow
Selected flows are based on actual mill cases
TrumpJet® 8 -10 l/s
High injection velocity > 24 m/s
High mass flow
704 mm
Conventional ejector 1,3 l/s
Low injection velocity 8...10 m/s
Low mass flow
208 mm
Conv. T-pipe nozzle <1,0 l/s
Low injection velocity 5 m/s
Low mass flow
166 mm

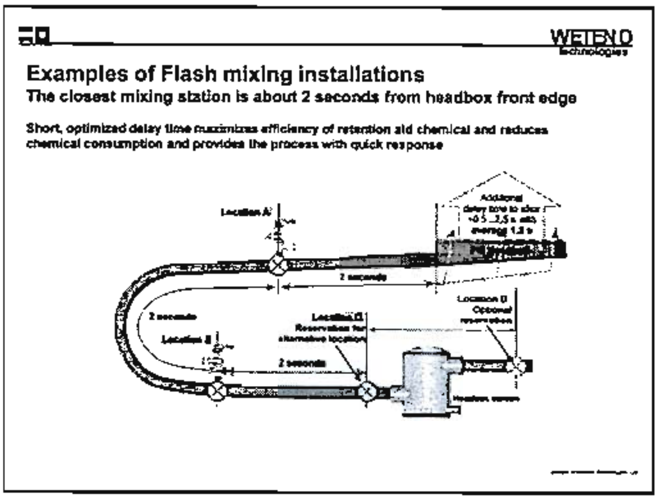

WETEND technologies
Injection and mixing energy comparison
W = ½* mv²
TrumpJet®
High injection velocity
High mass flow
Deep penetration
High flash mixing efficiency
Ejector and T-connection
Low injection velocity
Low mass flow
Low penetration
Small mixing efficiency


WETEND technologies
TrumpJet® Flash mixing patterns
A. 1 meter
B. 1 second
C. 2 seconds
D. 3 seconds
A. One (1) meter after injection
B. One (1) second after injection: The chemical is distributed across the entire pipe cross sectional area; there is already chemical in every "corner"
C. Two (2) seconds after injection: Good distribution of the chemical across the pipe. Headbox manifold feed flange can be located here.
D. Three(3) seconds after injection: Mixing developes in the headbox manifold. Prior to headbox turbulence zone deviation of the mixing from totally mixed conditions is <10% peak to peak and with average < 5%


WETEND technologies
TrumpJet® Flash Mixing system / Conventional mixing
Headbox feed pipe / additive delay time
in
1 second
2 seconds
6...30 seconds
Conventional mixing
2,5 - 5 meters
6 - 10 meters
Location of feed edge of headbox
in
1 second
2 seconds
Flash mixing
2,5 - 5 meters
5 - 10 meters

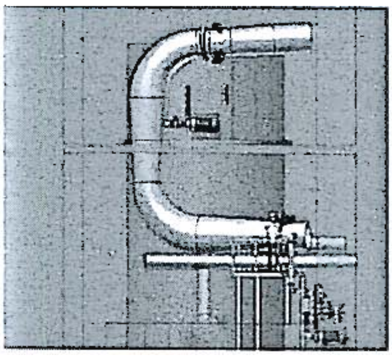

WETEND technologies
TrumpJet® Flash Mixing system / Conventional mixing
Headbox feed pipe / additive delay time
15 seconds
2 seconds
This is the previous slide in scale according to pipe lengths


WETEND technologies
TrumpJet® Flash Mixing system
Fast TrumpJet Flash mixing system of additives makes it possible to locate the latest mixing station very close to the headbox. This leaves freedom to locate other mixing stations to optimum, close locations into the process
Optimal and short


WETEND technologies
Examples of Flash mixing installations
The closest mixing station is about 2 seconds from headbox front edge
Short, optimized delay time maximizes efficiency of retention aid chemical and reduces chemical consumption and provides the process with quick response
2 seconds
2 seconds
2 seconds

