

IIoT and Remote O&M in the Pulp & Paper Industry

Webinar August 23, 2017



McIlvaine Company
Northfield, IL

Pulp & Paper Empowering IIoT with IIoW

The pulp and paper industry is implementing IIoT and Remote O&M. As it does so it also needs to organize the wisdom of all the component suppliers so that IIoT will be empowered by IIoW. With IIoT it is possible to maximize the efficiency of an existing pump and drive. However, interaction with the valve and pump suppliers is needed so that they can make their products even better for each specific unique application.

The suppliers of management systems need to better understand the capabilities of the component suppliers. The component suppliers need first to identify the specific opportunities and work toward providing each customer with the best products to fit his needs.

With cloud based management systems utilizing data analytics there will be the equivalent of continuous white papers on each component. This knowledge will encourage purchasers to buy the best products rather than the ones with the lowest cost.

Mcilvaine is providing a program built around specific forecasting of each component along with the broader analysis of the IIoT and Remote O&M opportunity .

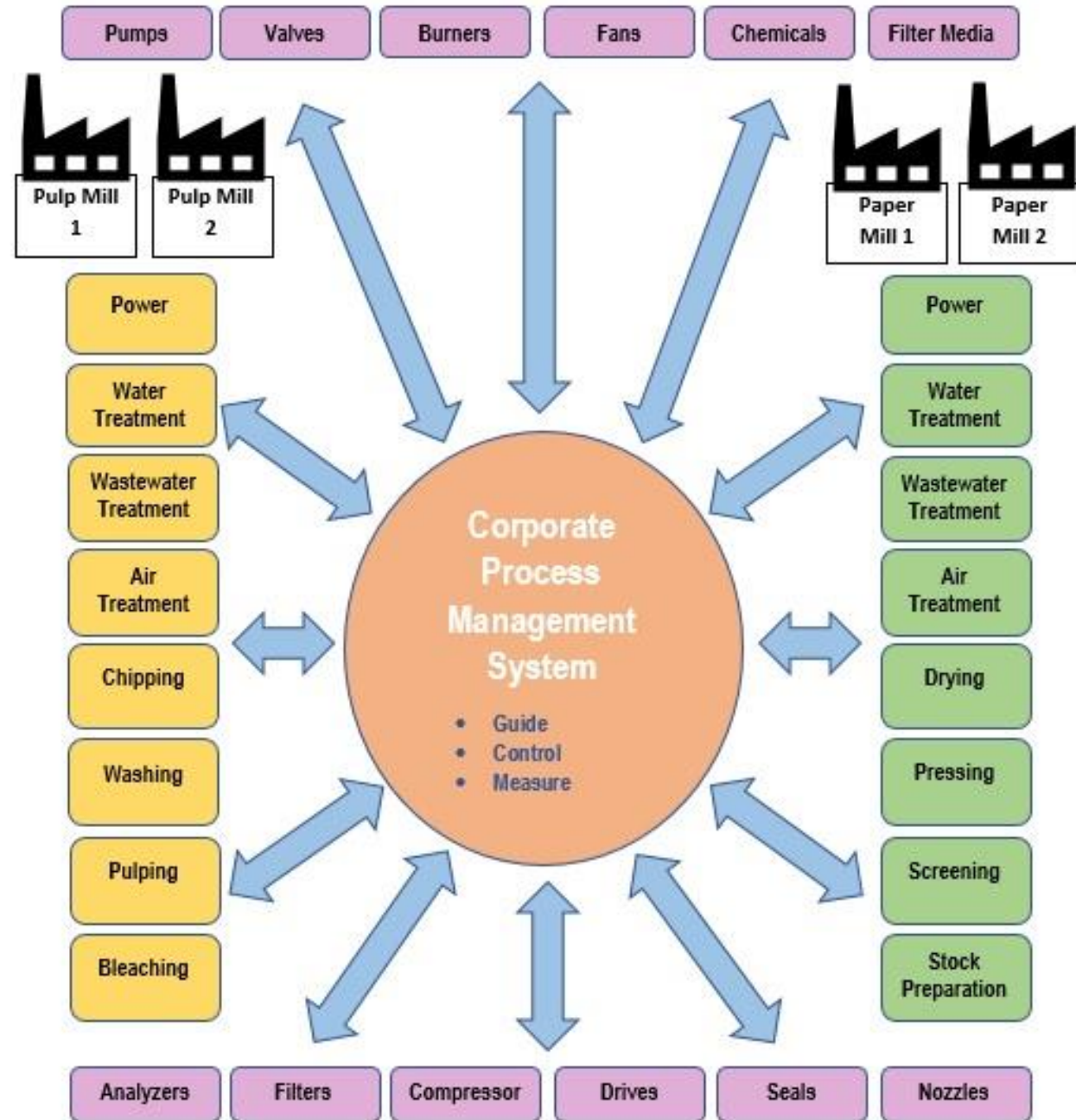


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Pulp and Paper IIoT Combust, Flow and Treat Markets

Forecast of Sales to the Pulp and Paper Industry

The 8 automation companies have a direct IIoT market in pulp and paper of \$90 million. They also sell another \$1 billion of combust, treat, and flow products and services to this industry. By making these products smarter they can boost revenue by \$106 million.

With better collaboration between divisions, the 8 companies can use their direct IIoT products to increase market share for all their products. With a 10% increase in market share along with the higher product revenue they could boost revenue by \$212 million.

Product suppliers who are not starting to leverage IIoT will lose market share and the potential to increase revenues per unit of product with better and smarter offerings.

Only two of the 8 companies (Emerson and GE) are major valve suppliers. the other 6 can be pursued for purposes of collaboration.

GE could be a formidable competitor in air pollution control with the Alstom acquisition. Siemens sold Wheelabrator. So the other 7 are collaboration prospects.

Sales of IIoT and Process Equipment to the Pulp and Paper Industry 2018 \$ millions

Product	Total Product Revenues		IIoT Impact	
	All suppliers	8 companies	All suppliers	8 companies
Guide	330	25	330	25
Control	550	45	550	45
Measure	220	20	220	20
Total Direct IIoT	1100	90	1100	90
Valves	1500	65	150	7
Air pollution Control systems	300	10	40	2
Pumps	1200	30	150	3
Water Treatment	2000	50	200	5
Wastewater Treatment	1000	30	100	3
Variable Speed Drives and Motors	1800	120	200	12
Turbines, Fans, and Compressors	3500	600	350	60
Other Process Equipment, Chemicals, and Services	10,000	140	1000	14
Indirect IIoT	21,300	1045	2190	106
Ratio of Indirect to Direct	19	12	2	1.2

Forecast of Purchases for 550 Major Producers

Forecasts of sales for specific products to each of 50 pulp and paper producers as well as 500 manufacturers in 11 other industries will provide a basis for collaboration among divisions within multi product companies as well as for setting up sales programs for each.

The IIoT & Remote O&M report has the forecasts for guide, control and 5 measurement segments for each of 550 companies x 3 continents = 11,550 forecasts.

The Valve report has forecasts for 550 companies x 8 control valve types plus 8 on/off valve types x 3 continents = 26,400 forecasts.

The scrubber, fabric filter, precipitator, thermal/catalytic, liquid filtration, cartridge, RO/UF/MF, ultrapure water, cleanroom, sedimentation, and centrifugation market reports also have detailed forecasts for the 550 companies.

Custom forecasts are available for the other products

Sales of IIoT and Process Equipment to Specific Pulp and Paper Producers 2018 \$ - millions

	All Producers	International Paper	Nine Dragon	Stora Enso
Guide	330	16	8	6
Control	550	33	16	12
Measure	220	11	5	2
Total Direct IIoT	1100	60	29	20
Valves	1500	90	45	30
Air Pollution Control Systems	300	18	9	6
Pumps	1200	72	36	24
Water Treatment	2000	120	60	40
Wastewater Treatment	1000	60	30	20
Variable Speed Drives and Motors	1800	108	54	36
Turbines, Fans, and Compressors	3500	210	105	70
Other Process Equipment, Chemicals, and services	10,000	600	300	200
Indirect IIoT	22800	1278	639	426
Ratio of Indirect to Direct	21	21	21	21

Pulp and Paper Manufacturers 2018 guide, control and measure purchases \$ millions					
	Interntl. Paper	Nine Dragon	Westrock	UPM	Stora Enso
Total	60	29	28	23	20
• guide	18	Forecasts for 550 purchasers			6
○ Americas	16				1.8
○ EMEA	2				3
○ Asia	0				1.2
• Control	30				10
○ Americas	27				1
○ EMEA	3				7
○ ASIA	0.				2
• Measure	12				4
○ Americas	10.8				1.2
○ EMEA	1.2				2
○ Asia	0				0.8
•					
○					
○					

Industry	No. Included
Total	555
Chemical	40
Electronics	15
Food	40
Metals	30
Mining	20
Oil and Gas	50
Pharmaceutical	30
Power	70
Pulp & Paper	50
Refinery	60
Stone	50
Wastewater	50
Water	50

Measure Markets

In 2018 the pulp and paper industry will spend \$220 million on analysers to measure gases, liquids and powders, (including chips and fibers). These are instruments in continuous service or for periodic use to analyse processes.

Pulp and Paper Manufacturers 2018 Analyzer Purchases

\$ millions

	International Paper	Nine Dragon	Westrock	UPM	Stora Enso
Total	10.4	5.5	5	4.5	4
Liquids	5,4	Forecasts for 550 Purchasers			2.2
o Americas	5				0.4
o EMEA	0.4	Industry	No. Included	1.6	
o Asia	0	Total	555	0,2	
Air and Gases	3	Chemical	40	1.2	
o Americas	2.6	Electronics	15	0.2	
o EMEA	0.4	Food	40	0.8	
o ASIA	0.	Metals	30	0.2	
Powders, Chips	2	Mining	20	0.8	
o Americas	1,7	Oil and Gas	50	0.2	
o EMEA	0.3	Pharmaceutical	30	0.5	
o Asia	0	Power	70	0.1	
		Pulp & Paper	50		
		Refinery	60		
		Stone	50		
		Wastewater	50		
		Water	50		

Pulp and Paper Industry Forecast

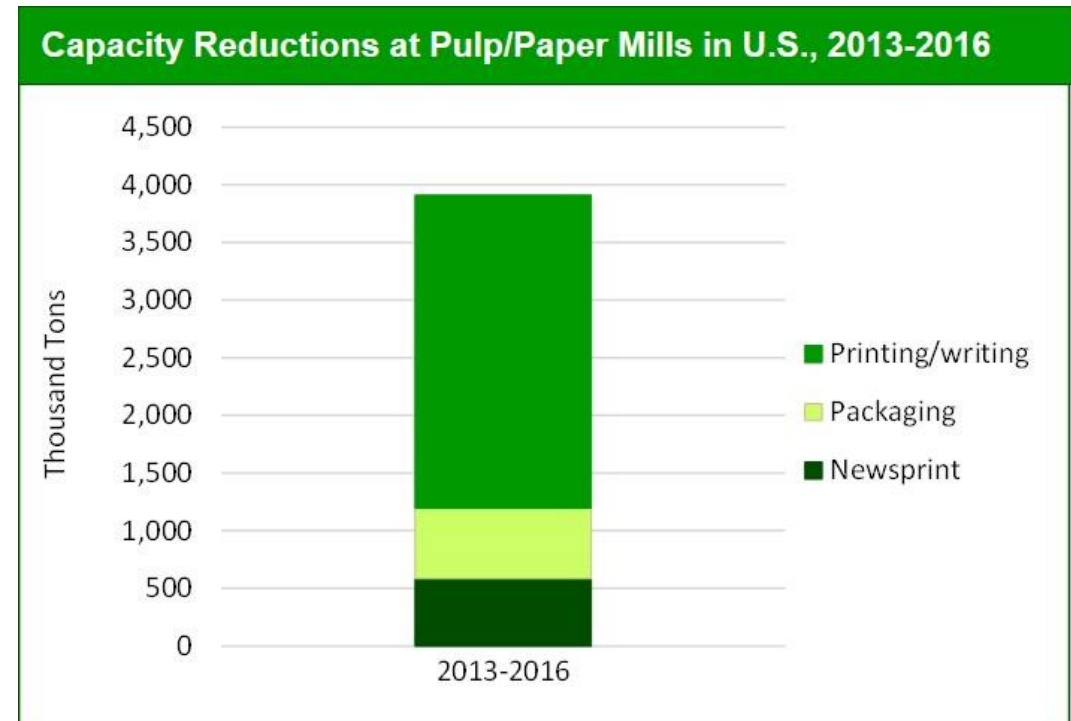
Regional and World Forecast of
Revenues and Tonnage

U.S. Pulp and Paper Output Down 3.9 billion tons for 2013-16

Pulp and paper mill closures and capacity reductions in the U.S. reduced annual output by over 3.9 million tons from 2013-2016.

Newsprint and printing and writing paper accounted for 84% of reductions, which tracks reduced demand for pulpwood in these sectors.

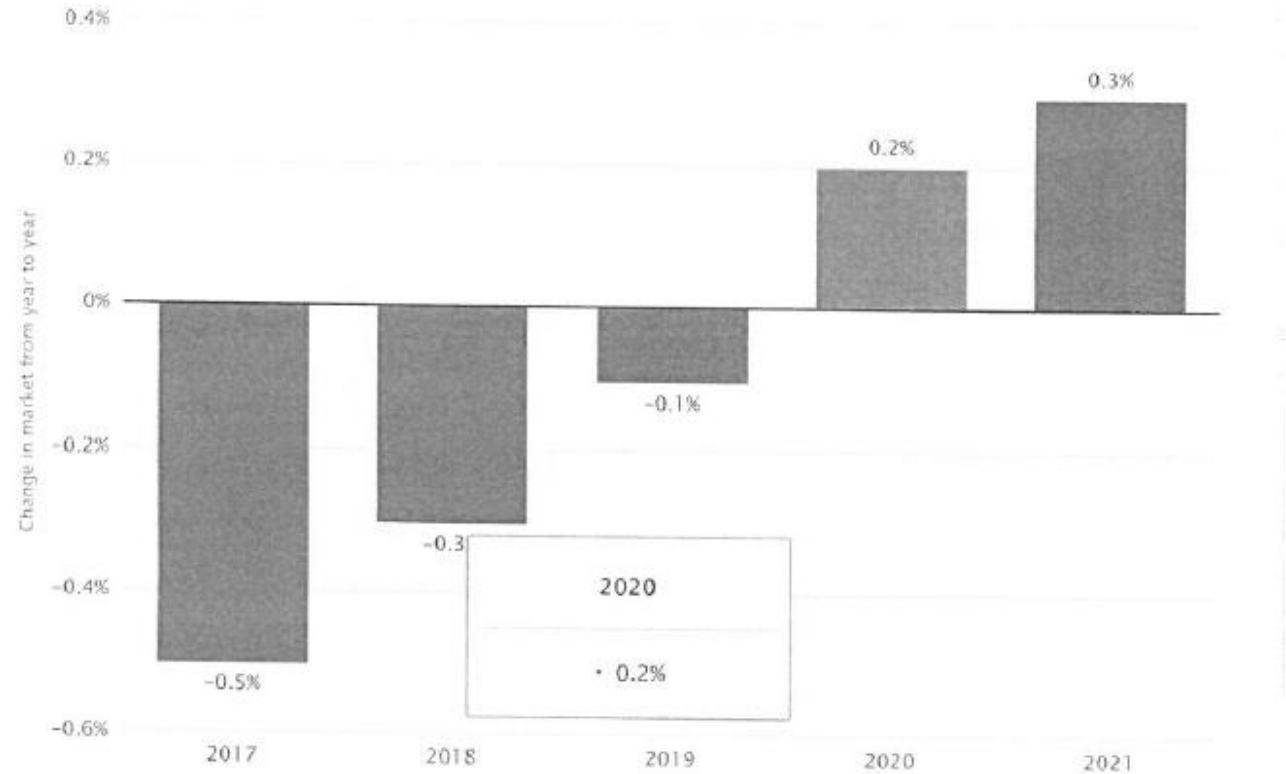
WestRock's decision to close mills in Coshocton, Ohio and Newberg, Oregon contributed to the decline in packaging production. According to WestRock, the closures were part of a strategic restructuring to better align supply with consumer demand.



Note: Figure includes primarily wood-using mills.

U.S. Paper Consumption 2017-21

Paper consumption in the U.S. will drop by half a percent this year and will not exceed 2016 levels until 2020



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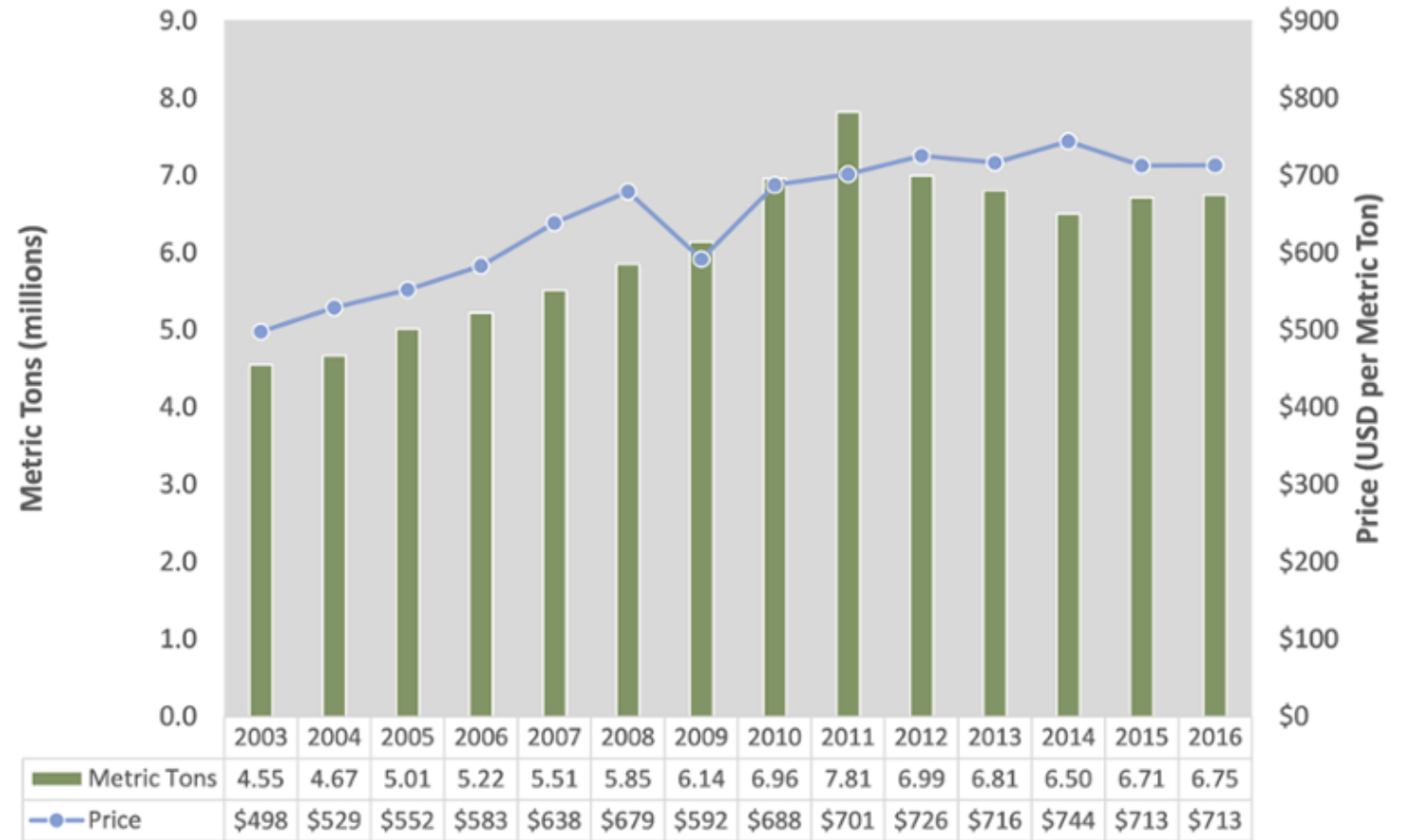


U.S. Exports of Pulp Lower than 2011

US exports of total market pulp are flattened in 2016

Exports reached 6.75 million metric tons, slightly up from 6.71 million in 2015, but below peak years between 2010 and 2013.

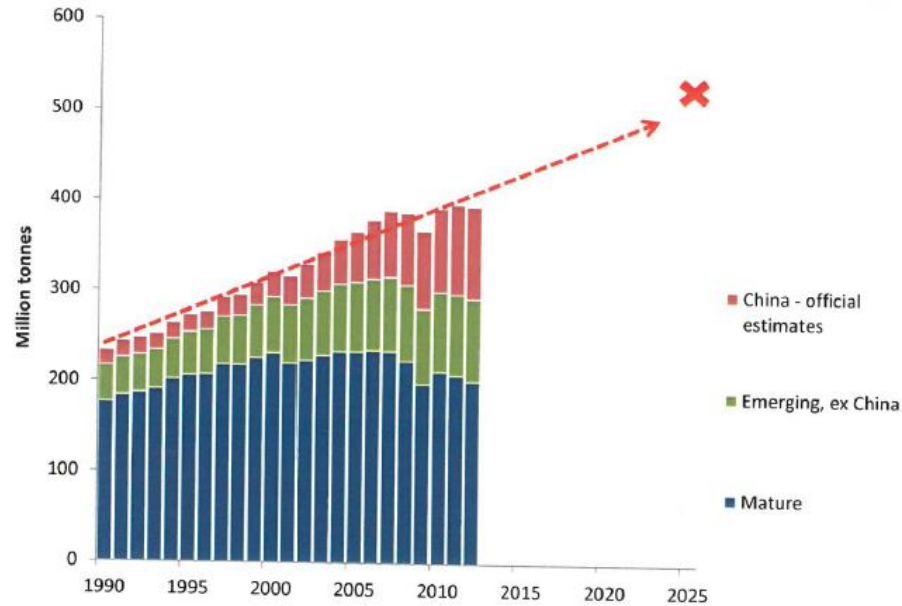
Export prices are flat at \$713 per metric ton.



Global Forest Product Companies Income to Rise 2-4% over 18 Months

- Higher prices and stronger wood product, paper packaging and market pulp demand offsetting rising input costs and lower paper demand will keep the outlook for the global paper and forest products industry stable, says Moody's Investors Service in a newly published global outlook for the sector. Consistent with the stable outlook, the rating agency expects consolidated operating income increases of 2-4% for its 46 globally-rated forest product companies over the next 12-18 months.
- Moody's expects that the consolidated operating income of the 29 North American companies it rates will remain essentially flat, with 2-4% growth over the outlook period. Such growth is consistent with analysts' expectations of modest operating income growth from North American paper packaging, wood products and timberland producers being partially offset by lower operating earnings from pulp and paper companies. Significantly, these same companies account for about 60% of the global rated industry's operating income.
- "Notably, despite flat operating incomes overall for the North American subset, US timberland and wood products companies including Weyerhaeuser Company, Rayonier Inc., and Potlatch Corporation stand to benefit as the demand for new US housing increases about 8% in 2017 and as lumber prices escalate with the implementation of duties on Canadian lumber exported to the US," said Moody's Senior Vice President Ed Sustar.
- With respect to the rating agency's five rated Latin American pulp producers, Moody's says their operating income growth will increase by 2-4%, as local players benefit from the concurrent positive effects of their low cost base and price hikes implemented in the past six months. And with international pulp prices being priced in US dollars, local currency depreciation will be a continued benefit to producers. In Brazil, Moody's forecasts real GDP to increase about 0.9% in 2017 and 1.5% in 2018, which will support local paper and packaging demand growth.
- For its part, of the 11 rated European producers, analysts expect consolidated operating income to increase 1-3% over the outlook period. These producers account for approximately 25% of the Moody's-rated operating income for the industry globally. Such an increase is consistent with expectations that stronger operating earnings regionally from rated packaging companies will outweigh those from paper producers, which continue to face secular declines. Nevertheless, in the report, Moody's analysts underscore expectations of an increase in operating income from European wood-based building producers, as larger investments in homebuilding and renovations bolster demand for lumber and panels. Packaging volume is similarly expected to grow as the European economy improves, and continuing weakness in the Euro should strengthen European exports in 2017. Moody's forecasts modest economic growth of about 1.4% for the Euro area in 2017 and 2018.

Paper Board production - consensus view

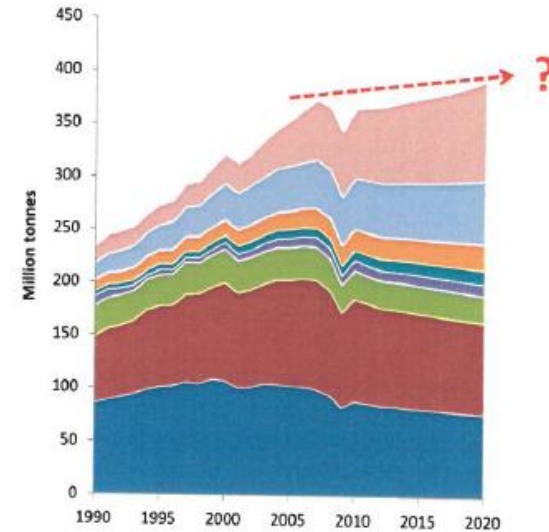
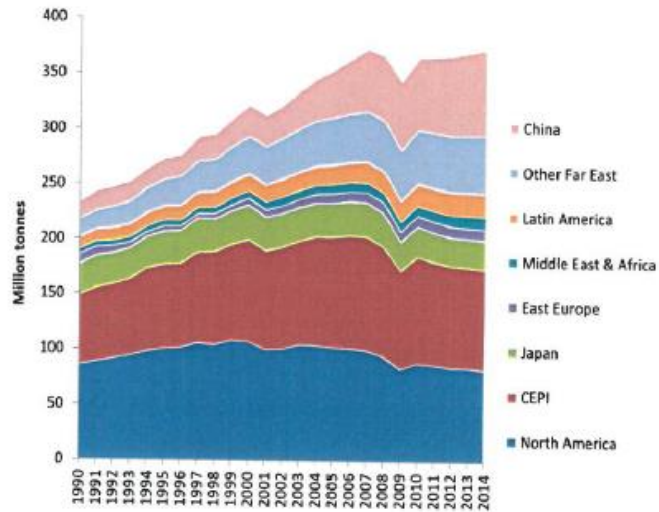


- Paper production falls in integrated regions (mature markets) and grows in non-integrated regions (EM)
- However, emerging markets have slowed considerably and the biggest growth market, China, has consistently been overstated
- Extrapolating based on forecasts of GDP or population growth is no longer valid -it would add 50 Mt 2012-2020

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Paper & Board production

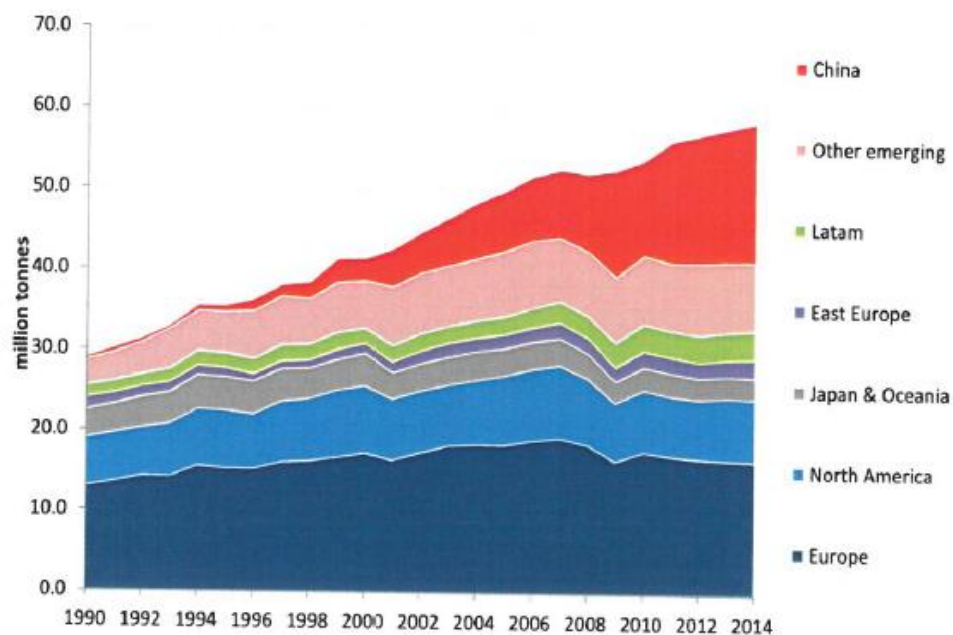
Hawkins Wright assumptions/illustrations



- From 2010 to 2014 global P&B demand has grown by 7.6 million tonnes.
- Chinese production grew from 65.5Mt to 77.6 million t.
- Rest of world fell from 300.3 to 295.8, as growth in Latam, East Europe and other emerging Asia was offset by declines elsewhere.

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Market pulp demand growth remains geared to China



- China accounted for 93% of global pulp demand growth in the past 10 years
- Last year, pulp demand in the rest of the world was lower than in 2004

Market pulp Capacity 2013 & 2014, - 2018



- In 2013 net capacity grew by 0.8 million tonnes, and in 2014 by 0.9 million tonnes (in line with demand).
- In 2014 Capacity growth of 0.9Mt was 0.8 million tonnes less than expected this time last year, due to closures or start-up delays
- The new lines of Eldorado, Ilim, Suzano, and MdP were partially offset by line closures of Cel du Maroc, Tofte, Huelva, Kamloops, Solombala . New supply has so far been absorbed by the market.
- In 2015-2018, new capacity 7.8 MTY will be added but partly offset by substitution and closures
- Environment and sustainability now top priority of China government
- Demand Growth forecast 5.1 MTY of which 4.7 in China/Asia

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Analysis of Largest Pulp and Paper Companies

Leading Pulp and Paper Suppliers by Tons of Production

Rank	Company Group	Country	Production in 2015 (1,000 ton)	Rank by Sales
1	International Paper	United States	23315	1
2	Nine Dragon Paper Holdings	China	12630	18
3	WestRock	United States	12487	4
4	UPM	Finland	9771	5
5	Stora Enso	Finland	9188	8
6	Oji Paper Company	Japan	9115	3
7	Sappi	South Africa	7306	15
8	Smurfit Kappa Group	Ireland	7000	9
9	DS Smith	United Kingdom	6802	13
10	Nippon Paper	Japan	6542	11

Top 100 Global Forest, Paper & Packaging Industry Companies

(US \$ millions)

Rank 2012	Rank 2011	Company name ¹	Country	Sales ²		Net income (Loss)		EBITDA as a % of sales	
				2012 \$	2011 \$	2012 \$	2011 \$	2012 %	2011 %
1	1	International Paper	US	27,833	26,034	799	1,355	18%	13%
2	2	Kimberly-Clark	US	21,063	20,846	1,750	1,684	17%	17%
3	4	Oji Paper	Japan	15,161	14,193	277	296	11%	13%
4	5	UPM - Kymmene	Finland	13,423	14,019	(1,613)	636	-6%	13%
5	3	Stora Enso	Finland	13,398	15,268	631	476	12%	12%
6	6	Nippon Paper Group	Japan	13,030	13,251	(521)	(291)	11%	11%
7	7	Svenska Cellulosa (SCA)	Sweden	12,619	12,543	732	94	14%	17%
8	8	Smurfit Kappa	Ireland	9,432	10,244	320	304	13%	13%
9	16	Rock-Tenn	US	9,208	5,400	249	146	12%	12%
10	9	Mondi Group	UK	7,468	7,991	314	557	15%	17%
11	10	Metsaliitto	Finland	6,431	7,444	79	(219)	10%	7%
12	11	Sappi	South Africa	6,347	7,286	104	(232)	12%	7%
13	17	Weyerhaeuser	US	6,221	5,378	385	273	19%	19%
14	13	Rengo	Japan	6,158	5,965	89	129	11%	12%
15	14	Domtar	Canada	5,482	5,676	172	369	14%	17%
16	12	MeadWestvaco	US	5,459	6,060	205	246	12%	23%
17	23	Unicharm	Japan	5,355	4,542	337	404	15%	16%
18	22	Sumitomo Forestry	Japan	5,188	4,614	116	(185)	7%	0%
19	18	Daio Paper	Japan	5,112	5,137	(67)	67	10%	10%
20	15	Sequana Capital	France	4,953	5,492	(153)	(107)	3%	4%
21	24	Sonoco	US	4,786	4,499	196	218	-4%	11%
22	21	CMPC	Chile	4,759	4,786	202	492	18%	21%
23	20	Resolute Forest Products	Canada	4,503	4,810	(2)	41	5%	9%
24	26	Graphic Packaging	US	4,337	4,206	123	277	14%	11%
25	28	Nine Dragons Paper Holdings	China	4,304	3,774	225	312	16%	17%

26	25	Arauco	Chile	4,280	4,374	135	86	19%	3%
27	19	PaperlinX	Australia	4,260	4,812	(267)	(112)	-1%	-1%
28	29	Cascades	Canada	3,646	3,667	(11)	100	8%	5%
29	30	Fibria Celulose (VCP + Aracruz)	Brazil	3,174	3,506	(362)	(520)	36%	38%
30	31	NewPage Corporation	US	3,131	3,502	1,258	(524)	6%	4%
31	40	Shandong Chenming	China	3,130	2,714	35	94	12%	11%
32	27	DS Smith	UK	3,121	3,969	119	113	11%	8%
33	37	West Fraser Timber	Canada	3,001	2,794	87	74	16%	8%
34	32	Norske Skog	Norway	2,914	3,375	(478)	(454)	-11%	-6%
35	39	Hokuetsu Paper	Japan	2,882	2,726	160	68	14%	14%
36	41	Packaging Corp of America	US	2,844	2,620	164	158	21%	17%
37	46	Boise Cascade	US	2,779	2,248	41	(46)	3%	1%
38	43	Canfor	Canada	2,715	2,449	32	11	17%	7%
39	33	Lenzing	Austria	2,688	2,980	232	372	16%	23%
40	34	Suzano	Brazil	2,669	2,904	(94)	18	13%	27%
41	35	Holmen	Sweden	2,598	2,877	274	610	22%	37%
42	44	Boise Inc.	US	2,555	2,404	52	75	20%	14%
43	38	Mayr-Melnhof Karton	Austria	2,510	2,729	153	165	12%	13%
44	36	Sodra	Sweden	2,483	2,805	(85)	109	1%	12%
45	42	Mitsubishi Paper	Japan	2,436	2,536	7	174	6%	7%
46	49	Hengan International	Hong Kong	2,388	2,190	454	345	29%	22%
47	50	Kimberly-Clark Mexico	Mexico	2,227	2,158	315	294	28%	28%
48	45	Klabin	Brazil	2,140	2,329	387	109	44%	26%
49	47	Ahlstrom	Finland	2,138	2,238	(1)	(45)	5%	9%
50	48	The Lecta Group	UK	2,089	2,196	(88)	33	4%	10%

2015 Capacity Developments

Company (Mill)	Location	Country	Grade	Mkt. Cap	Int. Cap	Status	Year	Date
Altri	Constancia	Portugal	BHK	-120		C	2011-2015	
Jari	Monte Duardo	Brazil	DP/BHK	330		C	2015	January
Paper Excellence (Chetwynd)	British Columbia	Canada	BCTMP (hwd)	240		C	2015	May 1
Nanning Phoenix	Nanning	China	BHK/BSK	-150		C	2015	Q1
CMPC	Guaiba	Brazil	BHK	1,300		C	2015	May 3
Yibin Paper	Yibin	China	Bamboo		200	C	2015	Q2
Yinquant Paper	Qing'an	China	Wheat Straw		90	C	2015	Q3
Portucel	Cacia	Portugal	BHK	70		C	2015	Q3
Sun Paper	Zoucheng	China	DP/BHK			C	2015	Q4
Sun Paper	Yanzhou	China	BHK	300		C	2015	Q4
Resolute	Calhoun	USA	BHK	75	25	C	2015	Q4
Tralim	Jiamusi	China	Straw		95	C	2015	Q4
Heinzel Pols	Styria	Austria	BSK	240		C	2015	Q4
Holmen	Iggesund	Sweden	BSK	50		C	2015	Q4
UPM (Kymi)	Kuusankoski	Finland	BSK	70		C	2015	Q4
UPM (Kymi)	Kuusankoski	Finland	BHK	100		C	2015	Q4
Verso	Androscoggin	Maine	BSK		225	C	2015	October
Verso	Wickliffe	Kentucky	BHK		200	C	2015	October
Paper Excellence (Howe Sound)	British Columbia	Canada	BSK	25		C	2015	Q4
Suzano	Suzano	Brazil	BHK (fluff)	100	-100	C	2015	Q4
Waggeryd	Vaggeryd	Sweden	BCTMP (swd)	20		C	2015	
Rottneros	Vallvik	Sweden	BSK	20		C	2015	
Chenming*	Nanchang	China	BCTMP		250	C	2015	

2016 Capacity Developments

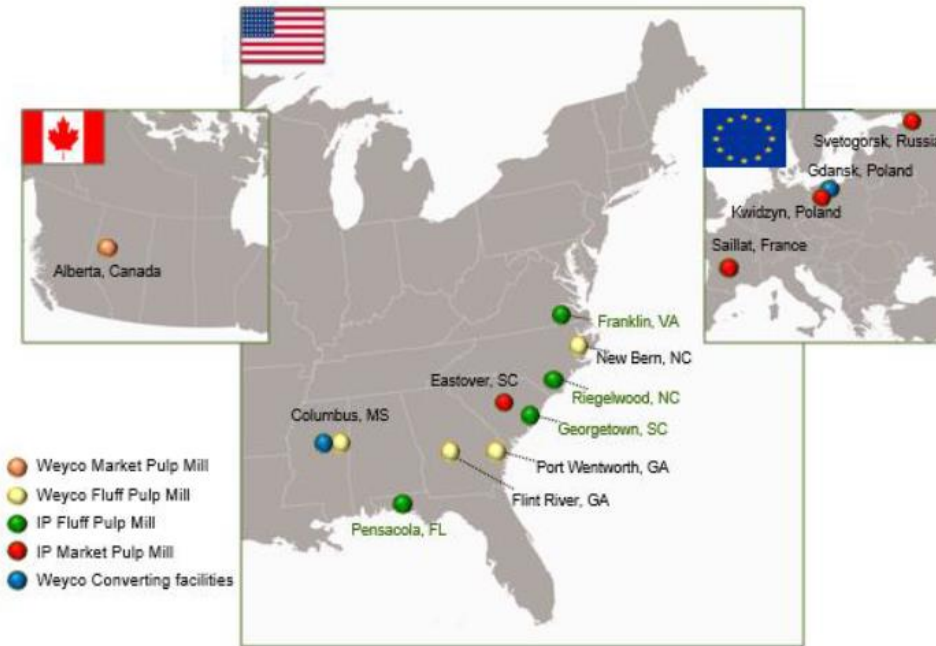
Company (Mill)	Location	Country	Grade	Mkt. Cap	Int. Cap	Status	Year	Date
ENCE	Navia	Spain	BHK	40		C	2015-16	Q2-Q1
Catalyst Paper	Maine	USA	BHK	-130		P	2015-18	
Expera	Old Town	USA	BSK/BHK		-180	C	2016	Q1
WestRock	Evadale	USA	BSK	-90	90	C	2016	Q1
Svetlogorsky	Svetlogorsk	Belarus	BSK/BHK/DP	400		C	2016	Q1
Klabin	Ortigueira	Brazil	BHK	1,100		C	2016	Q1
Klabin	Ortigueira	Brazil	BSK	400		C	2016	Q1
SodraCell	Morrum	Sweden	BSK	35		C	2016	Q1
IGIC (Woodland)	Maine	USA	BHK	-100	100	C	2016	Q1-Q2
International Paper (Riegelwood)	North Carolina	USA	BSK	360		C	2016	Q2
PT OKI/APP	Sumatra	Indonesia	BHK	2,800		C	2017	Q3
Double A	Alizay	France	BHK	130		C	2016	Q3
ITC	Bhadrachalam	India	BCTMP		105	C	2016	Q3
SodraCell	Varo	Sweden	BSK	275		C	2016	Q3
Domtar (Ashdown)	Arkansas	USA	BSK	230	-95	C	2016	Q3
Domtar (Ashdown)	Arkansas	USA	BHK		-135	C	2016	Q3
UPM	Kaukas	Finland	BSK/BHK	?		C	2016	End
Columbia Pulp	Washington	USA	UKP (Straw)	125		P	2016	
Yongfeng*	Xuyong	China	Bamboo		200	C	2016	
Irving	New Brunswick	Canada	BSK	30		C	2016	

International Paper

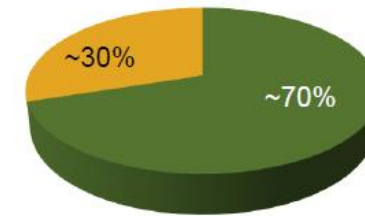
International Paper Repositioning and Automating

- “This is a 100-year-old industry, and most of the technology processes we utilize today were designed and built 50-100 years ago when energy and raw materials were inexpensive,” says Tommy Joseph, senior vice president of manufacturing and technology at International Paper, headquartered in Memphis, Tenn.
- The new mantra in this energy-and raw-materials-intensive industry: Make more product with less energy. “There is nothing new in the overall process. There is not a new way to make paper—it is a tried-and-true process,” Joseph says. “The real opportunity is around efficiency—investing in new processes, new technology and new capabilities that will reduce consumption and make more product with less energy.”
- With the help of automation and software vendors, companies like International Paper are proving their technology prowess. Because, quite frankly, Joseph adds, “the pulp and paper industry gets a bad rap. We have to be innovative.”
- So innovative, in fact, that International Paper has figured out how to adapt, change and reinvent itself to accommodate the market.
- In 2005 and 2006, International Paper underwent a major transformation, selling \$11 billion of the company’s vast forestland assets, as well as various non-core businesses to focus on packaging and paper. To that end, between 2008 and 2012, the manufacturer invested \$11 billion in acquisitions that transformed the company. Global business is now tied heavily to packaging paper and pulp. In 2016 IP bought Weyerhaeuser’s pulp business for \$2.2 billion. IP acquired five pulp mills (including one in Grande Prairie, Alta.) and two converting facilities that produce fluff pulp, softwood pulp, and specialty pulp for a number of consumer applications including diapers, other hygiene products, tissue and textiles
- “There has been a huge culture shift over the last 10 years,” says Joseph. With new capital and technology investments comes new training requirements. To help with that, the company is putting together collaborative online training for operators in multiple languages that can be applied while they are on the job or away from the job, in a common, systematic way. Ultimately, it’s about seamlessly sharing information.