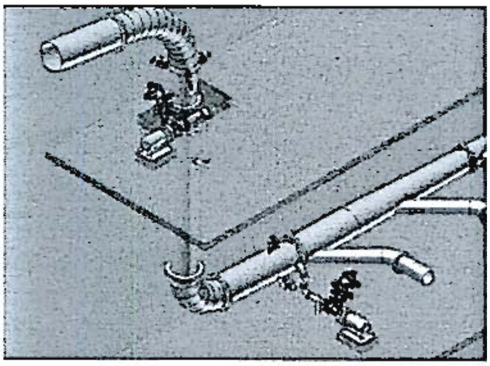
TrumpJet® installation examples

The closest mixing station is about 2 seconds from headbox front edge



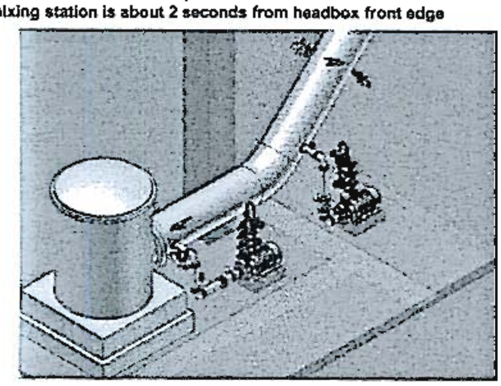
TrumpJet® installation examples

The closest mixing station is about 2 seconds from headbox front edge



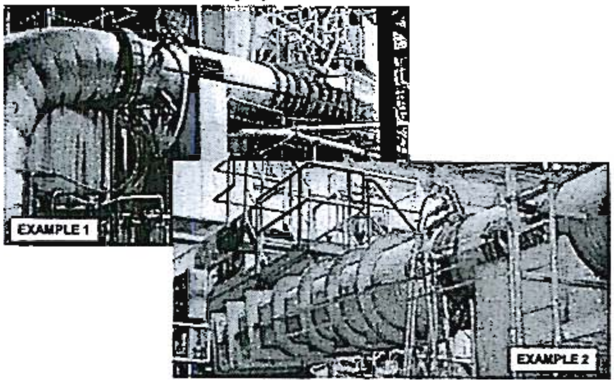
TrumpJet® installation examples

The closest mixing station is about 2 seconds from headbox front edge



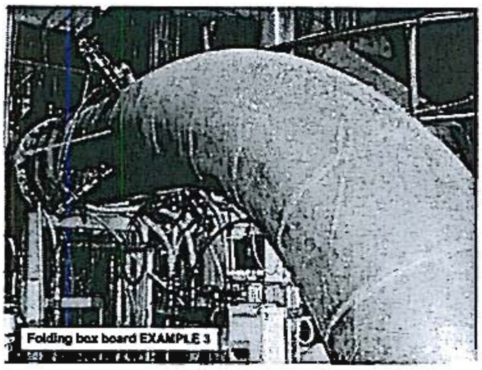
WETEND technologies

TrumpJet® Flash Mixing systems on a machine floor



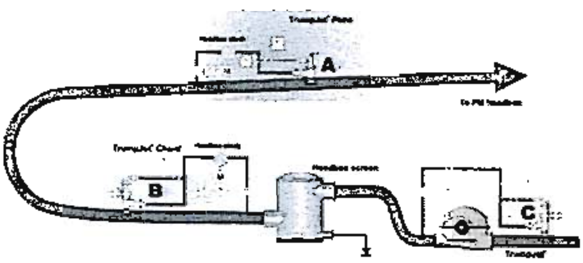
WETEND technologies

TrumpJet® Flash Mixing systems on a machine floor



WETEND technologies

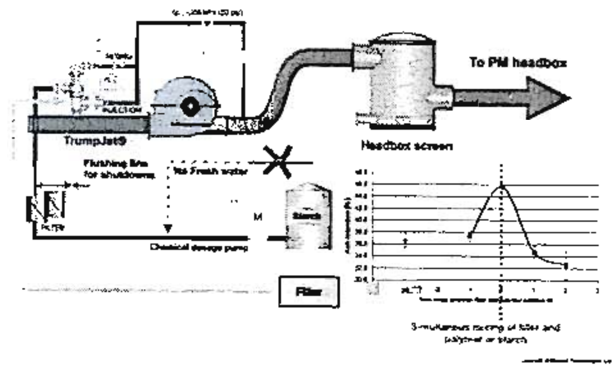
Flash Mixing of papermaking additives close to headbox with TrumpJet® mixing stations – A, B and C of mixing



WETEND technologies

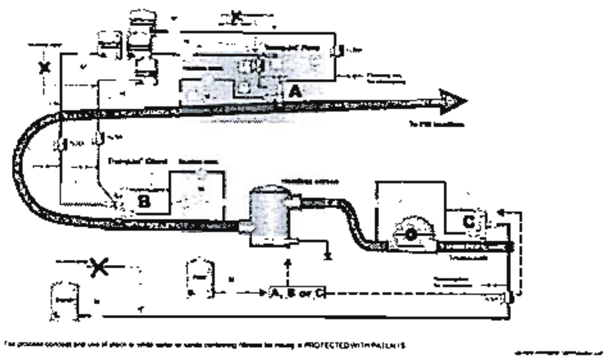
TrumpJet® Flash Mixing of starch and filler

Concept: the two additives are mixed simultaneously in same TrumpJet units



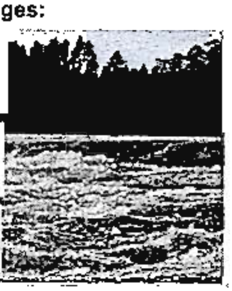
WETEND technologies

Flash Mixing of papermaking additives close to headbox with TrumpJet® mixing stations – A, B and C of mixing



WETEND technologies

Conventional method for mixing wet end chemicals Use of post- dilution water, disadvantages:



Increase in fresh water consumption:

0,5 – 3 m^3/ton

>10 to 15% from mill fresh water consumption

Increase in energy consumption:

The fresh water will be heated to process temperatute in one way or the other

Increase in CO_2 emission:

Increased energy consumption has potential to add CO_2 emission

Example: Dilution water need: 15 l/s, Temperature increase from 15 to 55 °C

Annual water consumption 0,5 million m^3

Energy consumption 25.000 MWh or 3 MW of absorbed power (@85%eff)

Annual CO_2 emission 7.000 tons

WETEND technologies

Energy/steam consumption with post dilution of additives

True mill simulation examples

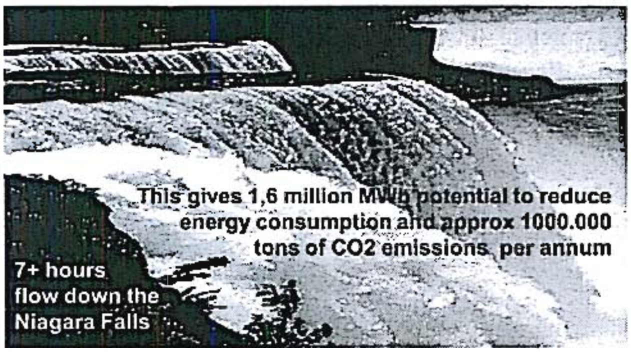
Mill case	Energy source and price		Fresh water consumption at the mill for post dilution with energy savings	
Four (4) LWC machines, total >1000 t/d with TMP, ground wood and purchased Kraft	Energy source Bark	Steam EUR/t 12	l/s 25,8 Savings: 430335 EUR	Steam t/h 4,15 WINTER 13,8 t/h; SUMMER 2,94 t/h
Three (3) large Linerboard machines with integrated Kraft mill, total 3000 t/d production	Energy source Natural gas	EUR/t 24	l/s 19,4 Savings: 450514 EUR	Steam t/h 2,17
Two (2) large Fine paper machines total 2000 t/d with integrated Kraft mill	Energy source Coal	EUR/t 5	l/s 19,2 Savings: 22526 EUR	Steam t/h 0,54

Study conducted 2008 for three American paper and board mills by:
American Processes Inc; Atlanta, USA and Wetend Technologies Ltd; Savonlinna, Finland

WETEND technologies

Annual Water and Energy Saving with TrumpJet® technology

35 million m³ of fresh water and (9 billion gal)
1,6 million MWh (5000 billion BTU) energy corresponding to 800.000 barrels of oil



WETEND technologies

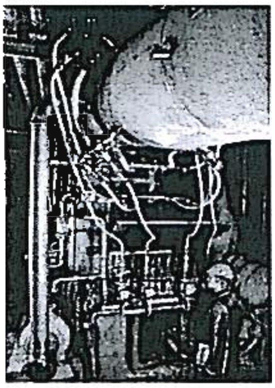
LWC machine in Finland 350.000 t/a; 1500 m/min