Global Cellulose Fibers | Business Overview



Current Product Mix¹



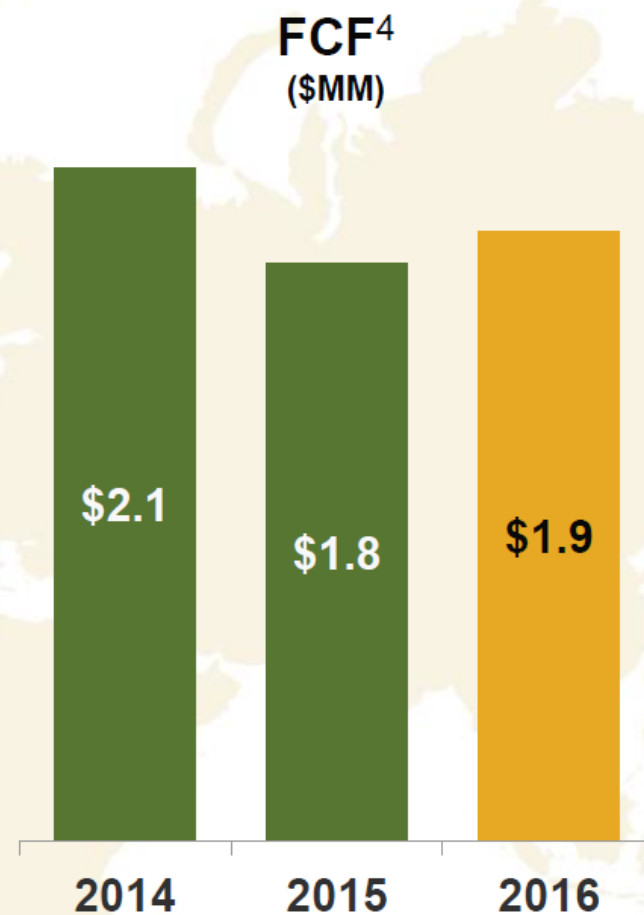
Fluff Pulp & Specialties Market Pulp

Total Capacity	~3.6MM MTPY	Targeted Mix
Fluff Pulp & Specialties	3.0MM	85%
Market Pulp	0.6MM	15%

¹ Combined businesses, with Riegelwood PM18 running SW market pulp

Full-Year 2016 Financial Results

\$ Billion (Except as noted)	2014	2015	2016
Sales	\$23.6	\$22.4	\$21.1
Adj. EBIT¹	\$2.7	\$2.6	\$2.3
Adj. Operating EPS²	\$3.00	\$3.65	\$3.35
Operating EPS impact of Ilim F/X³ – IP Share	(\$0.63)	(\$0.18)	\$0.06
Adj. EBITDA¹	\$4.1	\$3.9	\$3.5
Adj. EBITDA Margin	17.5%	17.6%	16.6%
FCF⁴	\$2.1	\$1.8	\$1.9
Year-End Debt	\$9.4	\$9.3	\$11.3
Cash Balance	\$1.9	\$1.0	\$1.0



¹ From continuing operations before special items and non-operating pension expense

² Adjusted operating EPS based on Adjusted Operating Earnings (defined as Net Earnings (GAAP) from continuing operations before special items and non-operating pension expense)

³ Represents F/X impact including that related to Ilim JV USD-denominated net debt (balance of ~\$0.6B at year end 2016)

⁴ See slide #27 for a reconciliation of cash provided by operations to Free Cash Flow



First Quarter Outlook¹ | Changes from 4Q16

		North America	EMEA & Russia	Brazil
Price / Mix	Packaging	Continued implementation	Stable	Stable
	Cellulose Fibers	Stable		
	Paper	Stable	Stable	Improving
Volume	Packaging	Stable	Stable	Stable
	Cellulose Fibers	Acquisition		
	Paper	Stable	Stable	Seasonal decrease
Operations & Other	Packaging	Non-repeats	Stable	Stable
	Cellulose Fibers	Stable		
	Paper	Non-repeats	Improving	Stable
Mill Maintenance Outages	Packaging	Increase \$46MM	N/A	Increase \$1MM
	Cellulose Fibers	Increase \$47MM		
	Papers	Increase \$23MM	Decrease \$15MM	N/A
Inputs & Freight	Packaging	Higher OCC & energy	Stable	Stable
	Cellulose Fibers	Higher energy		
	Printing Papers	Higher energy	Stable	Stable
Other Items		<ul style="list-style-type: none"> ▪ Corporate expense, ~\$15MM in 1Q17 ▪ Interest expense, in line with full-year outlook of ~\$575MM-\$600MM ▪ Tax rate, in line with full-year outlook of ~33% ▪ Ilim JV, lower due to normal seasonality 		

¹ Does not include impact from 1/22/17 Pensacola incident

Maintenance Outages Expenses | 2016 Actual

\$ Million	1Q16A	2Q16A	3Q16A	4Q16A	2016A
Industrial Packaging	\$73	\$80	\$44	\$36	\$233
North America	73	78	44	35	230
Brazil	0	2	0	1	3
Global Cellulose Fibers¹	\$50	\$9	\$16	\$3	\$78
Printing Papers Total	\$16	\$41	\$11	\$28	\$96
North America	16	26	0	13	55
Europe	0	8	10	15	33
Brazil	0	7	0	0	7
India	0	0	1	0	1
Consumer Packaging	\$19	\$3	\$2	\$11	\$35
North America	19	0	0	11	30
Europe	0	3	2	0	5
Total Impact	\$158	\$133	\$73	\$78	\$442

¹ 4Q'16 and FY'16 includes Dec'16 maintenance outages expenses from newly-acquired pulp business

Geographic Business Segment Operating Results | Quarterly

\$ Million	Sales			D & A	Adj. Operating Profit ¹		
	4Q15	3Q16	4Q16	4Q16	4Q15	3Q16	4Q16
Industrial Packaging							
North America	\$3,098	\$3,087	\$3,052	\$167	\$451	\$439	\$384
Europe	\$293	\$313	\$325	\$9	\$4	\$0	\$9
Brazil	\$48	\$62	\$77	\$7	(\$12)	(\$9)	(\$14)
Global Cellulose Fibers²							
Global Cellulose Fibers	\$244	\$241	\$379	\$40	\$14	(\$32)	(\$32)
Printing Papers							
North America	\$489	\$477	\$465	\$20	\$33	\$82	\$43
Europe	\$270	\$278	\$284	\$10	\$41	\$40	\$28
Brazil	\$252	\$229	\$260	\$25	\$58	\$53	\$50
India	\$41	\$35	\$47	\$5	(\$2)	(\$8)	\$0
Consumer Packaging							
North America	\$475	\$407	\$386	\$27	\$12	\$39	\$21
Europe	\$81	\$87	\$78	\$3	\$26	\$22	\$20

¹ Excludes special items (Non-GAAP)

² 4Q'16 and FY'16 includes Dec'16 results from newly-acquired pulp business

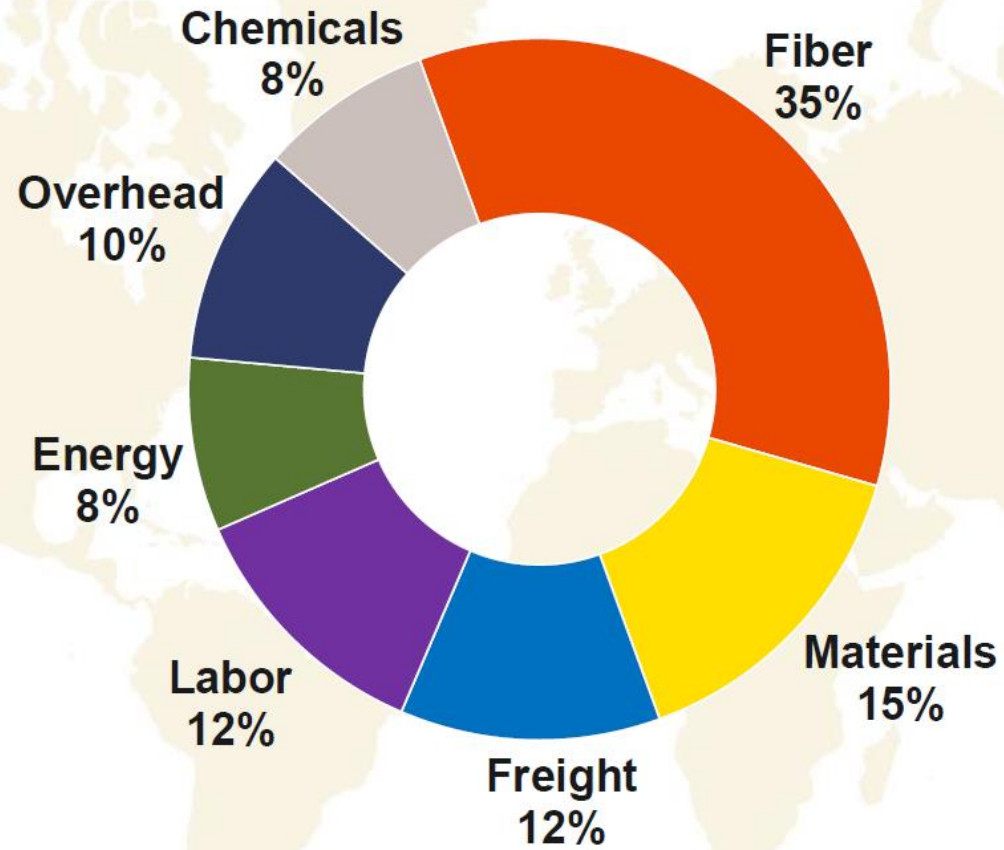
Geographic Business Segment Operating Results | Annually

\$ Million	Sales		Adj. Operating Profit ¹	
	2015	2016	2015	2016
Industrial Packaging				
North America	\$12,541	\$12,227	\$2,009	\$1,757
Europe	\$1,114	\$1,227	\$13	\$22
Brazil	\$228	\$232	(\$26)	(\$43)
Global Cellulose Fibers²				
Global Cellulose Fibers	\$975	\$1,092	\$68	(\$130)
Printing Papers				
North America	\$1,942	\$1,890	\$179	\$236
Europe	\$1,064	\$1,109	\$111	\$142
Brazil	\$878	\$897	\$186	\$173
India	\$172	\$167	(\$11)	(\$11)
Consumer Packaging				
North America	\$1,939	\$1,628	\$91	\$107
Europe	\$319	\$327	\$87	\$93

¹ Excludes special items (Non-GAAP)

² 4Q'16 and FY'16 includes Dec'16 results from newly-acquired pulp business

Total Cash Cost Components | FY 2016



North American mills only

U.S. Chemical Composite Cost Trend | 4Q16 Average Cost Up 3% vs. 3Q16



IP cost Indexed to January 2007 values

Delivered cost to U.S. facilities: includes Caustic Soda, Sodium Chlorate, Starch and Sulfuric Acid 2007 - 2008 excludes WY PKG



2017 Global Consumption | Annual Purchase Estimates for Key Inputs

	Commodity	U. S.	Non – U. S.
Energy	Natural Gas (MM BTUs)	75,000,000	11,000,000
	Fuel Oil (Barrels)	350,000	400,000
	Coal (Tons)	130,000	600,000
Fiber	Wood (Tons)	52,000,000	8,000,000
	Old Corrugated Containers / DLK (Tons)	4,800,000	400,000
Chemicals	Caustic Soda (Tons)	320,000	70,000
	Starch (Tons)	370,000	120,000
	Sodium Chlorate (Tons)	160,000	50,000
	LD Polyethylene (Tons)	40,000	-
	Latex (Tons)	10,000	6,000

Data does not include newly-acquired pulp business

Water permits provide valuable information- International Paper Olympia Washington ----2015

Mr. Jared Williamson
EHS Manager
International Paper
7727 Union Mills Road SE
Olympia WA 98503

RE: "Engineering Report International Paper - Olympia" date

Dear Mr. Williamson:

The Department of Ecology (Ecology) received one copy of the report in accordance with RCW 90.48.110 and Chapter 173-240 WAC, and the document is hereby **APPROVED** as an Engineering Report. We

Capacity:	Peak Day Flow (batch treatment, multiple batches of 5,000 tanks / day)
Design Flow	15,000 gpd (max day w/24-hr ops), no MMA flow established

The new pretreatment system will be a batch treatment system capable of 5,000 gallons per batch and three batches per day. This accommodates the average wastewater flow presently (about 8,000 gpd) and the max daily flow presently (13,600 gpd).

The system includes an influent equalization tank and effluent storage tanks (10,000 gal) for holding the wastewater after treatment. This assures compliance with pretreatment standards prior to discharge. Treatment consists of equalization in the holding tank, solids screening and then batch treatment. The batch treatment consisting of polymer addition, pH adjustment and mixing and then addition of a flocculant. The treated wastewater is then routed through a "Hy-Pack" solids filter press where solids are removed and treated water is routed to the effluent holding tank. It is anticipated that solids will need to be removed from the filter press after each batch. Removed solids will be taken off site for disposal.





Building the Case for Asset Framework at International Paper

Presented by Rick Smith

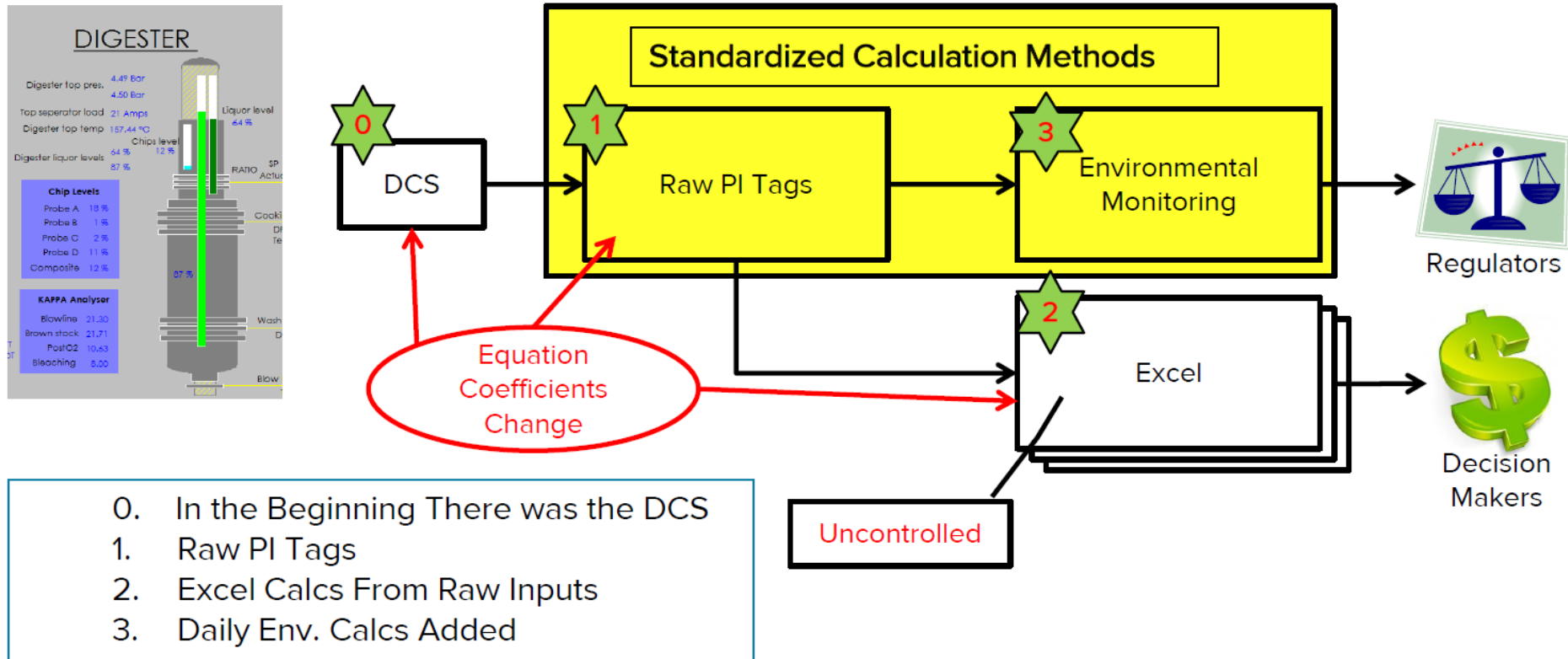


USERS CONFERENCE 2015

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Digester Production Calculations



0. In the Beginning There was the DCS
1. Raw PI Tags
2. Excel Calcs From Raw Inputs
3. Daily Env. Calcs Added

Build the Calculation Template...

Library

- Testing-Rick Smith
 - Categories
 - Analysis Categories
 - Attribute Categories
 - Element Categories
 - Reference Type Categories
 - Table Categories
 - Templates
 - Element Templates
 - BMACT Boiler
 - BMACT Boiler Info
 - Digester ODTDP Production
 - Digester Yield
 - EL_BleachPlant
 - EL_Facility
 - EL_PaperMachine
 - EL_PMEnergyValue_RMS
 - EL_PMTemplate
 - EL_Refiner
 - EL_RTS_Downtime
 - EL_RTS_w_SubStates
 - EL_ScrubberTemplate
 - Filter-High/Low
 - Event Frame Templates
 - Model Templates
 - Notification Templates

Digester ODTDP Production Template

General | **Attribute Templates** | Ports | Analysis Templates

Filter

Name	Description	Default Value	Unit Of Measure	Settings...
Category: Calculation Parameter				
Bulk Density	Bulk Density	10.65 lb/ft3		
Chip Meter Fill Factor	Chip Meter...	1		
Chip Meter Volume	Chip Meter...	24.6 ft3		
Yield		0		
Category: Calculation Result				
Production (ADTPD)	Production ...	0 ADTPD		
Production (ODTPD)	Production ...	0 ODTDP		
Category: Measurement				
Chip Meter Speed	Chip Meter...	0 rpm		
Kappa	Kappa Test	0		
Production from DCS	Production ...	0 ODTDP	oven dried pulp short t...	

Equations

$$S * D * V * F * Y * 1440 / 2000$$

Parameters

- D= Bulk Density
- F= Chip Meter Fill Factor
- S= Chip Meter Speed
- V= Chip Meter Volume
- Y= Yield

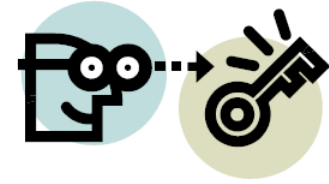
Asset Framework (AF) Calculation Conversion Benefits

- Standard Calculation Methodology
 - Controlled By the AF Template
 - Therefore, One Version of the Truth
- AF Becomes the One Stop Shop for...
 - Enterprise Alias for Calculated Results
 - Time Stamped Coefficient Changes
 - DCS/PI Calculation Comparison



Case #2: Downtime Tracking

- Overall Equipment Efficiency (OEE) =
Availability * Speed Efficiency * Quality
 - Availability: Downtime/Slowback System (RTS)
 - Speed Efficiency: Maximum Sustainable Rate
 - Quality: A1 Tons Acceptance
- Reliability Tracking System (RTS)
 - Windows Service Reads PI Data and Writes State Information to PI
 - 0=Normal; 1=Slow; 2=Down
 - Event System Triggers Off State Tag
 - Excel Report for Each Unit Operation
 - ~300 Unit Operations Monitored



Report Output

Top 15 Reasons Sorted by Equivalent Downtime

YEAR-TO-DATE				
REASON LEVEL 1	REASON LEVEL 2	REASON LEVEL 3	# of Incidents	Equiv. DT (%)
Internal Equipment	#1 Lime Kiln	Other	11	0.9%
Internal Equipment	#1 Lime Kiln	ID Fan	1	0.9%
Internal Equipment	#1 Lime Kiln	Precoat Filter	21	0.9%
Internal Equipment	#1 Lime Kiln	Scrubber	4	0.7%
External Upstream	#2 Recovery Boiler	GL Inventory Low	1	0.6%
Internal Process	#1 Lime Kiln	Cool Down	1	0.2%
Internal Equipment	#1 Caustic			
External Utilities	Other			
Internal Process	#1 Lime Kiln			
Internal Process	#1 Lime Kiln			
Internal Process	#1 Lime Kiln			
Internal Process	#1 Lime Kiln			
Total *				

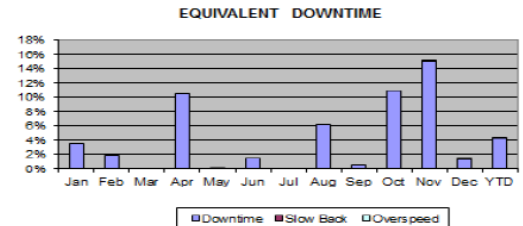
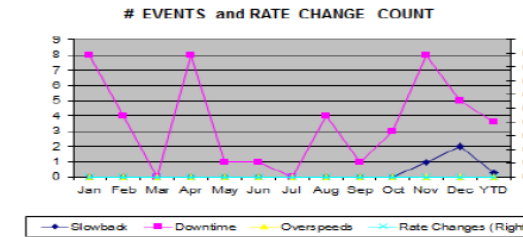


INTERNATIONAL PAPER

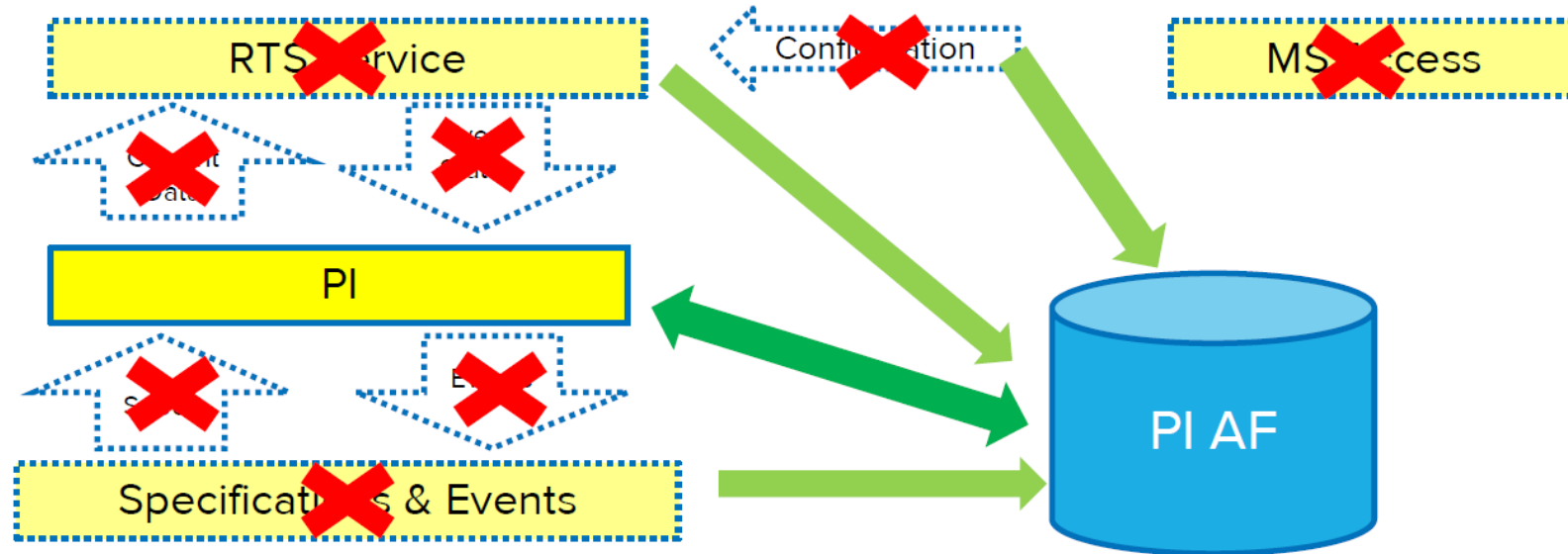
RTS Monthly Report
Downtime Summary

Date: **12/31/10**
Mill: **Mill-X**
Equipment: **#1 Lime Kiln**

EQUIVALENT DOWNTIME	For Month			Year-To-Date		
	No. of Events	Duration (Hr)	Equival. DT (%)	No. of Events	Duration (Hr)	Equival. DT (%)
Slowback Mode	2	1.1	0.1%	3	3.2	0.0%
Downtime Mode	5	10.5	1.4%	43	1041.2	4.3%
Total			1.4%			4.3%
Overspeed Mode	0	0.0	0.0%	0	0.0	0.0%
Availability (100 - Downtime %)	733.5	98.6%		7718.9	95.7%	
Avg. Time Between DT Events	148.8	hr		203.7	hr	
Average Downtime Event Time	0.0	hr		0.1	hr	



Future Downtime Data Flow

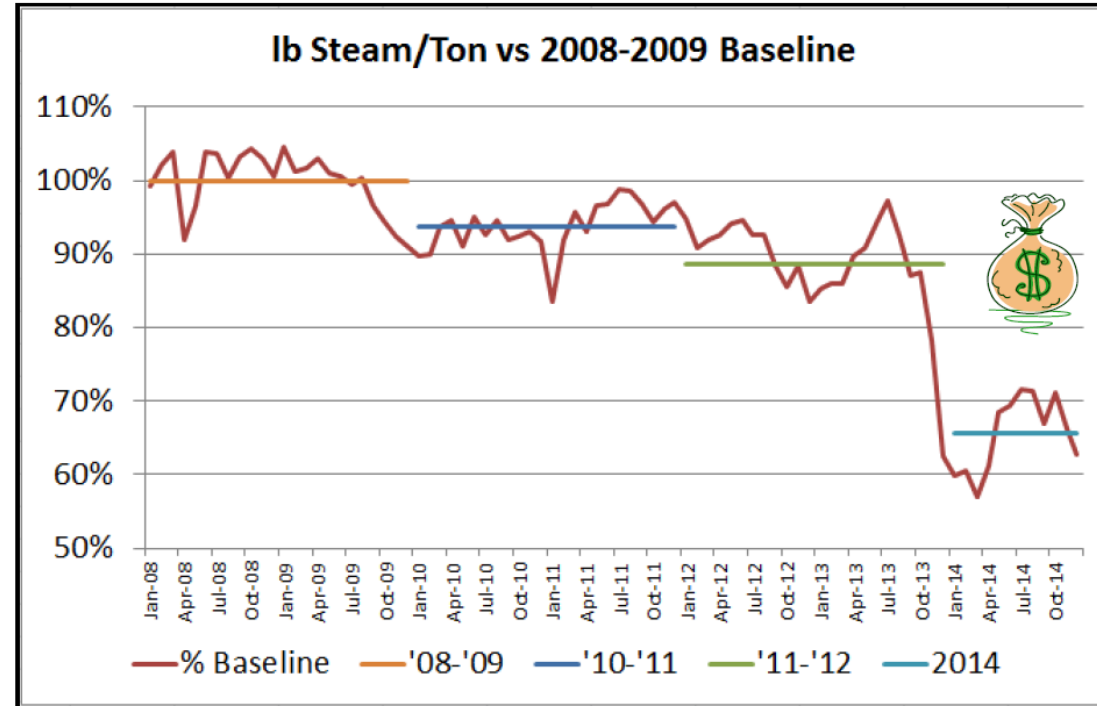


Event name	Start time	End time	Duration	Target.Average	Value.Average
EF_RTS_RTS-Test1_SS_2014-09-12 06:50:00	12-Sep-14 06:50:00			40.00	45.67
EF_RTS_RTS-Test1_SS_2014-09-16 06:20:00	16-Sep-14 06:20:00	16-Sep-14 06:31:00	0 0:11:00	40.00	27.75
EF_RTS_RTS-Test1_SS_2014-09-16 06:50:00	16-Sep-14 06:50:00	16-Sep-14 11:22:00	0 4:32:00	40.00	8.11
EF_RTS_RTS-Test1_SS_2014-09-16 18:32:00	16-Sep-14 18:32:00	16-Sep-14 23:07:00	0 4:35:00	40.00	9.42
EF_RTS_RTS-Test1_SS_2014-09-16 23:11:00	16-Sep-14 23:11:00	16-Sep-14 23:32:00	0 0:21:00	40.00	26.70



Case #3: Tracking (Energy) Consumption

- Huge Cost Driver
- Time Consuming to Monitor
- When to Invest?
- Where to Invest?



Monthly Summary

	Start time	End time	ProductionRate	Tons	Electricity_KwhPerTon	Steam_HP_LbsPerTon	Electricity	Steam_HP
PM1_01/2013	01-Jan-13 00:00:00	01-Feb-13 00:00:00	52.99943161	39431.57813	78.89457703	1424.099365	3110937.75	56154.48438
PM1_02/2013	01-Feb-13 00:00:00	01-Mar-13 00:00:00	65.14954376	43780.49219	72.2878418	1326.632324	3164797.25	58080.61719
PM1_03/2013	01-Mar-13 00:00:00	01-Apr-13 00:00:00	63.43252182	47130.36328	67.87601471	1332.900024	3199021.25	62820.0625
PM1_04/2013	01-Apr-13 00:00:00	01-May-13 00:00:00	60.65192032	43669.38281	71.24710846	1341.715454	3111317.25	58591.88672
PM1_01/2014	01-Jan-14 00:00:00	01-Feb-14 00:00:00	45.7202034	34015.83203	82.536026	1544.678101	2807531.5	52543.51172
PM1_02/2014	01-Feb-14 00:00:00	01-Mar-14 00:00:00	67.36373901	45268.43359	75.16860199	1325.387329	3402765	59998.21094
PM1_03/2014	01-Mar-14 00:00:00	01-Apr-14 00:00:00	57.92578125	43038.85547	76.41738892	1475.846313	3288917	63518.73438
	Start time	End time	ProductionRate	Tons	Electricity_KwhPerTon	Steam_HP_LbsPerTon	Electricity	Steam_HP
PM2_01/2013	01-Jan-13 00:00:00	01-Feb-13 00:00:00	39.713871	29547.12109	225.8252258	2240.65332	6672485.5	66204.85156
PM2_02/2013	01-Feb-13 00:00:00	01-Mar-13 00:00:00	46.81391907	31458.95313	214.6317444	2141.956787	6752090	67383.71875
PM2_03/2013	01-Mar-13 00:00:00	01-Apr-13 00:00:00	46.71214676	34707.125	211.1295166	2120.703613	7327698.5	73603.52344
PM2_04/2013	01-Apr-13 00:00:00	01-May-13 00:00:00	46.98371887	33828.27734	209.9403076	2136.415771	7101919	72271.26563
PM2_01/2014	01-Jan-14 00:00:00	01-Feb-14 00:00:00	37.06420517	27575.76953	246.0911713	2492.465332	6786153.5	68731.64844
PM2_02/2014	01-Feb-14 00:00:00	01-Mar-14 00:00:00	44.85942459	30145.53125	218.7319183	2245.138916	6593790	67680.90625
PM2_03/2014	01-Mar-14 00:00:00	01-Apr-14 00:00:00	45.86004639	34074.01563	214.614624	2179.784424	7312782	74274.00781
PM2_04/2014	01-Apr-14 00:00:00		35.81909561	23842.70313	208.6723785	2263.317139	4975320	53963.67188

Date Range

Monthly Averages

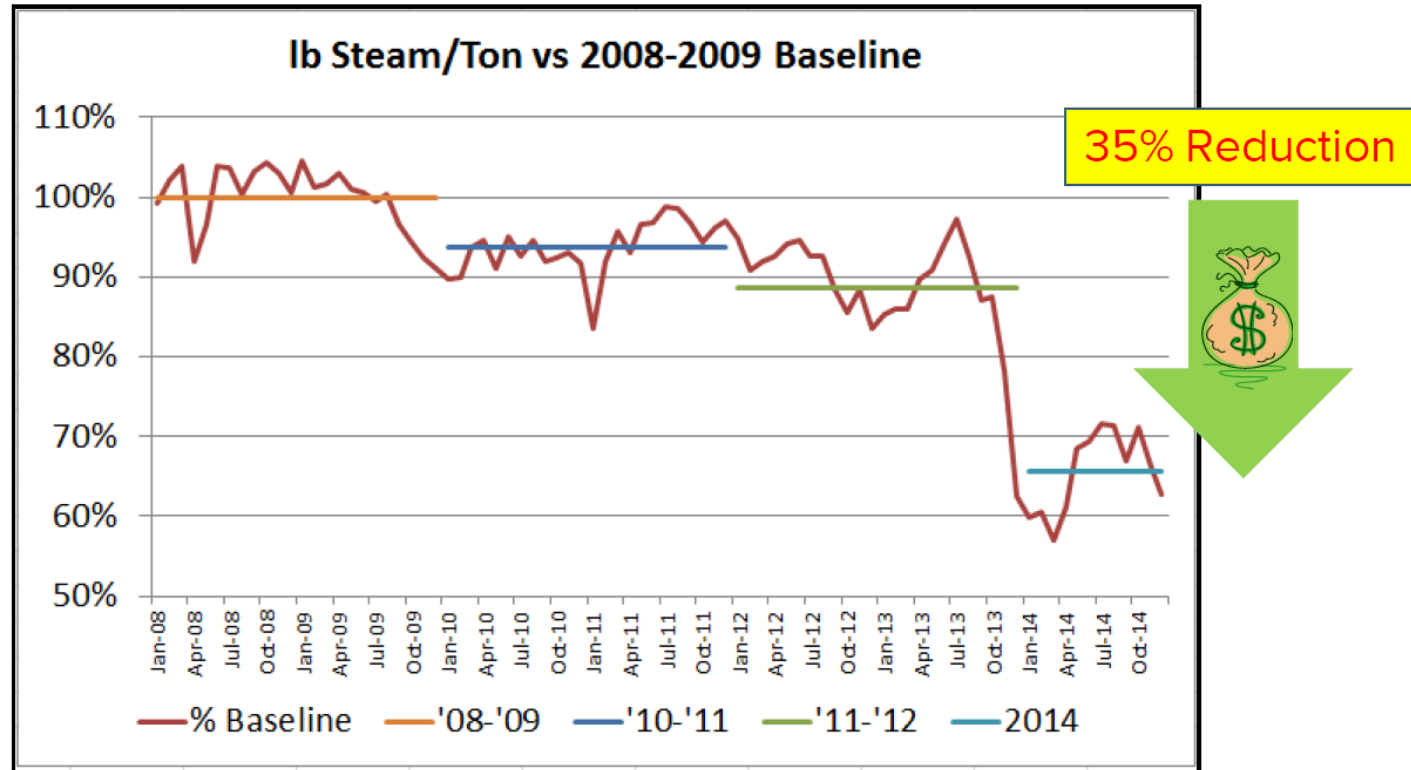


1. 15-Second Refresh
2. Data Cleaned and Summarized

Monthly Totals



In the End, All the Effort IS Worth It



Rick Smith

Richard.SmithJr@ipaper.com

Manufacturing Process Information Consultant
International Paper



Stora Enso

Plant Locations and Operations

Sales totalled EUR 9.8 billion in 2016.. Annual production capacity is 5.8 million tonnes of chemical pulp, 10.1 million tonnes of paper and board, 1.3 billion square metres of corrugated packaging and 5.4 million cubic metres of sawn wood products, including 2.4 million cubic metres of value-added products. The company has 25 000 employees, in more than 35 countries.

Europe: Stora Enso's head office is in Helsinki, Finland. It also has head office functions in Stockholm, Sweden. Most of the group's sales and operations take place in Europe, where they are a leading producer of board, pulp, paper and wood products. Germany and Sweden are the biggest markets for the group's products in Europe. Stora Enso operates an Innovation Centre for packaging in Finland and for biomaterials in Sweden. In Northern Europe they source most of their main raw material – wood – from private forest owners and their forest associates Bergvik Skog and Tornator. They promote forest certification and sustainable forestry. They also actively promote and participate in recycling schemes, especially in densely populated parts of Europe. Consumer Board, Packaging Solutions, Biomaterials, Wood Products and Paper divisions. Number of employees: Finland 6 700; Sweden 5 100; Poland 1 900; Germany 1 500; Russia 1 100; Other European countries 3 700.

Brazil: Latin America is important for Stora Enso to obtain low-cost pulp from tree plantations. In Brazil, they own 50% of Veracel Celulose pulp mill as part of a joint operation with Fibria. Their share of the eucalyptus pulp is mostly used in their European paper and board mills. They also own land, around half of which is former pasture lands planted with eucalyptus. The other half is dedicated to protecting local biodiversity by restoring the natural Atlantic rainforest. Biomaterials division. Number of employees: 480.

Uruguay: The Montes del Plata pulp mill, a 50% joint operation between Stora Enso and Arauco has been in operation since 2014. Stora Enso's share is sold entirely as market pulp, mainly in Europe and Asia. Stora Enso's tree plantations are also utilised as pastures by local farmers through land rental schemes. Biomaterials division. Number of employees: 340.

China: The demand for Stora Enso's products, especially consumer board and packaging, is growing fast in China. In 2016 their new consumer board mill started up in Beihai, in the Guangxi region, where their operations also include eucalyptus plantations. In addition, Stora Enso has three packaging plants and operates one joint operation paper mill. Consumer Board, Packaging Solutions, Paper divisions. Number of employees: 5 100.

Pakistan: Stora Enso owns 35% of an equity-accounted investment in Pakistan. Bulleh Shah Packaging produces corrugated packaging, consumer board, containerboard and paper for the textile, dairy, food and electronics industries in Pakistan. With regard to sustainability they focus on human and labour rights, for example, by auditing and educating suppliers as well as through community investments. Consumer Board division.

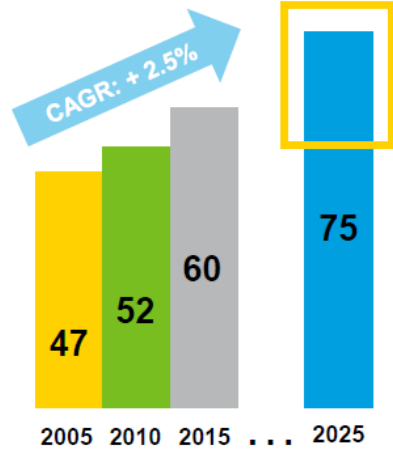
Laos: Stora Enso has a trial plantation in Laos that combines tree-growing with food production. Their focus on sustainability includes an agro-forestry model that enables local villagers to safely grow food on the plantation. Biomaterials division. Number of employees: 130.

USA: Stora Enso has a pilot facility in Danville, Virginia to develop technologies for the conversion of biomass into highly refined sugars and lignin. The production of xylose from hemicellulose will begin in 2017 at the demonstration and market development plant in Raceland, Louisiana. These new technologies will enable the development of sustainable replacements for fossil-based technologies in various industries. Biomaterials division. Number of employees: 90.