TrumpJet Flash mixing system for cationic polymer

Results

- Fresh water saving 800 m³/day
- Energy saving through elimination of fresh water
- Reduction of cationic polymer consumption 25..35%
- Improved or unchaged dewatering
- Good uniform quality of paper
- Good runnability

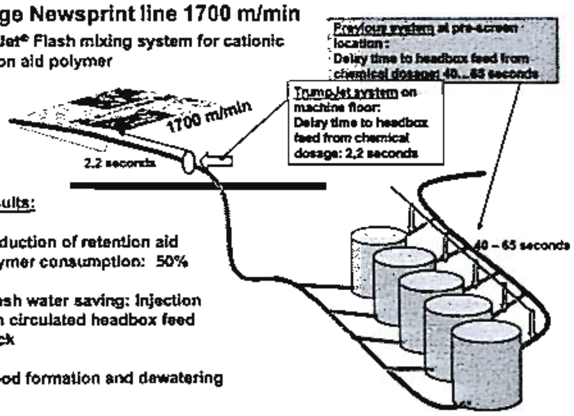
- Injection with circulated headbox feed stock
    - Use of fresh water / filtrate eliminated



WETEND technologies

A large Newsprint line 1700 m/min

TrumpJet® Flash mixing system for cationic retention aid polymer



Results:

- Reduction of retention aid polymer consumption: 50%
- Fresh water saving: Injection with circulated headbox feed stock
- Good formation and dewatering

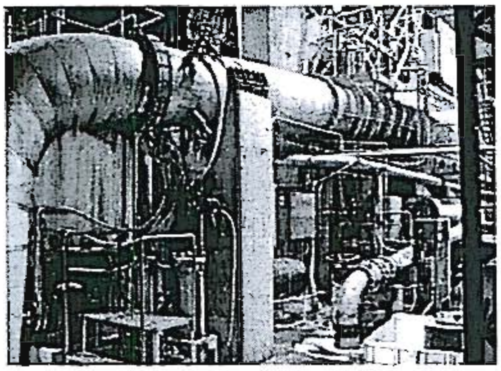
WETEND technologies

Mechanical Printing Paper, Finland

slide A

TrumpJet Flash mixing system for cationic polymer and micro polymer

TrumpJet Poco mixing station for micropolymer on the machine floor



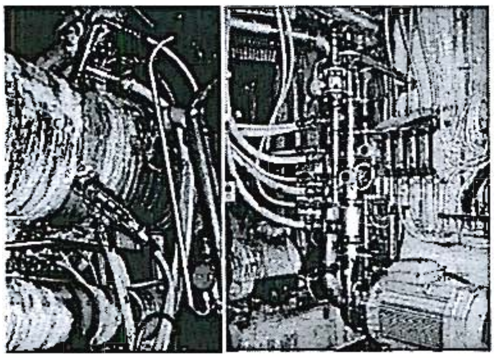
WETEND technologies

Mechancial Printing Paper, Finland

slide B

TrumpJet Flash mixing system for cationic polymer and micro polymer

TrumpJet mixing station for cationic polymer located in the basement

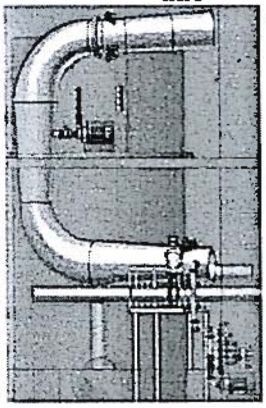


WETEND technologies

Mechanical Printing Paper, Finland

slide C

TrumpJet Flash mixing system for cationic polymer and micro polymer



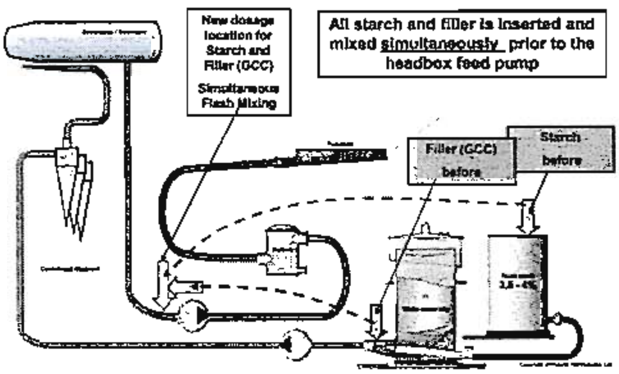
Results:

- Reduction of cationic polymer consumption 30%
- Reduction of micropolymer consumption 50%
- Increase of filler retention 10...15% units
- Increase of total retention 10% units
- Injection with circulated headbox feed stock
- Use of fresh water and use of filtrate eliminated

WETEND technologies

A Large Fine Paper machine, China

Starch and filler (GCC) mixing results with TrumpJet® Flash Mixing system

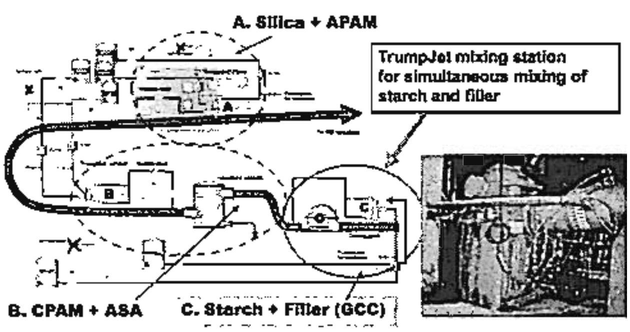


WETEND technologies

A Large Fine Paper machine, China

Starch and filler (GCC) mixing results with TrumpJet® Flash Mixing system

Three (3) TrumpJet mixing stations for 6 additives



WETEND technologies

A Large Fine Paper machine, China

Starch and filler (GCC) mixing results with TrumpJet® Flash Mixing system

RESULTS:

- Reduced starch consumption 20%
- Reduced CPAM consumption 30-40%
- Reduced APAM consumption 30%
- Total retention unchanged

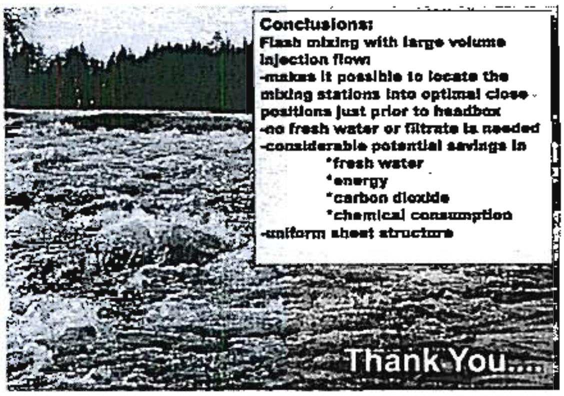
Use of fresh water eliminated with all three mixing stations:
- Annual water saving total: 1 million m^3
- Annual energy saving: 33.000 MWh
- Annual CO2 reduction: 20.000 tons

- ASA dosage unchanged
- Consumption of OBA slightly reduced
- Total net efficiency improved

- Formation unchanged
- Tensile MD/CD slightly better or the same
- Internal bond strength the same
- CD/MD profiles unchanged
- Dewatering unchanged

- Improved operation of centrifugal cleaners
- Less good filler in rejects of cleaners

WETEND technologies



Conclusions:
Flash mixing with large volume injection flow:
- makes it possible to locate the mixing stations into optimal close positions just prior to headbox
- no fresh water or filtrate is needed
- considerable potential savings in
  - fresh water
  - energy
  - carbon dioxide
  - chemical consumption
- uniform sheet structure

Paul Dekock

Clariant

Summary of Presentation:

A large quantity of waste paper and board is recycled, providing a relatively cheap source of cellulosic fibre raw material for papermaking. The quality of fibre in wastepaper is deteriorating due to increased recycling. Inevitably the dry strength of a paper sheet suffers as a consequence. There is now a desire to raise the standards associated with dry strength closer to the values achieved with virgin fibre. Lowering the basis weight of a paper sheet, whilst maintaining an acceptable level of strength, provides major cost benefits. The use of new synthetic polymers may be the answer for improving the overall strength of recycled fibre.

Biographical Notes:

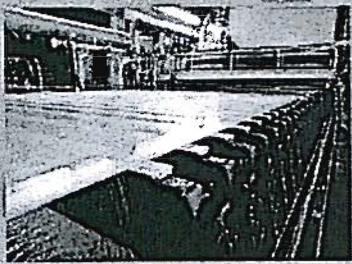
Worked at Clariant for 10 years; in that time I have worked in the following areas; Process Development, Functional Coatings and Process Chemicals. During this time I also completed my Degree (part time) in Chemistry.

Contact Details:

Clariant SE, UK Branch
Clariant House
Unit 2, Rawdon Park
Yeadon
Leeds
LS19 7BA
United Kingdom

Tel: +44 113 239 7936
E-mail: Paul.dekock@clariant.com

Strength enhancement of recycled fibre with a new range of chemical additives.



PITA Seminar 2010
Wet end Chemistry – Mini Conference

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Dry strength applications in the paper industry

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- Linerboard
- Corrugating medium
- Cylinder board
- Core / tube board
- Liquid packaging board
- Sack paper
- Moulded pulp
- Tissue / towelling

Dry strength evaluation....measurement of performance

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- Burst
  - Definition: Maximum uniformly distributed pressure, applied at right angles to its surface, that a single piece can withstand under test conditions
- Tensile
  - Definition: Maximum tensile force per unit width that a test piece will withstand before breaking. Commonly used for tissue and towelling grades
- Stiffness
  - Definition: The force required in Newton's to bend a rectangular test piece to a specified angle
- Compression Strength tester (SCT)
  - Definition: Maximum compression force per unit width of test piece until onset of failure in test. This test is independent of sheet weight
- Corrugating medium test (CMT, Concora)
  - Measures the resistance of the flute to flat crushing (Newtons)

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Benefits of using strength aids…

With the demand for recycled fibre increasing, this inevitably leads to loss in fibre quality and hence, overall strength is or can be significantly reduced.

The use of strength aids can improve the quality by;

- Increase the number of bonds in the contact areas between fibres
- No reduction in fibre length (compared with mechanical refining)
- Improve fibre retention and water removal, improving fibre-fibre contact in the press section
- Allow a reduction in sheet weight and fibre costs
- Allow the use of lower quality fibre, reducing costs
- Reduce dusting at the Yankee cylinder

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The dry strength of a paper sheet

The strength of the final sheet is dependant on one or more of the following factors:

- Individual fibre strength and length
  - Bonding within a fibre is significantly stronger than inter-fibre bonding
- Inter-fibre bond strength
  - Specific bond strength (SBS)
  - Relative bonded area (RBA)
- Sheet formation
  - Poor formation has a negative effect on strength
  - Over flocculation

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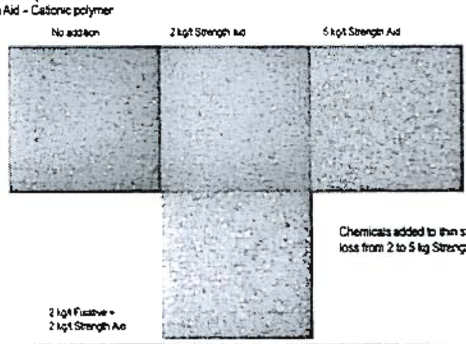
Loss of strength through over-flocculation

Fully bleached softwood tissue pulp from UK Tissue mill. Contains small quantity of cationic direct dye.
Strength Aid – Cationic polymer



Chemicals added to thin stock. Strength loss from 2 to 5 kg Strength Aid = 16%

Dry strength chemistries for wet-end application

- Cationic starch
  - Modified starch solutions used in tissue; addition does lead to a loss in hand feel (softness)
- Cationic polyacrylamides (non reactive)
- Glyoxylated cationic polyacrylamides (reactive)
  - Homo- and co-crosslinking reactions below pH 6.5
- Polyvinylamine + anionic polyacrylamide
  - Reactive, can lead to permanent wet-strength
- Polyamideamine – epichlorohydrin (reactive)
  - Permanent wet-strength may be a problem, typically used for towelling
- Polyamideamine (branched, non-reactive)
  - Cartabond Range

Polyamideamine - epichlorohydrin chemistry

- Sold mostly as wet-strength resins to tissue indusrty
- Polymer reacts in the sheet during drying
  - Permanently boned to the fibre (Covalent Bonding)
- Most efficient in alkaline pH range
- Products also give good dry-strength
- Improved stiffness at high humidity
- Broke treatment is difficult
  - Only hypochlorite is effective for polymer oxidation
- PAA-epi chemistry is relatively cheap to produce