Pulp demand keeps growing, especially in segments selected in Stora Enso strategy



Pulp demand to 2025
in million tonnes (Mt)

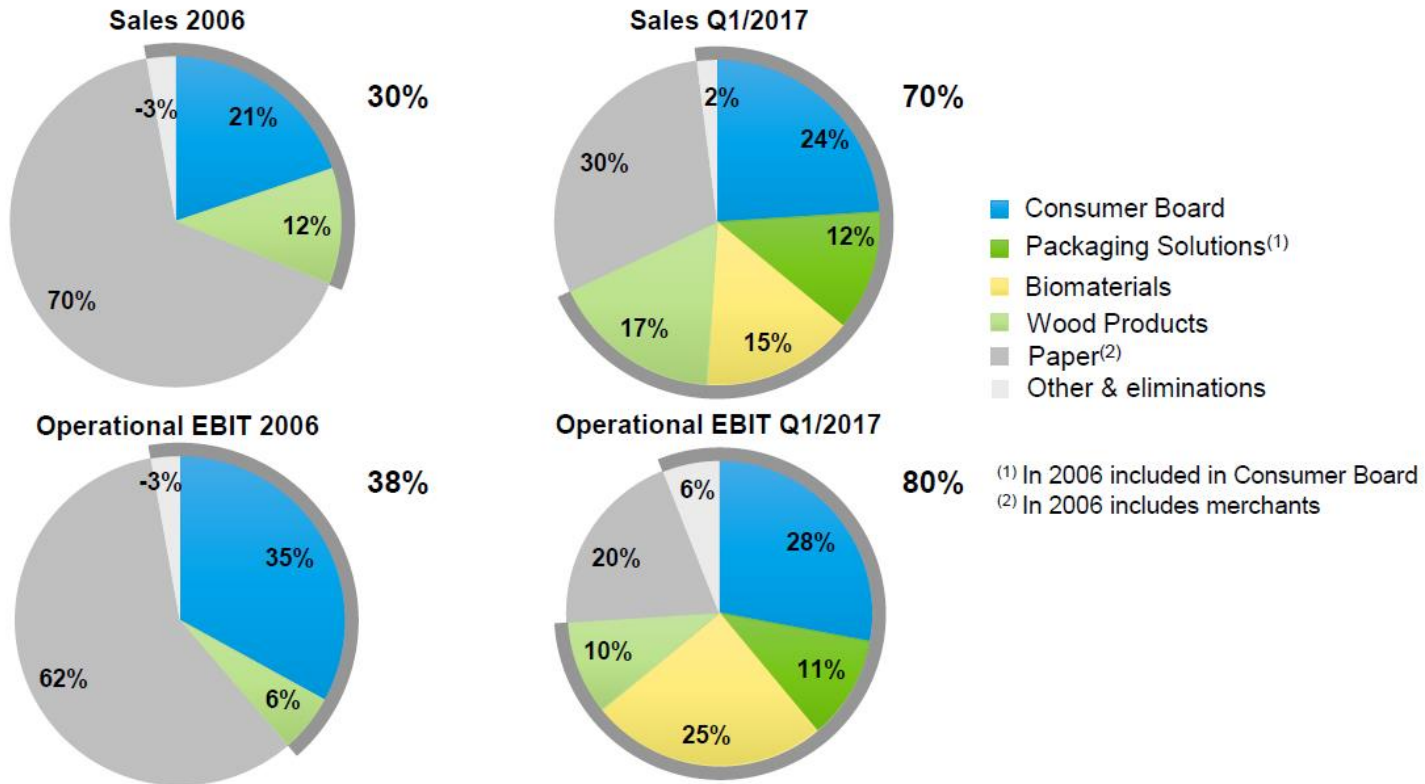


Grade	Mt
Hardwood	9.7
Softwood	1.2
Fluff	2
Dissolving Pulp	2.6

Source: Hawkins Wright, Pöyry, Stora Enso

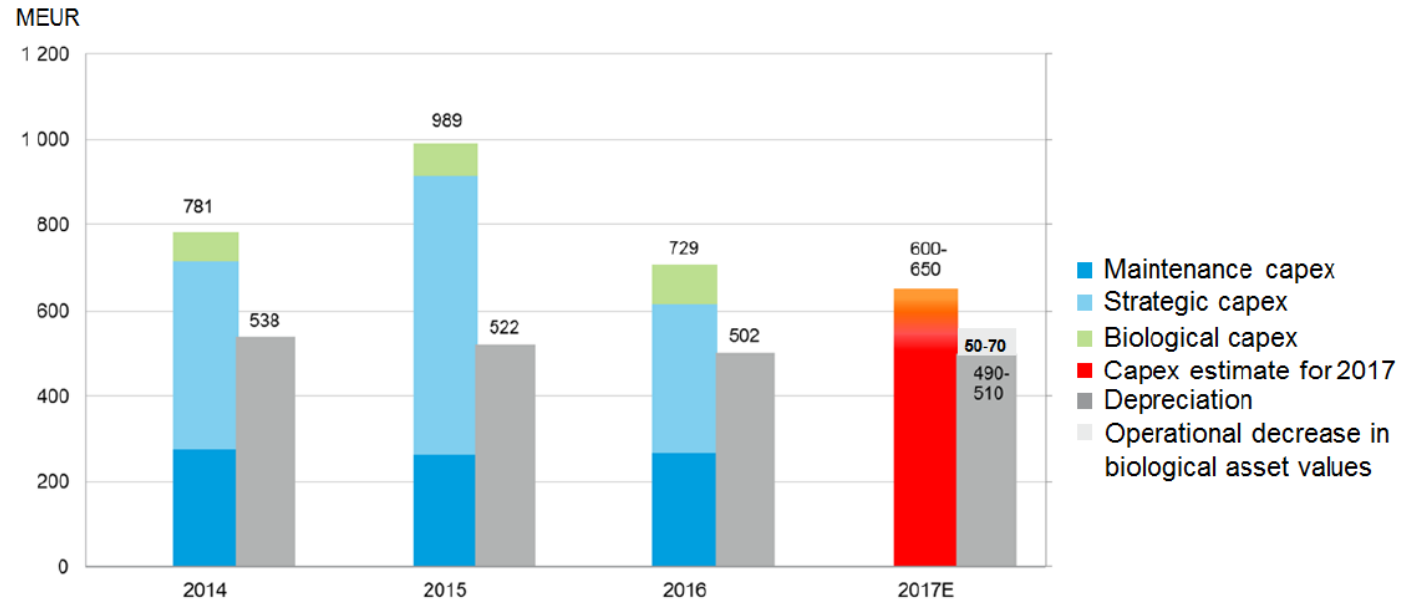
Transformation journey

Growth businesses 70% of sales and 80% of operational EBIT



Capital allocation

Capex on its way to the level of depreciation





Thermo Fisher Photometric Analyser

This laboratory analyzer provides contaminant samples such as silica and iron in minutes rather than hours.

In addition to the labor saving features, this quick response would make it more useful to be used in conjunction with process management systems



Also located in Kemi is a paper and packaging mill called Stora Enso, part of a global organization that provides renewable solutions in packaging, biomaterials, and wood and paper. Their customers include packagers and the construction industry as well as publishers, printing houses, and paper merchants. Close to 92% of the paper products they produce are exported with approximately 6% sent to the US for packaging cosmetics. Packaging solutions are developed from renewable raw materials where every stage from pulp production to material production to recycling is considered part of their sustainable innovation and development process.



Thermo Automated Discrete Photometric Analyzer for Silica and Phosphate at Stora Enso

The laboratory at Stora Enso in Kemi serves in a contract service function measuring a variety of clean and wastewater samples from the surrounding area. This includes three paper plants, a pine pulp mill, a power plant, a Swedish steel company (located about 17 miles from Tornio), and the harbor (which is used for the transportation of oil products). Production process and test samples are measured at the other mills.

Since the same water is used for multiple purposes in this region, testing standards are extremely strict and the lab is checked by authorities at least once per month. To ensure the safety of the local population of 184,000 people, drinking water is tested by laboratory personnel once a week for taste and smell.

A little over four years ago, Arja Saarento, the Development Manager at Stora Enso, was asked to reduce the exposure of her technicians to chemical toxins and as a result, needed to

evaluate and update their analytical procedures. At that time they used a semi-automated photometer for all their testing purposes. In order to switch methodologies, they sponsored a local student who completed a Masters Level thesis and developed all the required testing methods for the industry. Afterwards, they were not only able to eliminate the handling of volatile compounds like thiogluconic acid, but benefitted from a significant time savings once new equipment was installed. They purchased a Thermo Scientific™ Gallery™ automated discrete photometric analyzer to test the 10–20 samples they receive every day and immediately recovered half a day in testing time.

"Silica is an important parameter for a power plant," said Saarento. "It is followed by iron which is the next most important parameter."

Thermo Fisher Gallery at Stora Enso

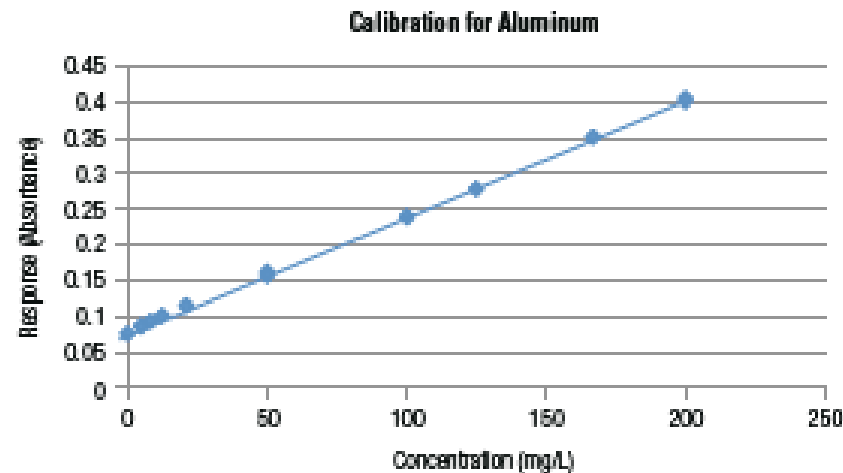
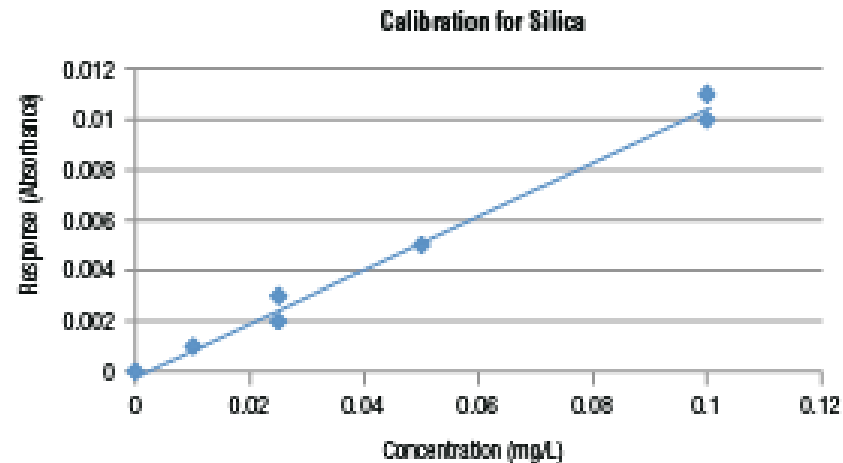
With the Gallery instrument, the lab can complete tests for silica and phosphate in about 40 minutes. Other parameters measured include: aluminum, chlorine, chloride, sulfate, calcium, magnesium, nitrite, and total nitrate.

Five people including Petri Akionemi, Laboratory Manager, rotate and use the Gallery analyzer to complete the required tests.

"A new user can become familiar with all the required tests within one to two weeks, said Akionemi. "It is very easy to learn to use."

Stora Enso added a Gallery photometric analyzer to their laboratory equipment about four years ago. They were not only able to eliminate the exposure to toxic compounds for their technicians but realize a significant reduction in test time from four hours to 40 minutes. The Gallery instrument is not only fast, but easy to use. In addition, it provides reliable results that adhere to the strict standards imposed by authorities so that the water in the region can be used for any purpose and is ultimately safe for human consumption.

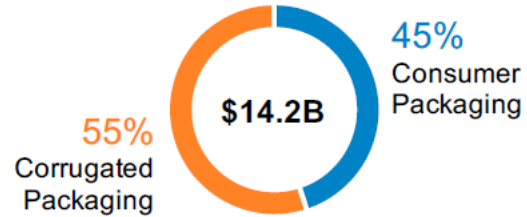
The Gallery analyzer is fast, easy to use, and provides reliable results in minutes.



Westrock

WestRock Overview

FY16 Net Sales⁽¹⁾



FY16 Financial Metrics⁽¹⁾

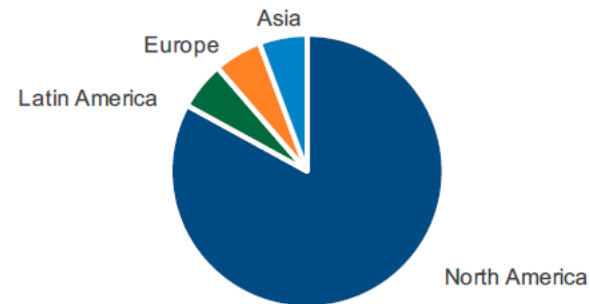
Revenue	\$14,172M
Adj. EBITDA	\$2,270M
Capex	\$797M
Adj. free cash flow ⁽²⁾	\$1,031M
Dividend payout	\$381M
Annual dividend	\$1.60/sh
Leverage (as of 3/31/17)	2.32x



Market-Leading Positions⁽³⁾

#1 North American Consumer Paperboard	#2 North American Containerboard
#2 North American Folding Carton	#2 North American Corrugated Packaging
#1 North American Merchandising Displays	#2 Brazil Corrugated Packaging
#2 Beverage Multi-pack Packaging	

Sales by Geography⁽¹⁾



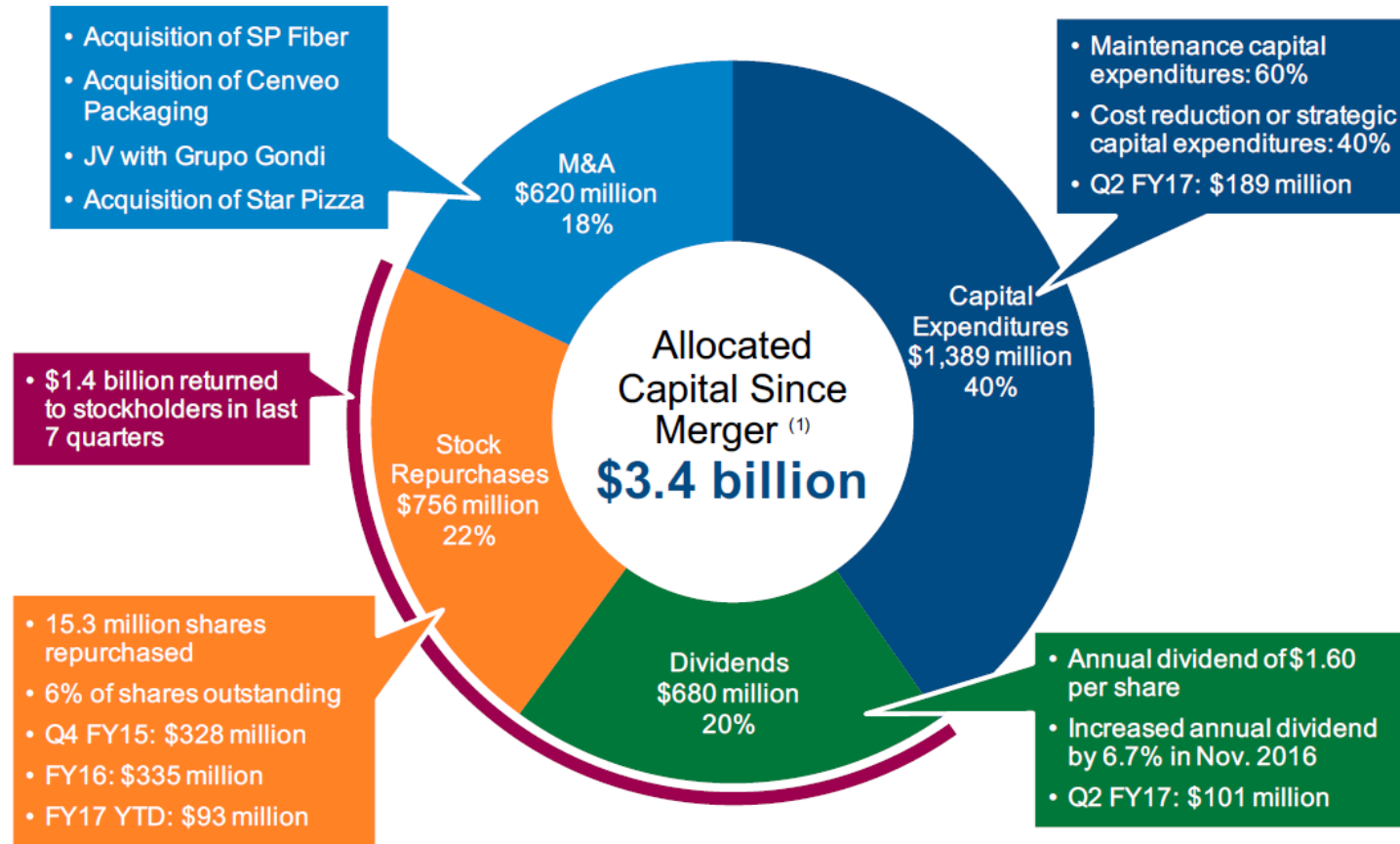
1) Represents trailing twelve months ended September 2016 sales adjusted for separation of Ingevity.
 2) Non-GAAP Financial Measure. We believe the most directly comparable GAAP measure is Operating Cash Flow. See Use of Non-GAAP Financial Measures and Reconciliation in Appendix.
 3) Source of rankings: Company and market research. Rankings are based on capacity.

Update on Q3 FY17 Activities – Executing on our Strategy

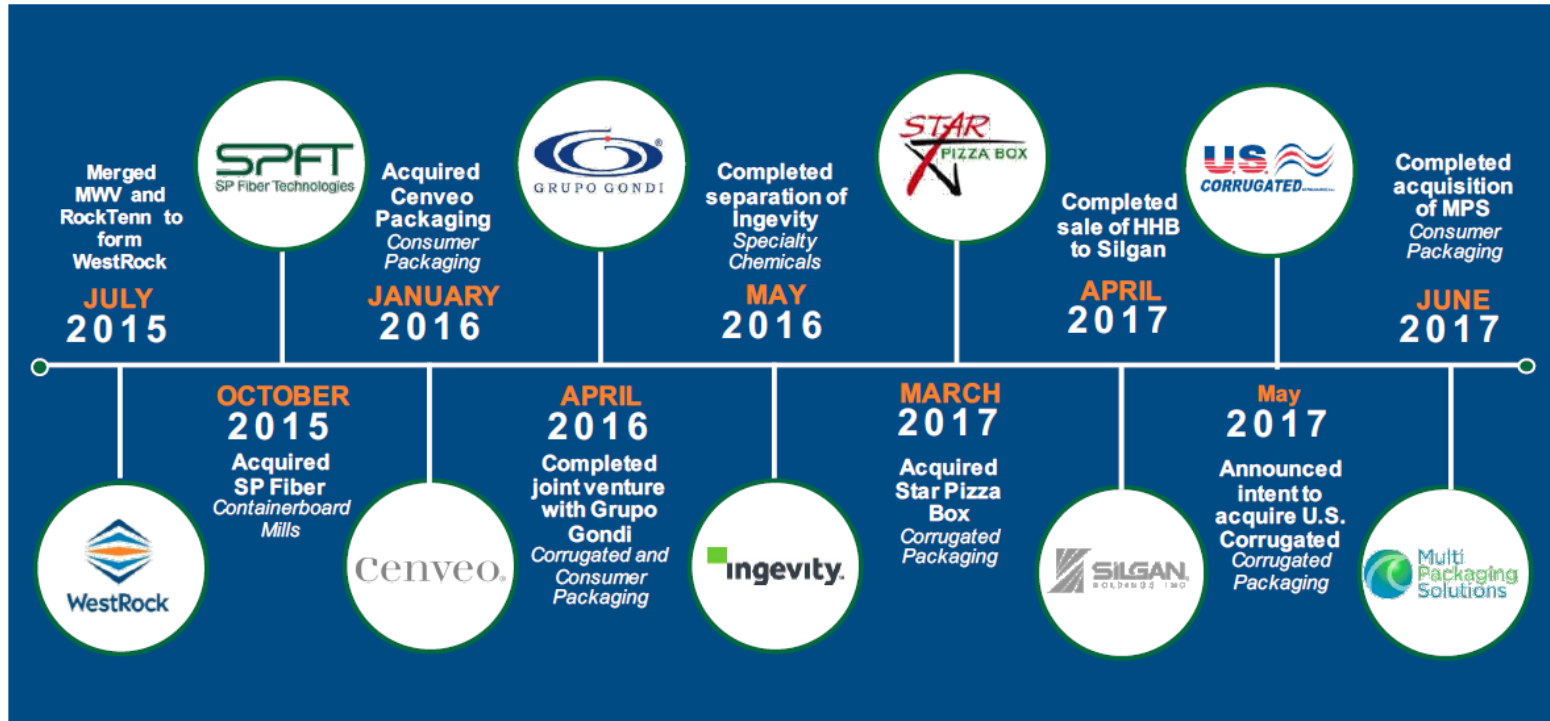
- Completed acquisition of Multi Packaging Solutions on 6/6/17
- Announced acquisition of five corrugated converting facilities from U.S. Corrugated for \$192 million; expected to close in June 2017
 - Expect to integrate approximately 105K tons of containerboard converted annually by the acquired facilities and another 50K tons under a long-term contract with a newly created company from the remaining assets of U.S. Corrugated
 - Purchase price represents an EBITDA multiple of 5 times on a post-synergy basis
- Compared to the prior year, WestRock is seeing continued strong container shipments in its North American corrugated container business
 - April 2017 corrugated container shipments increased more than 6% on an MMSF per day basis and decreased 4% on an absolute basis; April 2017 had 19 shipping days, two less than April 2016
 - May 2017 corrugated container shipments increased almost 6% on an MMSF per day basis and 11% on an absolute basis; May 2017 had 22 shipping days, one more than May 2016
 - The combined April/May 2017 corrugated container shipments increased 6% on an MMSF per day basis and increased 3.5% on an absolute basis; the combined April/May 2017 period had 41 shipping days, one less than April/May 2016
- Grupo Gondi, one of the leading Mexican companies operating in the paper and packaging industry- minority owned by WestRock⁽¹⁾, announced plans to build a state-of-the-art, 350K metric ton, recycled lightweight containerboard mill in Mexico

¹⁾ At 3/31/2017, we held a 25% ownership interest in Grupo Gondi. During April, Gondi bought back a minority investor's stake, effectively increasing our ownership interest to 27%.