Cationic dry strength resin...Cartabond Range

- 3-dimensional polyamide polymer
  - Branched structure (cross-linked)
- Pale yellow viscous liquid
  - Active content = 20 – 30%
  - Viscosity = 400 - 900 mPas
  - pH = 6.5
- Effective papermaking pH range = 5.0 – 8.0
- Shelf life = 12 months

Charge density of Cartabond 0529E (meq/g, as supplied)		
pH 4	pH 7	pH 9
0.76 – 1.05	0.43 – 0.61	0.00

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Dry strength chemistry...comparison

Product Type	Addition rate (kg/t) (as received)	Dry strength	Wet strength
Cationic starch	5 – 15 (Dry)	Moderate - High	Waterleaf
Polyvinylamine / anionic polyacrylamide	5 – 15 Of each component	Moderate - High	Temporary - Permanent
Glyoxylated polyacrylamide	5 – 20 Low solids	Low - Moderate	Temporary - Permanent
Polyamideamine - epichlorohydrin	10 – 30	High	Permanent
Cartabond	5 – 10	Moderate - high	Waterleaf - Temporary

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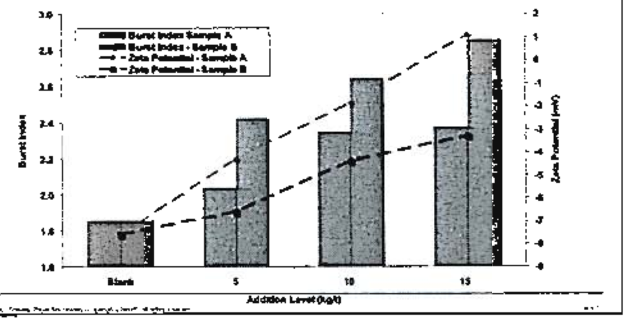
Impact on strength and Zeta Potential

Thickstock from liner mill, diluted with backwater to give a working consistency of 2%. Products added to the thick stock (Zeta potential measured). Sheets formed using British Standard Former

Sample A – Highly cationic
Sample B – Moderately cationic

- Results show that the addition of Sample A affects the fibre charge more than Sample B.
- Sample B imparts a greater degree of strength – less flocculation and reduction.



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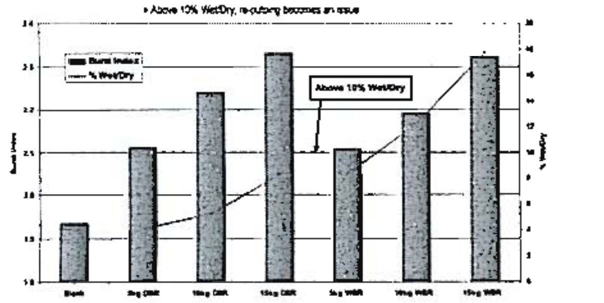
Dry strength Vs. Wet Strength

Laboratory waste furnish at 2% consistency.

DSR – Cartabond @ 30%
WSR – 2G Wet strength @ 20%

- Similar strength Dry strength results with regards to Burst
- DSR does not have a great impact on wet strength
- Above 10% Wet/Dry, re-pulping becomes an issue



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Unique approach to improving dry strength

- The enhancement of wet end strength aids by the use of a novel chemical addition
- Cartafen Liquid
  - Slightly anionic phenolic resin
  - High substantivity to hydrophobic surfaces
  - Perfectly suited to lignin-containing pulps
  - Most effective in highly anionic machine circuits
  - Cationics can interfere with resin adsorption
- Can be used to improve the performance of cationic chemical additives
  - Wet end Starch
  - Wet strength resins
  - Retention aids

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Cartafen… "fibre activation"

- Phenolic polymer
  - 3- dimensional cross-linked structure
- Brown, slightly viscous liquid
  - Active content = 32%
  - Viscosity = 200 - 300 mPas
  - pH = 8.5 – 9.0
- Effective papermaking pH range = 5.0 – 8.0
- Added first to increase cationic "demand" of fibre
- Shelf life = 12 months

Charge density of Cartafen (meq/g, as supplied)		
pH 4	pH 7	pH 9
-0.397	-0.616	-0.733

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Cartafen…How it works.

- Targeted specifically for all forms of recycled fibre
  - Replenish anionic charge at fibre surface
  - Increase demand for cationic additives
  - Performance is enhanced in closed systems; high conductivity
- Cartafen has a strong affinity for recycled fibre
  - Especially from high yield and unbleached pulps
  - Adsorption through hydrogen bonding and Van der Waals forces
    - Non cellulosic materials such as lignins on fibre surfaces
  - This adsorption of a negatively charged product increases the amount of anionic sites on fibre surface

= Better performance from cationic additives

= Increased strength and less waste

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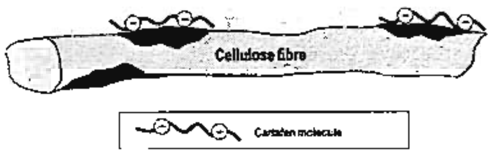
Adsorption Of Cartafen on Brown Fibre

- Brown fibre, especially after recycling, has a much lower surface charge, due to a high level of lignin derivatives. Cartafen has affinity for the hydrophobic lignin in brown fibre and, being anionic, the adsorbed chemical increases the negative charge on the fibre's surface. This adsorption increases the fibre's demand for cationic additives.



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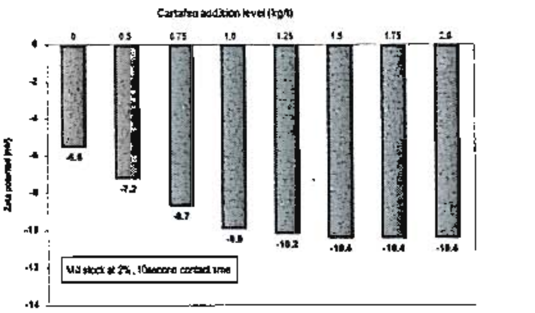
Effect of Cartafen on Zeta Potential



- At 1kg/t, fibre charge has been lowered from -5.5mV to -9.9mV

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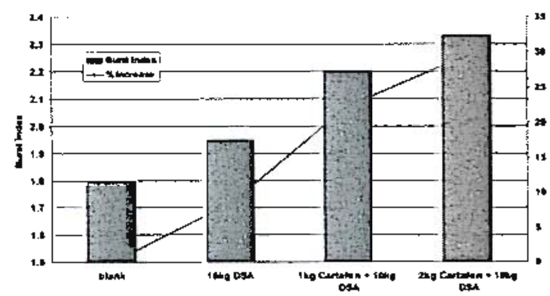
Effect on Cartafen on Dry strength performance

Laboratory based furnish of 100% OCC @ 2% consistency

Chemicals added on an as received basis



- Pre addition of 1kg/t Cartafen improved the burst index from 1.96 to 2.2
- This is an additional improvement in strength of 13% over the 10kg/t DSA

Fibre Activation With Cartafen – Which Mills Can Benefit?

Clariant

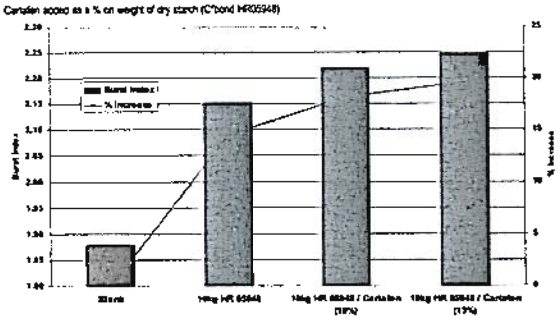
- Brown packaging mills using OCC as the main fibre source
  - Fresh water usage is usually low therefore conductivities high
  - Cartafen improves the performance of cationic retention and strength additives (incl starch)
- Core board and tube paper mills
- Newsprint mills, using 100% DIP as the fibre source
  - Improves retention (water removal) and stickies control
- Tissue mills using wastepaper
  - Cartafen helps to control stickies
  - Improves the retention of wet strength resins
  - Provides cost saving by reducing dosage levels of other chemicals

Addition of Cartafen to cooked Starch

Clariant

Work carried out using Waste stock from a liner mill

Cartafen added as a % on weight of dry starch (C*bond HR05948)



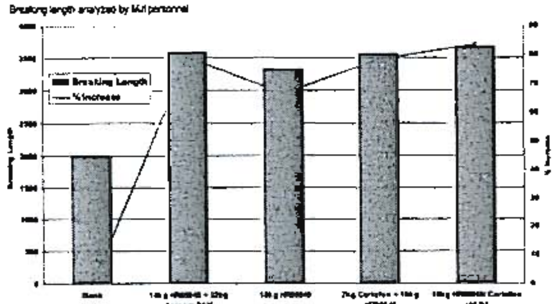
- Cartafen added to cooked starch, will boost its dry strength potential

Replacement of anionic PAM

Clariant

Work carried out using Mills stock on their pilot machine (Width 30cm)

Breaking length analysed by Mill personnel



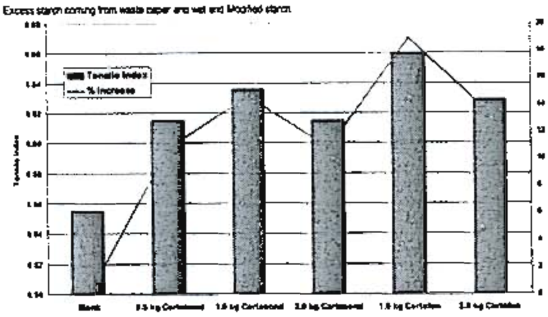
- 2kg Cartafen can replace 32kg of the anionic PAM
- Similar results were seen when Cartafen was added to the cooked starch

Clariant

Fixation of starch in waste paper

Work carried out using Tissue machine stock from 100% bleached recycled fibre

Excess starch coming from waste paper and wet end Modified starch



- The addition of 1kg Cartafen improved the strength by over 18%
- The Cartabond (DSR) also gave encouraging improvements in strength

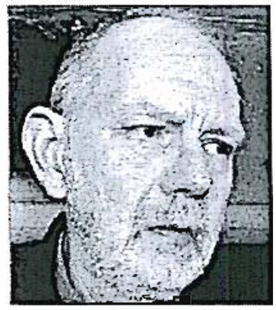
Clariant

PITA Seminar 2010

Thank you.

Martin Georgeson

Roqquette UK Ltd



Summary of Presentation:

A short review of the application of starches at the wet-end, the benefits which can be achieved and the limitations encountered. The development of bio-polymers and examples of their application in tissue, ASA emulsification and strength development. Outline of future developments.

Biographical Notes:

Martin Georgeson qualified in Paper Science at UMIST and, following a period spent doing research, joined the Paper Industry 'a long time ago'. Working for among others Reed and Smith, Bowaters and Inveresk. After Inveresk closed their Woodhall Mill in 1984, Martin joined Roquette where he has managed to be gainfully employed since.

Contact Details:

Roquette Uk Ltd.
22 Sallow Road
Weldon Industrial Estate
Corby
Northamptonshire
NN17 5JX

Tel: (+44) 07831 177217
E-mail: martin.georgeson@roquette.com

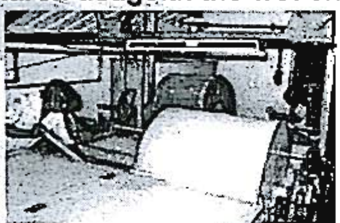
ROQUETTE

Biopolymers At The Wet-End, A New Approach

Martin Georgeson RUK
&
Regis Houzé RF

Introduction

A short outline of the development of starch usage at the wet end.



- Cooked and uncooked native starches (beater starches) as well as other natural polymers have been added to stock since the earliest days of papermaking

Cationic Starches

Floc Formed with Cationic Starch

- Cationic starches have positively charged groups grafted on to the molecular chains and are attracted to the negative charges on fibre and filler.