Disciplined Capital Allocation Strategy Focused on Value Creation at 3/31/17



Focusing the WestRock Portfolio



Q2 FY17 Adjusted Segment Sales, Adjusted EBITDA and Adjusted EBITDA Margin

Q2 FY17

(\$ in millions, except percentages)

	Corrugated Packaging	Consumer Packaging	Land and Development	Corporate / Eliminations	Consolidated
Segment Net Sales	\$ 2,065.0	\$ 1,554.6	\$ 100.0	\$ (63.3)	\$ 3,656.3
Less: Trade Sales	(72.0)	-	-	-	(72.0)
Adjusted Segment Sales	<u>\$ 1,993.0</u>	<u>\$ 1,554.6</u>	<u>\$ 100.0</u>	<u>\$ (63.3)</u>	<u>\$ 3,584.3</u>
Segment Income	\$ 159.5	\$ 118.8	\$ 17.5	\$ -	\$ 295.8
Non-allocated Expenses	-	-	-	(12.6)	(12.6)
Depreciation and Amortization	145.3	116.3	0.2	2.1	263.9
Less: Deferred Financing Costs	-	-	-	(1.1)	(1.1)
Segment EBITDA	304.8	235.1	17.7	(11.6)	546.0
Plus: Inventory Step-up	0.5	-	-	-	0.5
Adjusted Segment EBITDA	<u>\$ 305.3</u>	<u>\$ 235.1</u>	<u>\$ 17.7</u>	<u>\$ (11.6)</u>	<u>\$ 546.5</u>
Segment EBITDA Margins	<u>14.8%</u>	<u>15.1%</u>			
Adjusted Segment EBITDA Margins	<u>15.3%</u>	<u>15.1%</u>			

Q2 FY17 Packaging Shipments Results ⁽¹⁾

Corrugated Packaging		FY15				FY16				FY17	
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
North America Corrugated											
	Unit										
External Box, Containerboard & Kraft Paper Shipments	Thousands of tons	1,908.2	1,877.1	1,953.0	1,934.0	1,940.6	1,969.2	2,019.8	2,063.5	1,951.8	2,049.5
Newsprint Shipments	Thousands of tons	-	-	-	-	26.0	-	-	-	-	-
Pulp Shipments	Thousands of tons	87.6	59.6	79.6	84.0	80.1	71.1	94.3	89.7	80.1	66.6
Total North American Corrugated Packaging Shipments	Thousands of tons	1,995.8	1,936.7	2,032.6	2,018.0	2,046.7	2,040.3	2,114.1	2,153.2	2,031.9	2,116.1
Corrugated Container Shipments ⁽²⁾	Billions of square feet	18.2	18.1	18.8	18.7	18.7	18.2	18.6	18.9	18.8	18.7
Corrugated Container Shipments per Shipping Day ⁽²⁾	Millions of square feet	297.7	292.6	298.7	292.6	306.3	288.6	291.4	294.5	312.9	291.9
Corrugated Packaging Maintenance Downtime	Thousands of tons	68.5	79.6	104.1	3.1	119.9	68.1	60.5	32.2	115.4	77.8
Corrugated Packaging Economic Downtime	Thousands of tons	53.1	24.5	29.5	83.9	144.0	30.1	71.7	-	0.1	-
Brazil and India											
Corrugated Packaging Shipments	Thousands of tons	166.5	168.2	175.1	171.4	180.2	173.5	166.8	164.8	151.0	171.0
Corrugated Container Shipments	Billions of square feet	1.4	1.4	1.5	1.4	1.5	1.3	1.4	1.6	1.5	1.6
Corrugated Container Shipments per Shipping Day	Millions of square feet	18.7	20.4	19.9	18.1	19.2	18.1	18.7	19.8	20.4	20.2
Total Corrugated Packaging Segment Shipments ⁽³⁾	Thousands of tons	2,162.3	2,104.9	2,207.7	2,189.4	2,226.9	2,213.8	2,280.9	2,318.0	2,182.9	2,287.1
Consumer Packaging											
WestRock											
Consumer Packaging Paperboard and Converting Shipments	Thousands of tons	871.0	875.4	955.3	955.1	876.0	898.3	911.0	929.9	879.0	906.8
Pulp Shipments	Thousands of tons	68.3	45.6	60.7	88.8	73.3	76.1	75.3	68.8	37.5	40.2
Total Consumer Packaging Segment Shipments	Thousands of tons	939.3	921.0	1,016.0	1,043.9	949.3	974.4	986.3	998.7	916.5	947.0
Consumer Packaging Converting Shipments	Billions of square feet	8.6	8.6	9.2	9.2	8.8	9.0	9.5	9.4	9.0	8.9

Key Commodity Annual Consumption Volumes and FX by Currency

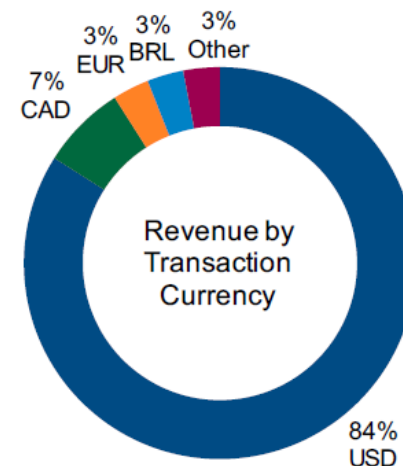
Annual Consumption Volumes

Commodity Category	Volume
Recycled Fiber (tons millions)	4.9
Wood (tons millions)	31
Natural Gas (cubic feet billions)	67
Diesel (gallons millions)	87
Electricity (kwh billions)	4.7
Polyethylene (lbs millions)	35
Caustic Soda (tons thousands)	199
Starch (lbs millions)	523

Sensitivity Analysis

Category	Increase in Spot Price	Annual EPS Impact
Recycled Fiber (tons millions)	+\$10.00 / ton	(\$0.10)
Natural Gas (cubic feet billions)	+\$0.25 / MMBTU	(\$0.04)
FX Translation Impact	+10% USD Appreciation	(\$0.06 - \$0.07)

FX By Currency in Q2 FY17



Weyerhaeuser

Weyerhaeuser Facilities

- Locations of their principal manufacturing facilities as of December 31, 2016, by major product group were:
- Structural lumber – U.S. — Alabama, Arkansas, Louisiana, Mississippi, Montana, North Carolina, Oklahoma, Oregon and Washington – Canada — Alberta and British Columbia
- Engineered wood products – U.S. — Alabama, Louisiana, Oregon and West Virginia – Canada — British Columbia and Ontario
- Oriented strand board – U.S. — Louisiana, Michigan, North Carolina and West Virginia – Canada — Alberta and Saskatchewan
- Softwood plywood – U.S. — Arkansas, Montana and Louisiana
- •Medium density fiberboard – U.S. — Montana

Weyerhaeuser Biomass Activities

- Weyerhaeuser uses significant biomass for energy production at mills. EPA is currently working on rules regarding regulation of biomass emissions. The impact of these greenhouse gas and biomass rules, as well as recent court decisions, on operations remains uncertain. To address concerns about greenhouse gases as a pollutant, the company will :
- closely monitor legislative, regulatory and scientific developments pertaining to climate change;
- adopted in 2006, as part of the company's sustainability program, a goal of reducing greenhouse gas emissions by 40 percent by 2020 compared with our emissions in 2000, assuming a comparable portfolio and regulations
- achieve this goal by increasing energy efficiency and using more greenhouse gas-neutral, biomass fuels instead of fossil fuels; and
- reduced greenhouse gas emissions by approximately 25 percent considering changes in the asset portfolio according to 2014 data, compared to our 2000 baseline.

New Water Limits being Promulgated by States

- State governments continue to promulgate total maximum daily load (TMDL) requirements for pollutants in water bodies that do not meet state or EPA water quality standards. State TMDL requirements may: •set limits on pollutants that may be discharged to a body of water; or •set additional requirements, such as best management practices for nonpoint sources, including timberland operations, to reduce the amounts of pollutants. It is not possible to estimate the capital expenditures that may be required for us to meet pollution allocations across the various proposed state TMDL programs until a specific TMDL is promulgated. In Canada, various levels of government have been working to address water issues including use, quality and management. Recent areas of focus include water allocation, regional watershed protection, protection of drinking water, water pricing and a national water quality index.
- In 2016, Washington State Department of Ecology (WA DOE) adopted human health-based water quality criteria. The EPA subsequently promulgated its own water quality standards for Washington state for the protection of human health for certain pollutants. It is unclear what effect, if any, these rules will have on Weyerhaeuser manufacturing operations in Washington state.

Guide

2018 market of \$330 million for Pulp & Paper. Eight automation supplier's share will be \$25 million or 7.5 % of the total.

This segment includes IIoT related consulting, software and services (ABB definition).

Guide Examples

Product	Supplier Examples
Consulting Relative to IIoT	GE, Kemira, Buckman, Solenis, Andritz, Emerson, OSIsoft, Accenture
Software	GE, Emerson, OSIsoft, IBM
Services	GE, Kemira, Buckman, Solenis, Andritz, /Emerson

Specific Examples
Accenture
Andritz
Buckman
Emerson
GE
Kemira

Accenture Helps set the Course for Large Pulp Company

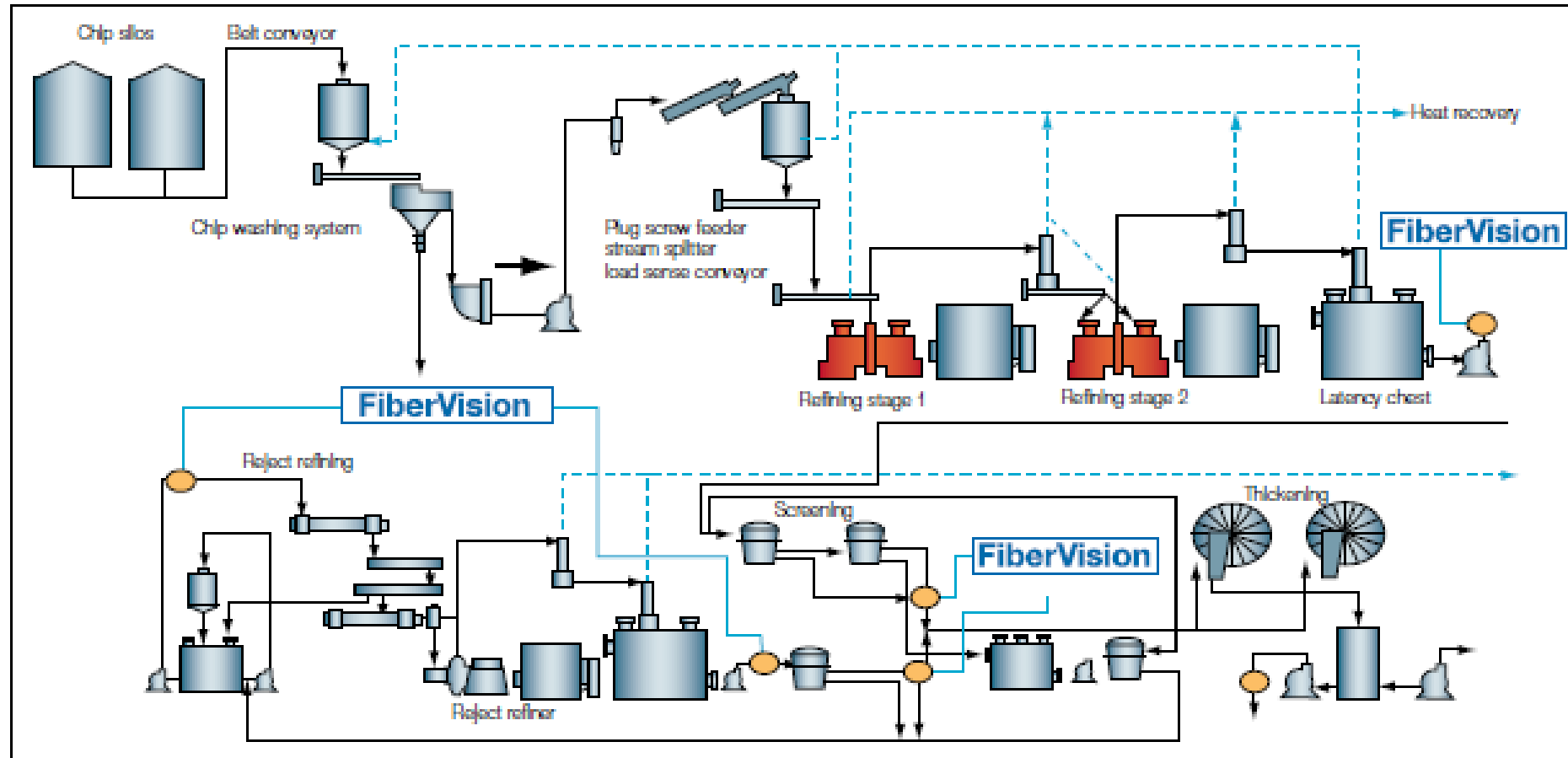
A large pulp company and a world leader in eucalyptus bleached hardwood Kraft pulp production came to Accenture to improve operations. Managing more than one million hectares of renewable forest, the company also maintains approximately 500 thousand hectares designated to environmental conservation.

After just ten weeks, the client and Accenture successfully implemented:

- An assessment of current gaps and opportunities in the client's international operations.
- A process design to align the client's international business processes with its growth strategy.
- A standardized set of commercial and international logistics business rules, allowing the company to better compare business results among business units.
- A roadmap identifying control, profitability and compliance levels, and adhering to local requirements for the company's international offices and trading.

Andritz Fibervision Applications in Paper Processes

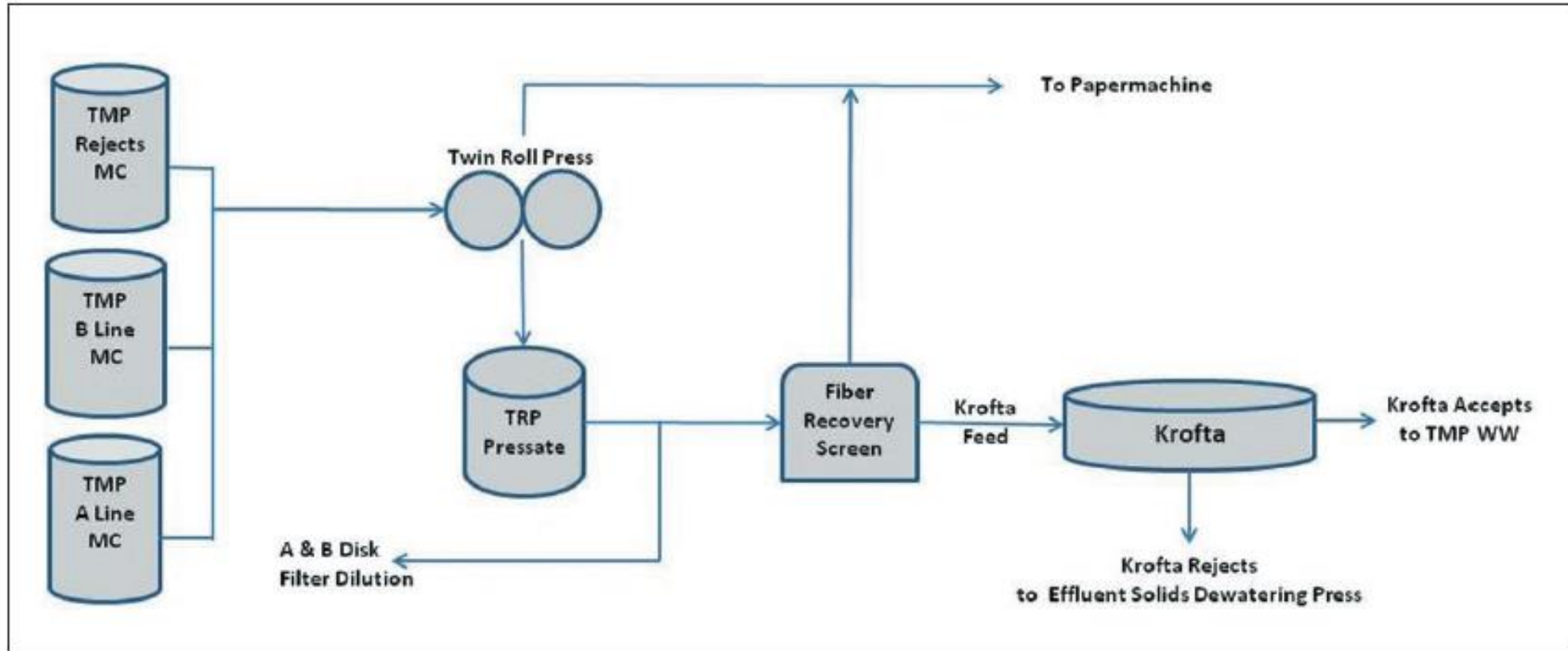
Typical Fibervision Installation



Buckman combines Chemistry and Equipment Knowledge at Ponderay Newsprint

- Ponderay Newsprint Company, located in Usk, Wash., utilizes a unique strategy of combining chemistry and mechanical equipment to concentrate, treat, and remove TMP white water extractives in the pulp mill to reduce chemical costs, increase sheet strength and maximize paper machine production
- Recently, a significant mill wide step change was observed in the process when the strategy of super-clarifying the TMP white water at the Krofta DAF clarifier was implemented. The Krofta has proven to be a valuable process tool, not only for improving the efficiency of the TMP water lock, but also helping the mill achieve energy, water, and fiber loss sustainability goals.
- A Krofta DAF Clarifier was recently configured into the TMP process in an effort to chemically treat and purge the extractives from the extractives-rich TRP pressate stream. A fiber recovery screen was added to scalp the usable fiber and minimize fiber loss at the Krofta . This project has provided a way to reclaim fiber and heat (energy) while reducing water usage helping the mill meet sustainability goals. Prior to the TMP water lock and Krofta implementation, the mill relied primarily on a polymeric pitch control program, which has been reduced significantly providing chemical cost saving.

Optimizing Flotation with Remote Chemical Adjustment



Emerson Digester Process Control is a Demonstration of Deep Process Knowledge

A complete automation solution for production management and quality control of the batch digester process. SmartProcess® COOK has many successful installations for both the Kraft pulping and sulfite pulping processes. The solution includes control of all digester sequences from liquor and chip filling to the final blow. Digester scheduling and model-based cooking control are at the core of the solution. Emerson provides a comprehensive operator interface and production and quality reports, all custom-developed for the mill in which it is installed.

Improvement Highlights

- Variability Reduction: 20 - 40%.
- Production Increase: 2- 10%.
- Steam Reduction: 5 - 15%.

Objectives/Benefits

- Production Management Improvement: optimize digester scheduling, increase yield .
- Quality Improvement: lower kappa variability from batch to batch, decrease rejects.
- Reduce Energy and Chemical Usage: optimize the usage of steam and cooking liquor.
- Improve Downstream Processes: improved washer efficiencies, reduce bleaching chemical costs, improve paper machine efficiency.
- Improve Safety: improve reliability of interlocking, decrease operator work load, enforce standard operating procedures (SOPs).

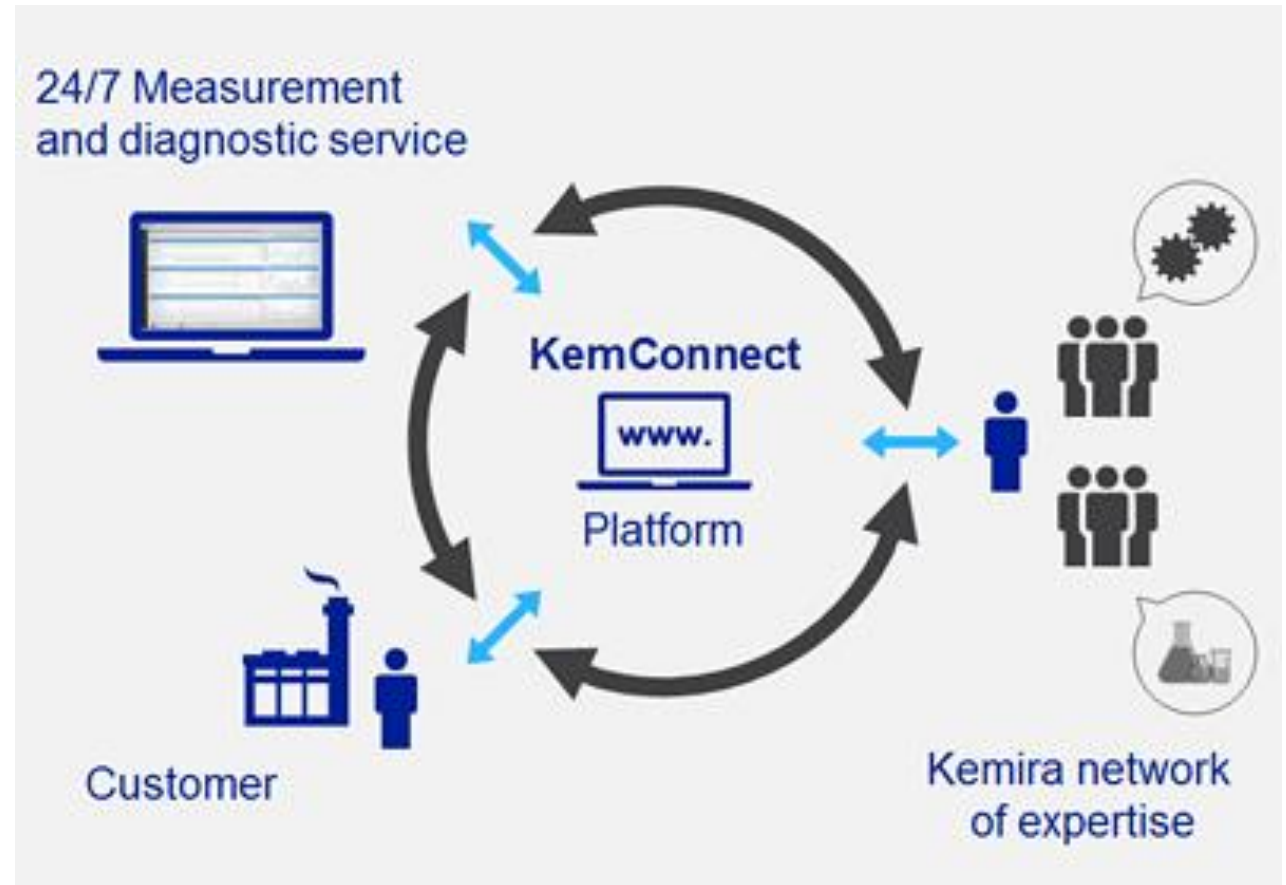
GE and Kemira have Distribution Agreement for InSight Knowledge Management to the Pulp Industry

- GE and Kemira announced a formal distribution agreement, which combines GE's advanced water technology with Kemira's on-site services to deliver a seamless offering to the global pulp and paper industry.
- For the first time, GE's newest and most advanced boiler and utility area cooling product technologies as well as membrane cleaning chemistry and the entire chemistry water portfolio is now available to the pulp and paper industry. Also included are the remote monitoring and diagnostics products—including the InSight* Knowledge Management Solution and TrueSense*—and Novus* polymers for wastewater treatment. Pulp and paper manufacturers also will have access to experts at GE's Service Reliability Center for 24-hour monitoring and support, all backed by both GE and Kemira on-site expertise.
- “Kemira has long been recognized as a technology leader, supplying process, functional and bleaching chemistry solutions to producers of pulp, packaging and board, tissue and towel and printing and writing grades globally. This makes Kemira an ideal partner to bring GE's water products and services to the paper industry and now positions Kemira with the broadest technical and product portfolio in the industry,” said Billy Ford, senior vice president, paper, Kemira. “After a successful 18-month pilot program with GE in the Americas, we have increased the scope of our alliance to offer a comprehensive water treatment solution to the global pulp and paper market.”
- “Pulp and paper mills use vast amounts of water to create an end product while also generating considerable wastewater. GE is eager to bring our water solutions to the pulp and paper industry, and Kemira is well-positioned to bring our advanced technologies to their customers,” said Kevin Cassidy, chemical and monitoring solutions general manager—water and process technologies for GE Power & Water.

Kemira offers Remote Monitoring with Expert Support

Kemira control and monitoring connects smarter process management to a global network of application specialists, chemistry know-how and the right products and technologies. It allows real-time process follow up and ensures that the chemical additions are at the optimal level. Kemira KemConnect is the basic foundation for Kemira's smarter process management in all applications.

This includes remote monitoring of odors, wastewater, water, and sludge



Kemira Total Chemistry Management

Kemira Total Chemistry Management (TCM) is an approach where a single chemical vendor supplies a full scope of chemicals to a paper or board mill. TCM calls for close cooperation between the chemical supplier and the customer, enabling an overall approach to the production process. This in turn results in improved operational efficiency and competitiveness as well as reduced costs.

Kemira is a pioneer of TCM with a strong commitment to the pulp and paper industry. They have unique expertise covering the whole process from pulping to coating, and use this expertise to create value both in the customer's production process and for the final product.

Kemira TCM approach allows their customers to have direct access to their best-in-class application knowhow and technical service as well as new innovations from their R&D. TCM scope may also include equipment for chemical addition as well as control and monitoring technologies.

Key customer benefits:

- Innovation and application expertise
- Reduced costs
- Operational efficiency
- Full scope chemical supply
- Technologies for chemical addition, monitoring and control

Control

Control

Product	Supplier Examples
DCS, SCADA, Edge Computers, Other Automation	ABB, Yokogawa, Emerson, Andritz, Buckman, Honeywell
<i>This includes both the OEMS and the actual suppliers. For OEMS such as Andritz the revenue potential depends on whether it is the primary or secondary supplier.</i>	
Transmitters, transducers, switches, complimentary products and accessories.	ABB. Honeywell, Yokogawa, Schneider Electric , Rockwell, Klay, Ashcroft, Moore, Novus
<i>Some of the suppliers such as ABB are integrated and supply guide, control and measurement. Others such as Klay and Moore have more limited product offerings</i>	


Specific Examples
ABB
Andritz
Buckman
Emerson
Honeywell

ABB Collaborative Production Management System at KPAQ

- KPAQ Industries purchased a system from ABB to improve efficiency at its Kraft paper mill in St. Francisville, La. This two machine mill makes virgin unbleached pulp and paper products.
- KPAQ decided on a collaborative production management (CPM) system from ABB, which has been successfully integrated into KPAQ's existing ERP system, various production systems and accounting systems to help with sales/order management, production planning, production management, decision support and product tracking.
- A key benefit of using ABB's CPM system is that KPAQ can streamline its entire operation, handling all mill functions in one comprehensive system to have a single point of access to all production data. The system also can expand to correspond with KPAQ's production growth
- The mill has been able to reduce shorts and overruns by providing real-time accuracy of block/run/order status, reducing manual calculations, according to Jeff Rake, president.. "Shorts are very seldom an experience anymore," he said. "And we can apply overruns to future products." Improved trimming operations means they are able to identify and produce sizes that are most likely to sell as trim rolls (the highest-priced alternative).

Andritz Automation provides Remote Monitoring and Control for Pulp and Paper Plants

Andritz Automation instruments, helps operators achieve the best information about their operations. Better information means better control and the resultant benefits.

- Control and measure crucial parameters in key pulping process areas 
- Reduce energy consumption
- Improve frequency of measurement
- Minimize equipment wear and tear
- Achieve more consistent operation
- Produce higher value products

FiberVision is a state-of-the-art online sensor that helps pulp operations reduce specific energy consumption, achieve higher value product, improve frequency of measurement and decrease down time.

Buckman Controllers Configured with OnSite

Controllers and their configurations:

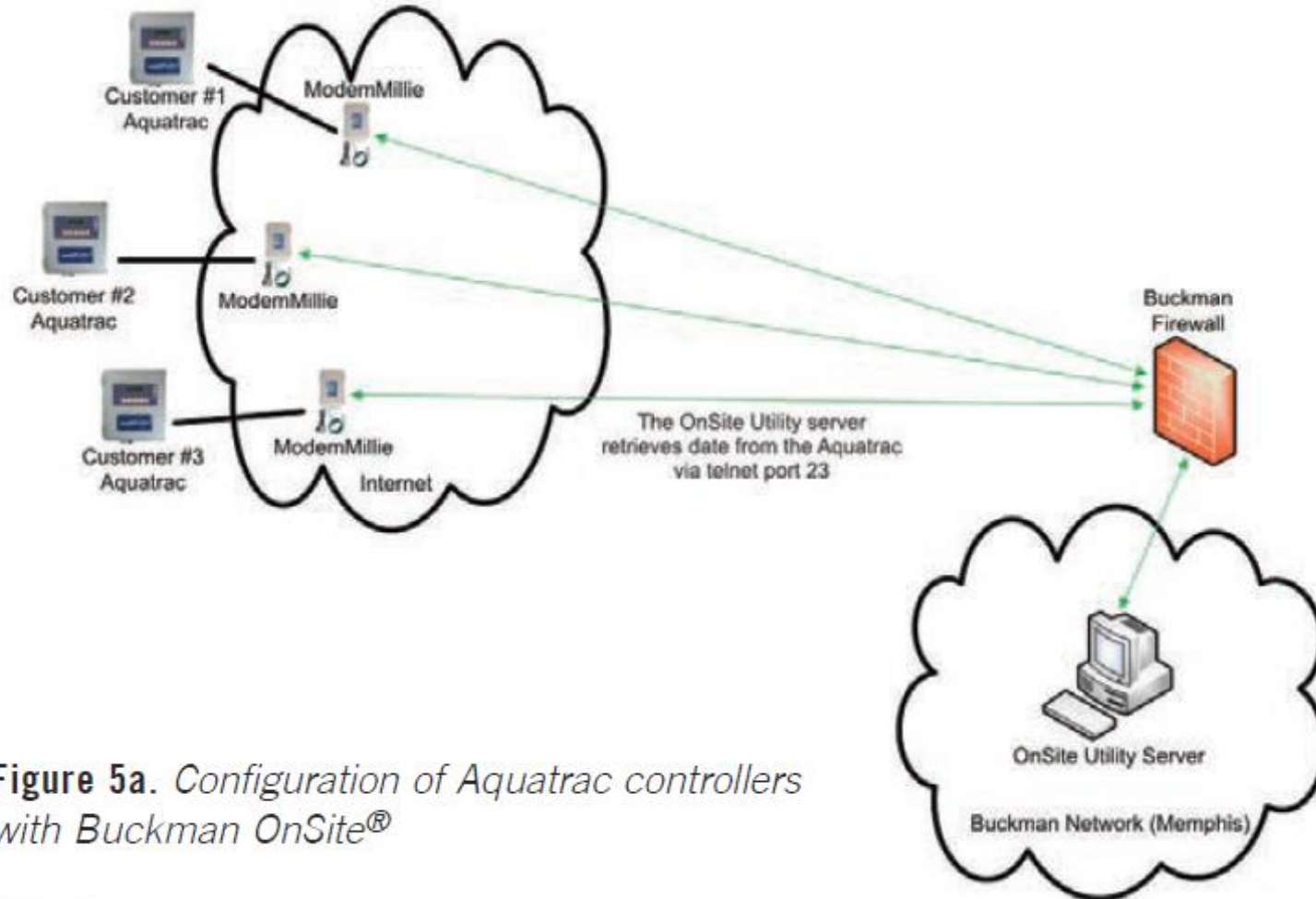


Figure 5a. Configuration of Aquatrac controllers with Buckman OnSite®

INTEGRATING EZE MONITOR® AND BUCKMAN ONSITE®

EZe Monitor can be equipped with several different types of online process controllers (data collection devices). The devices are typically connected via cellular modem, or in some cases may be connected to the customer's network. It couples a powerful multi-I/O platform with analytical sensors and extensive communications technologies. These flexible configuration options make setup and configuration easy and fast.

Automation System Layout

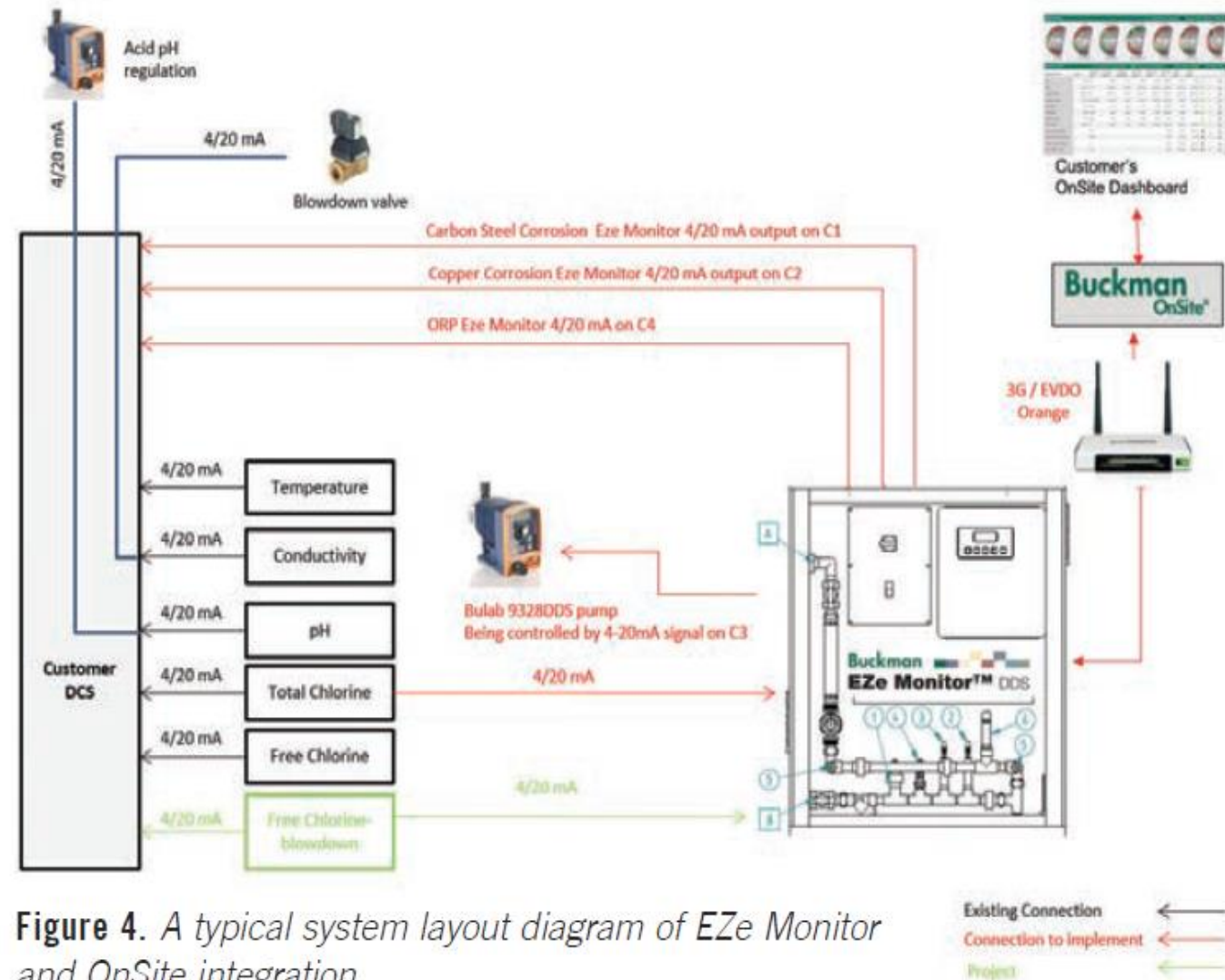


Figure 4. A typical system layout diagram of EZe Monitor and OnSite integration

Emerson Digester Control Systems

SmartProcess® Cook for Batch Digesters Background

At the head of the pulp and paper mill's fiberline is the batch digester house. This process area greatly effects quality and efficiency in downstream operations. In a batch digester house, minimizing pulp quality variation while maintaining production goals is a very tough challenge. Variations in wood properties and cooking liquor strengths must be compensated for. Chip and liquor filling, temperature rise, and digester cooking must be carefully controlled to maintain consistent pulp quality. Sequencing of digesters must be managed to prevent process upsets and hazardous conditions. In order to meet production targets, digester blow schedules must be maintained and optimized. It is easy to see why controlling the operations in a batch digester house is so demanding.

- SmartProcess® COOK controls chip and liquor filling of the digesters to insure proper chip packing and alkali/wood and liquor/wood ratio. The digester temperature rise is carefully controlled to bring the digester to the cooking temperature target. An adaptive cooking model controls the cook. The digester pressure is controlled throughout the cook with the blowback valve.
- The cooking model determines the completion of the cook. SmartProcess® COOK controls the valves for the digester blow sequence while monitoring process levels to insure a smooth and safe sequence. The application can be setup for operators to confirm digester sequence steps such as blow, uncap, fill, and steam. Transitions to these steps can be completely automatic if desired.
- The Digester Scheduling control manages digester schedule with respect to the limitations of the digester house equipment and available steam supply. The digesters are synchronized in order to preserve minimum intervals between cooking phases, prevent blow collisions, and meet production rate targets.
- Pulp quality is controlled by a model-based cooking algorithm which determines the required alkali-to-wood ratio and the length of the cook. SmartProcess COOK can incorporate online analyzers, if available, for Kappa No. and liquor strength

SmartProcess® Cook primary control modules:

- Chip Filling Control - Blow Control
- Liquor Filling Control - Digester Scheduling
- Steaming Control - Steam Limiting and Smoothing Controls
- Cooking Control - Pulp Quality Control
- Relief Control - Grade Change Control

Emerson Pulp and Paper Transmitter

With its compact size and rugged construction, the Rosemount 2090P Pulp and Paper Pressure Transmitter is ideal for the pulp and paper industries. This lightweight transmitter is engineered with a 1 in. flush mount compatible with PMC process connection or 1 1/2 in. threaded mounting connection. This transmitter can be calibrated to ranges as low as 0 to 1.5 psi (0.1 bar) and as high as 0 to 300 psi (20.7 bar) for reliable measurement capabilities.



Finch Paper using Honeywell Experion PKS

Finch Paper LLC is a pulp and paper mill in Glen Falls, NY. The company produces approximately 700 tons of high-quality uncoated text and cover, opaque, and digital papers each day. According to - Steve Padasak, Engineering & Process Control Superintendent, Finch Paper LLC — Finch Paper is in the middle of a 10-year plan to upgrade control technology from one end of their mill to another. With Honeywell's assistance, the money they save or make from our improvements is funding the next phases of the project.

Migration of the powerhouse HMI was part of Finch's overall program of control system modernization based on Experion PKS. In addition, the company was already engaged in a service contract with Honeywell and had first-hand experience with its people and their capabilities. The Experion HMI solution provides access to mill data that was not available prior to the upgrade. The operator stations offer sequence of events alarm summary, a large number of standard displays, and the ability to connect separate plants together for collaboration and real-time decision-making. In addition, Honeywell's Uniformance™ PHD software is now used as the historian to log plant data. PHD data can be called up directly in Experion trends alongside locally collected history to obtain business related information and lab data.

The following results have been achieved at the Glen Falls mill:

- Better efficiency and productivity, with operators able to make faster, more informed decisions.
- Ability to input process data and access as needed with Honeywell Uniformance historian providing management with a way to track and manage their business
- Quick transition to the new HMI due to the use of similar methodologies for system graphics, layout and design.
- Improved operator confidence directly correlated to increased effectiveness.
- Increased connectivity and information sharing capability throughout the mill, resulting in enhanced business performance.