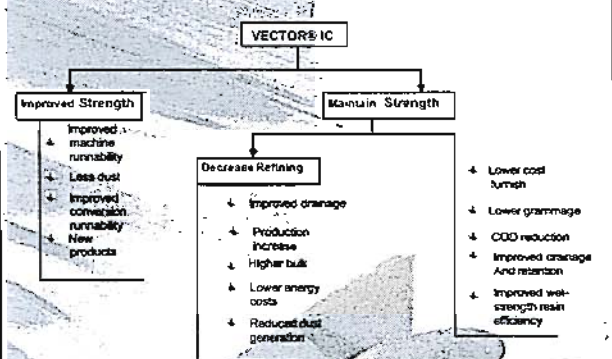
Liquid Biopolymers (VECTOR® Range)

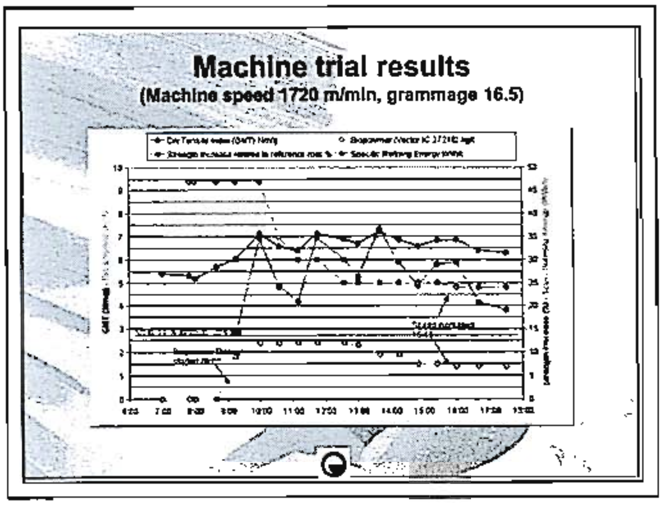
- Derived from starch combined with various additives
- 'Made to measure': solids, charge and charge density tailored to suit specific applications
- FDA & BfR compliant.

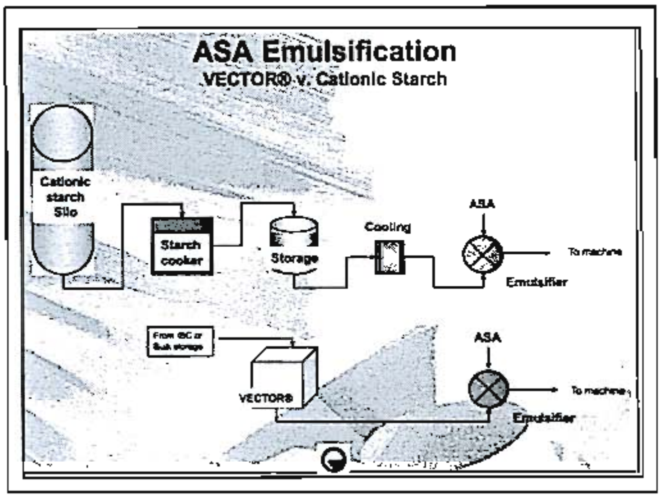
Biopolymers for Tissue

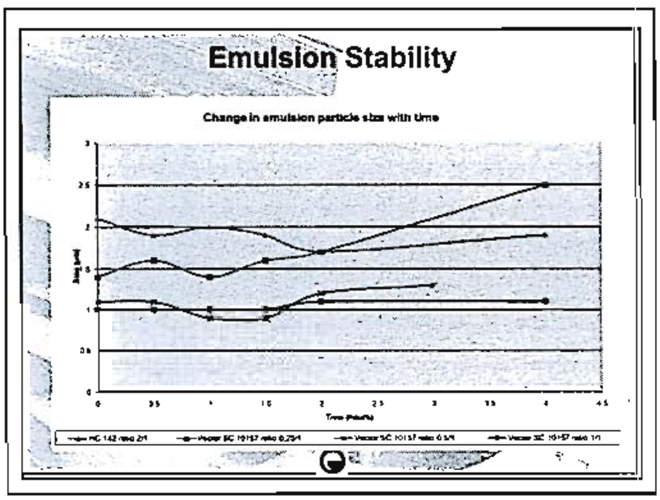
- Dry Strength Agents (DSA) are used in tissue manufacture for a number of reasons. The most widely used and most effective are based on natural polymers.

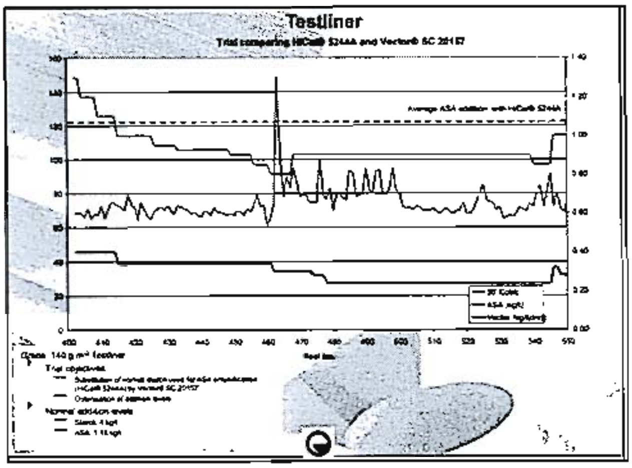
Benefits




Machine trial results
(Machine speed 1720 m/min, grammage 16.5)


ASA Emulsification
VECTOR® v. Cationic Starch
Cationic starch Silo
Starch cooker
Storage
Cooling
ASA
To machine
Emulsifier
ASA
VECTOR®
To machine
Emulsifier


Emulsion Stability
Change in emulsion particle size with time



Strength Improvement with Biopolymer

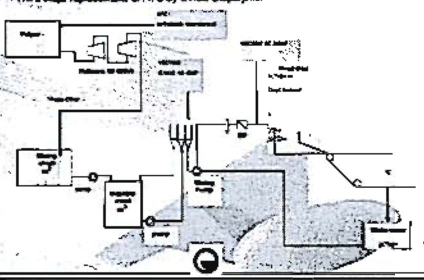
Mechanical Pulp
- High levels of anionic trash.
- Dust & debris
- Bond strength

Waste Paper
- Closed circuits
- High conductivity
- Contaminants
- Ionic balance

High functionality biopolymers have been developed to provide a solution to at least some of these problems.

Strength Improvement with Biopolymer

- 100% virgin fibers – 650 µS – Filter paper
  - First step: replacement of anionic PAM by anionic Biopolymer
  - Second step, addition of of cationic Biopolymer
  - Third step, replacement of ATC by a new Biopolymer



Strength Improvement with Biopolymer

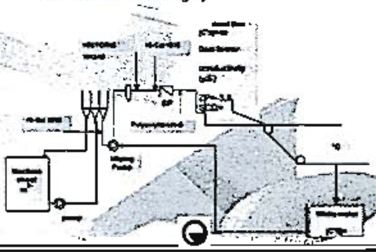
- Grade: White-lined chipboard, 750μ
- Machine: vat-formers x 9
- Sizing/retention system: rosin with microparticles, no cationic starch
- Trial addition: 1 kg/t of VECTOR® SC 2015 (highly cationic)

Results

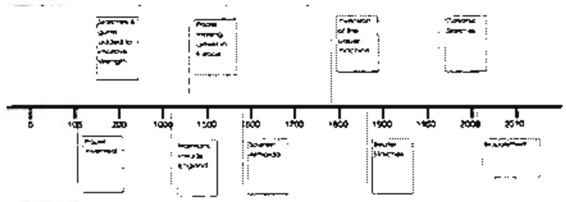
- Significant improvement in retention
- Improved formation
- Increased drainage
- Grammage reduced by 40 g/m²

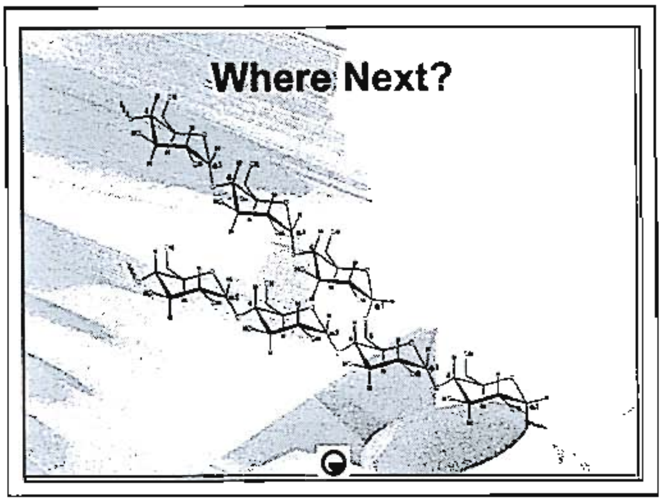
Strength Improvement with Biopolymer

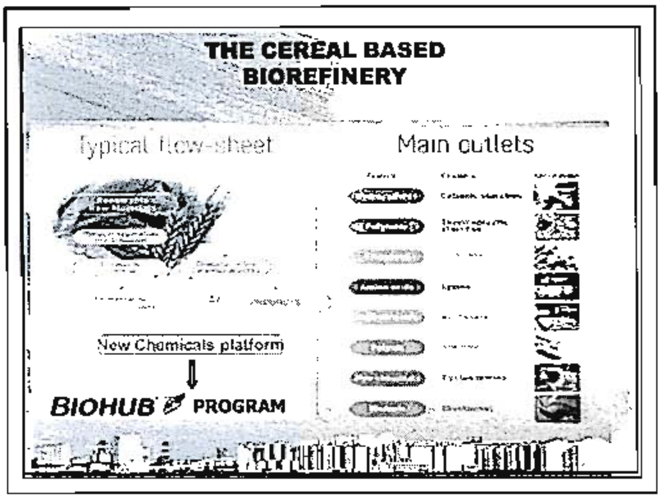
- 100% virgin fibres – Offset paper
  - HI-CAT® A: 6 kg/t
    - Receiving complaints on dusting...
  - Introduction of 1.2 kg/t of VECTOR® C1412AS-EXP:
    - Increase of the cationic starch up to 10 kg.
      - BURST + 8% - SCOTT BOND + 15%
      - Retention aid: -50%.
      - Reduction of dusting by 50%.



Important Events in Papermaking




Where Next?


THE CEREAL BASED
BIOREFINERY
Typical flow-sheet
Main outlets
New Chemicals platform
BIOHUB PROGRAM

Dr Philip Cooper

(Technical Manager)
Blackburn Chemicals Ltd

Summary of Presentation:

The presentation "Foam Control in Paper Systems" gives an overview of the role of foam and dearators in the paper industry. Starting with definitions of what comprises a stable foam, following on with a pictorial representation of the major structural elements found in a typical foam. A brief description of the changes which occur within foam as a function of time is given, highlighting the fact that in many cases a chemical additive (a deaerator) is required to control air within the paper system.

Biographical Notes:

1998 – present	Blackburn Chemicals Ltd	organic/silicone defoamers
1994 - 1998	Rhodia	silicone foam control agents
1989 – 1994	Bevaloid/Rhone Poulenc	organic foam control agents

Contact Details:

Blackburn Chemicals Ltd
Whitebirk Industrial Estate
Blackburn
BB1 5SX

Tel +44(0) 1254 52222
Fax +44(0) 1254 664224
E-mail: lab@bbchem.co.uk

BLACKBURN CHEMICALS LIMITED

BLACKBURN CHEMICALS LIMITED

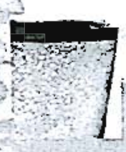
An Introduction to Foam Control in Paper Systems.

Overview.

- What is foam?
- Identify the nature of the foaming problem.
- Present the Dispelair paper products.
- Describe the mode of action of the paper products.
- Future developments.

Foam.

- *What is foam?*
  Foam is a dispersion of gas in a liquid.

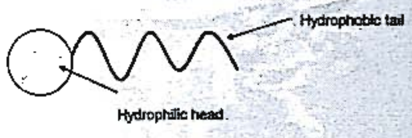


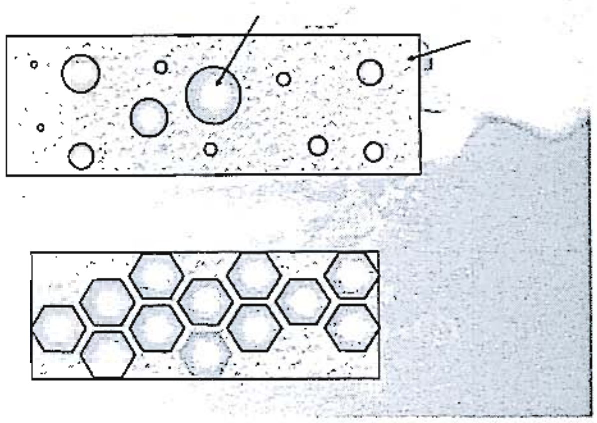
- *How is foam generated?*

  - by mechanical means, stirring, cascading, bubbling.
  - by the introduction of gas from chemical and biological processes.
  - by decreasing the pressure above a liquid supersaturated with a gas.

How is foam stabilised?

- Require a surface active agent to stabilize foam (i.e. a surfactant) as pure liquids do not foam.





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