Ontario Pulp Mill using Honeywell Control Performance Monitor

A major pulp and paper company's mill in Ontario, Canada produces both high quality uncoated paper and market pulp on three machines. The facility produces 279,000 MT of value added paper and 99,000 MT of market NBSK. The site employs 698 people. A global leader in newsprint and uncoated groundwood papers, the organization chose to implement Control Performance Monitor as part of their continuous improvement program. Control Performance Monitor's 6 Sigma performance analysis tools allowed them to refine controller maintenance and pinpoint opportunities for improvement. The company was looking for a way to improve process performance throughout the mill. Historically, maintenance personnel based control loop maintenance on operator complaints. The loops giving the operators the greatest amount of trouble were given priority.

- The company chose Control Performance Monitor to help the company reduce process variability by following the 6 Sigma methodology:
- Define: Find the inadequacies in the existing control maintenance programs and identify new methodology and work practices. Target areas with the largest Return on Assets (ROA) potential.
- Measure: Measure or benchmark the current control performance and variability across each process unit. Identify the lost opportunity in each unit from inadequate exploitation of the control infrastructure.
- Analyze: Analyze the data, process and current control configurations, operating philosophies and maintenance practices. Determine the root cause where problems exist.
- Improve: Make necessary performance improvements as identified. Tune or redesign controllers. Maintain valves and sensors. Modify standard operating procedures and maintenance practices.
- Control: Adjust maintenance work practices. Train staff with the tools and methodology. Revisit the program to ensure

Measure

Measurement Products and Suppliers

Product	Supplier Examples
Liquid Pressure, Flow	FCI, Intek, Novus
Liquid Contaminants and Concentrations	Yokogawa, Aquar, Thermo Fisher
Air, Gas Flow, Pressure	Kurz, Sierra Instrument
Gas Contaminants	Thermo Fisher
Powder, Recycled Paper Flow Including Volumetric and Gravimetric	Berthold, Magnetrol
Powder Size, Chip Moisture and Other Parameters	Berthold, Valcom

Specific Examples
Ashcroft
Berthold
FCI
Emerson
Intek
Kurz
Magnetrol
Thermo Fisher
Yokogawa

Ashcroft Pressure Instrumentation

- Durable pressure instrumentation will meet the unique hazards of measuring the pressure of caustic chemicals, and the safety requirements established to protect operators and equipment.
- With a choice of robust wetted materials, pressure switches and gauges can directly monitor a variety of challenging media. In extreme conditions, diaphragm seals will ensure compatibility with black liquor and other harsh chemicals, while isolation rings make it possible for slurries to pass through pipelines without fouling the pressure measuring instruments.
- With these devices in place, down-time due to corrosion and clogging can be quickly eliminated.

Berthold Radiometric Belt Weigher for Recycled Paper

- The processing of recycled paper involves cooking of the paper to recover lignin.
- In order to control the amount of paper that enters the cooking process, a radiometric belt weigher is used. This measures the bulk flow noncontacting and non-intrusive, without any moving parts.
- Installations are possible on all conveyor types, e.g. belt conveyors, drag chain conveyors, bucket conveyors or screw conveyors.
- The measurement is highly accurate and repeatable, so that there is no need for re-calibrations.

Berthold using Microwave Technology to Measure Chip Moisture

- The determination of dry fibrous material is important to keep the boiler efficiency constant. Especially in the summer time, when the wood chip stockpiles are moistened the water concentration can vary drastically. The Micro-Polar system based on non contacting microwave transmission technology is used to measure the moisture content online. With an emitting antenna below and a receiving antenna above the belt, the microwave penetrates the whole material cross-section leading to high representative, real-time information. An additional radiometric system can be used to compensate for variations in bulk density and load.

E+H pH Measurement in Fibrous Media

Orbipore CPS91 is the analog specialist for pH measurement in fibrous media or media with a high content of suspended solids such as dispersions, precipitation reactions or emulsions. The open aperture prevents fouling and guarantees the most reliable measurement under extreme process conditions

Benefits

- Open aperture for application in heavily soiled media
- Low maintenance and long service life due to stabilized gel filling
- Not affected by fluctuations in pressure and temperature

Emerson Magnetic Flow Meter addresses Variability in Paper Quality

- Boise-Cascade was experiencing variability in paper quality due to erratic pressure screen reject flows. In an attempt to reduce this variability, they minimized analog damping of the existing flowmeter. Due to instability in this measurement, they did not achieve the desired results.
- Based on these issues, the mill decided to test new magnetic flowmeters from multiple suppliers that would provide stable measurement with minimal damping. The results of this test would determine the plant standard for magmeter applications. SOLUTION After discussions with many different manufacturers, the mill chose two meters to test in the pressure screen reject flow application - a Dual-Frequency magnetic flowmeter from one manufacturer, and the Rosemount 8712/8707 High Signal Magnetic Flowmeter System. To meet the desired result of improved process control, all Magmeters in this application were set with their lowest analogue damping.
- The results from testing showed the Rosemount 8712/8707 High Signal Magnetic Flowmeter outperformed the Dual-Frequency magmeter supplied by the other manufacturer, reducing the variability by 85% when compared to the original measurement. The High Signal technology generates a magnetic field ten-times stronger than the Dual-Frequency meter from the other

FCI Thermal Dispersion Level Switch for Black Liquor

- Fluid Components International (FCI) designs and manufactures thermal mass flow meters, flow switches and level switches for industrial process measurement applications utilizing patented thermal dispersion flow measurement technologies.
- The difficult and challenging interface application of black liquor and soap is solved by using FCI's thermal dispersion technology to differentiate between the black liquor and soap at the high and low levels in the skim tank.
- FCI's FLT93S FlexSwitch[®] level switches feature a rugged, no moving parts design with 316L all welded stainless steel that is not prone to the typical failure of mechanical flotation devices or dp level systems. The FLT93S FlexSwitch also feature two field adjustable alarm relays and is temperature compensated for wide temperature changes in process media.

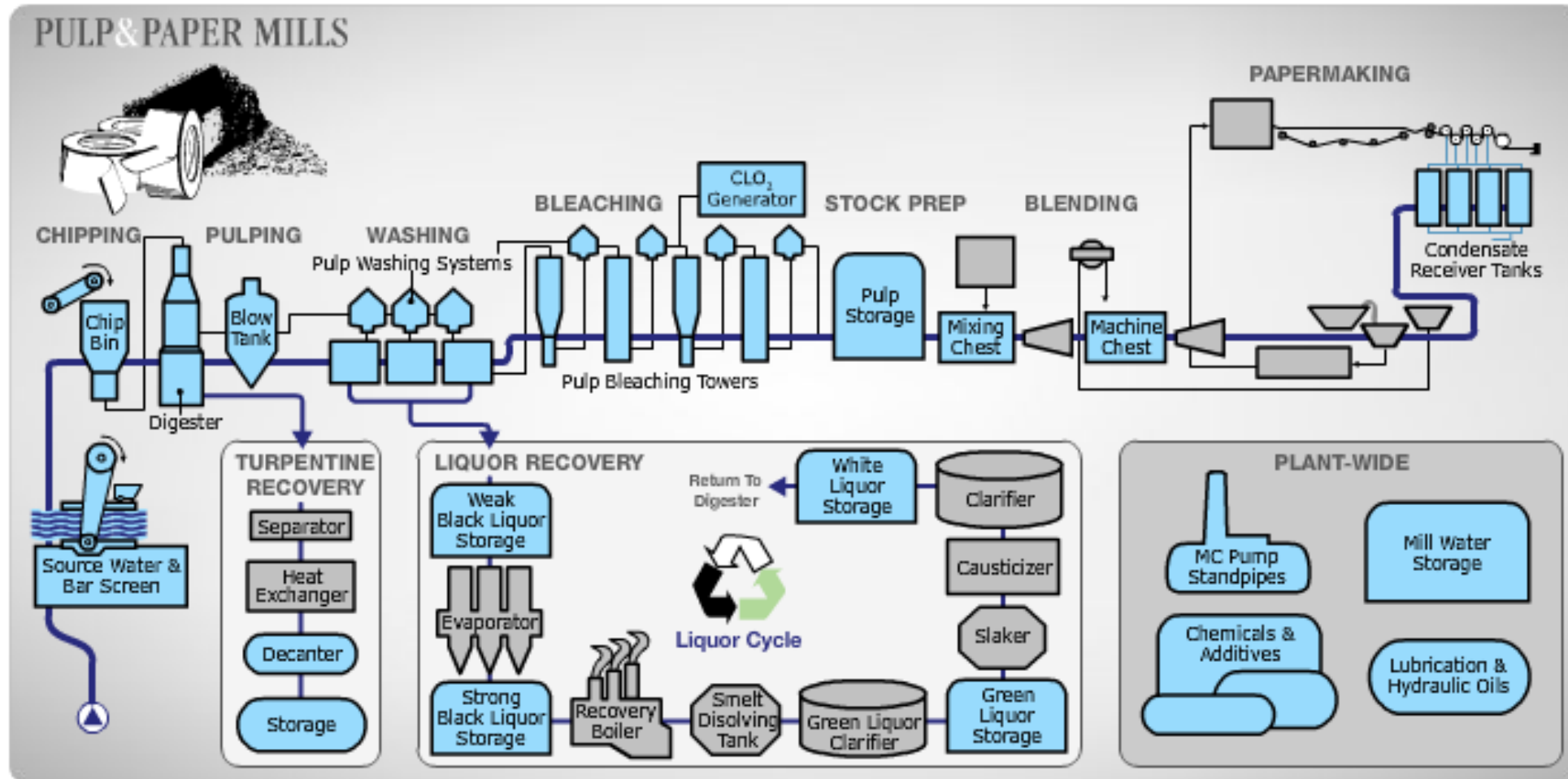
Intek Flow Meters and Switches for P&P

- The addition of small amounts of specialty chemicals and dyes in pulp and paper processing is an ongoing problem. With low flow measurement capability, chemicals that might have previously been added all at once to a batch can now be fed continuously at very low flow rates.
- A manufacturer of paper products purchased a *Rheotherm* flow meter to measure the low flow of a hardening agent used in a two-component primer. Previously, the primer was premixed in a large tank at the start of the paper coating process. This worked well until there was an interruption in the process. With the hardener already added, the primer would set up. Once the primer hardened, it would have to be chipped out of the tank and a new batch made. This is a time consuming procedure and expensive problem.
- With the unique low flow capability of the *Rheotherm* flow meter, the customer could revamp his process so the hardener is added continuously at a low flow rate, just before the primer is applied to the paper. If the process stops, the hardener flow can be stopped and no product is wasted. The typical flow rate is less than 150 ml/min
- A large paper company called Intek after being fined by the EPA for creating foam in a local stream. Normally, their treated wastewater has a defoamer added before it is discharged into the local waterway. However, the first time an undetected failure of the defoamer pump occurred, they had a problem. The addition of a *Rheotherm* flow switch to this critical service has prevented additional occurrences and fines.
- Several large paper companies use *Rheotherm flow* meters to measure their low flow rates of various dyes. Dye flow rates ranging from less than 1 to several hundred cc/min are repeatedly measured, and the flow sensors easily withstand solvent or water flushing.

Kurz Flow Meter Application on Gases in a Pulp Mill

- Measuring combustion air to a boiler
- Measuring primary/secondary/tertiary air to a recovery boiler
- Monitoring stack flue gas
- Measuring stack emissions
- Monitoring digester gases and aeration air
- Measuring inlet combustion air to gas turbine generator sets
- Controlling tight fuel-to-air tolerances, such as with natural gas
- Measuring turbine exhaust gases
- Measuring overfire and underfire air

Magnetrol Provides Level and Flow Control (all processes in blue)



Magnetrol Level Switches for Pulp Chips

- The majority of mills make pulp stock from wood chips. Mill chippers produce uniformly sized wood pieces that pass through vibrating screens to further sort for size consistency. Chips are stored in large silos and conveyed to the chip bin where they are pre-steamed prior to entering the pulp digester.

Level switches monitoring pulp chip levels are designed exclusively for bulk solids. Level switches monitor high and low pulp chip levels, actuate filling operations, and trigger alarms in the event of plugged flow or overflow conditions. Level controls must contend with dusty atmospheres, steam, vapors, and the chips changing angle of repose.



Thermo Fisher Density Gauge

- Eliminate the need for pipe modification and process downtime with the innovative Thermo Scientific™ ConsistencyPRO Density Gauge for Consistency in Pulp and Paper. It redefines the standard for consistency measurement. The system is completely non-intrusive and is not affected by pressure, viscosity, corrosives, or abrasives. The system simply mounts around the existing process pipe. For ease of installation, the ConsistencyPRO combines an improved scintillation-based detector with the power of a smart transmitter in an explosion-proof housing.



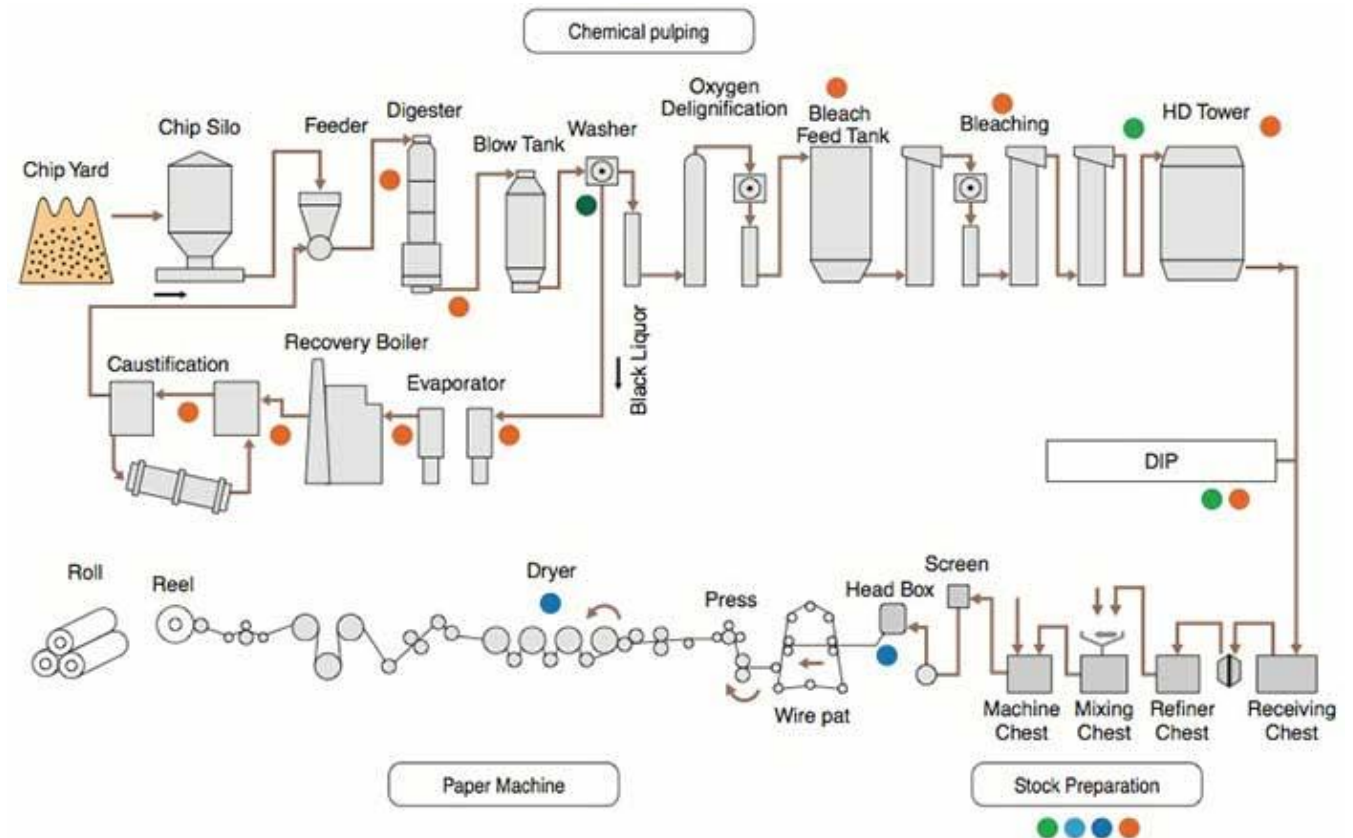
Thermo Fisher TRS Monitor



- Measure total reduced sulfur (TRS) using field-proven, pulsed fluorescence technology with Thermo Scientific™ Continuous Emissions Monitoring Systems (CEMS). Designed to meet the needs of the pulp and paper industry in complying with the regulatory requirements of 40 CFR part 60 as set forth by the U.S. EPA.
- In order to measure TRS in accordance with the federal regulations, the sample must be measured on a dry basis and be corrected to a fixed Oxygen (O_2) content. This is accomplished by extracting the sample from the process using the Thermo Scientific PRO902C Low-Flow Dilution Probe.
- First, the sample is passed through a water removal device to provide a dry sample. The oxygen content is measured and the sample is diluted to an appropriate level, depending on the site conditions.
- The diluted sample is sent through a sample line to the instrument cabinet and passes through a selective scrubber where Sulfur Dioxide (SO_2) is removed and TRS is allowed to pass. Next, the sample is routed to a thermal oxidizer where the TRS compounds react with O_2 under high temperature, and is then sent on to the Model 43i Pulsed Fluorescent SO_2 analyzer.

Yokogawa Measures Flow and Constituents

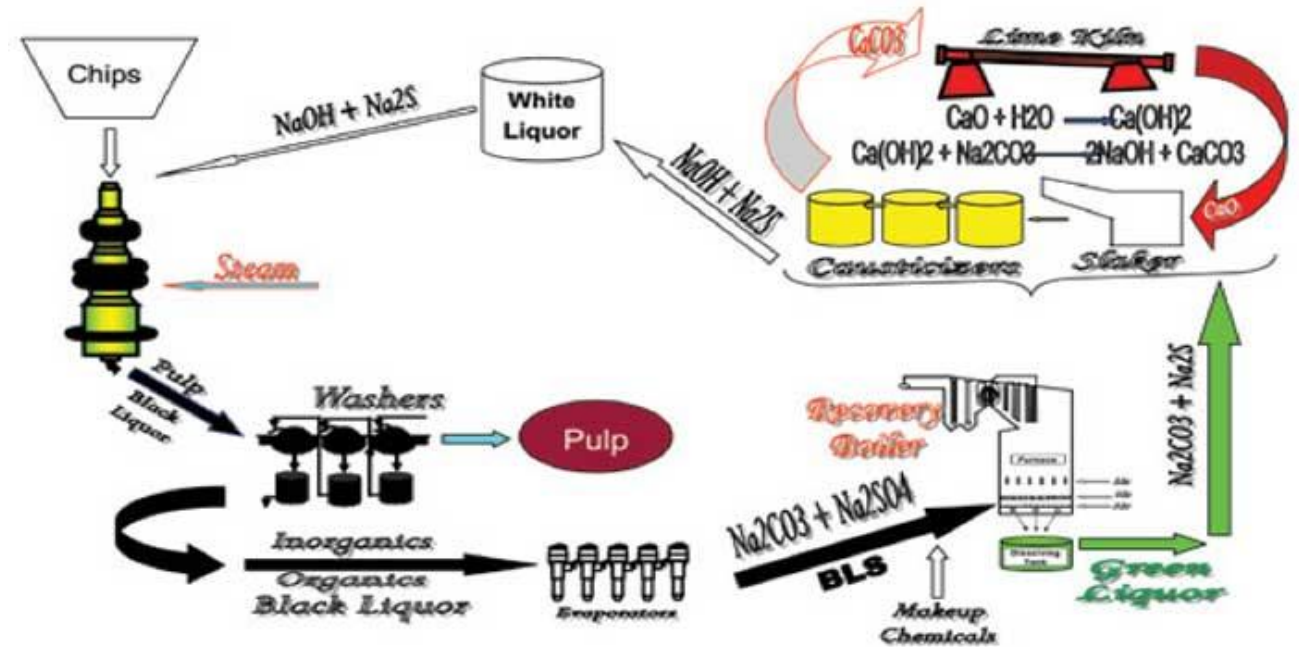
Yokogawa has developed the process measurement & control product line-up with the collaboration with pulp & paper industry based on the process knowhow and experiences. Yokogawa's wide and powerful sensors line-up are available with "best-fit-model selection" for every process in the pulp & paper plant, and delivers stability, precision, robustness in process measurement even under the challenging application such as digester and washer in chemical pulp plant. The high performance and intelligent controller helps to achieve higher quality production control in the pulp and paper.



Yokogawa Measurement of Alkali Concentration

Yokogawa recommends using the ISC450G Inductive Conductivity sensor to measure the alkali concentration in black liquor because the sensor has proven to be rugged and reliable with a minimum of maintenance needed. The Yokogawa ISC40G sensor comes in two different chemical resistant materials PEEK and Teflon, along with various process connection capabilities. This allows for a wide range of flexibility for installation from threaded to flanged to flow thru.

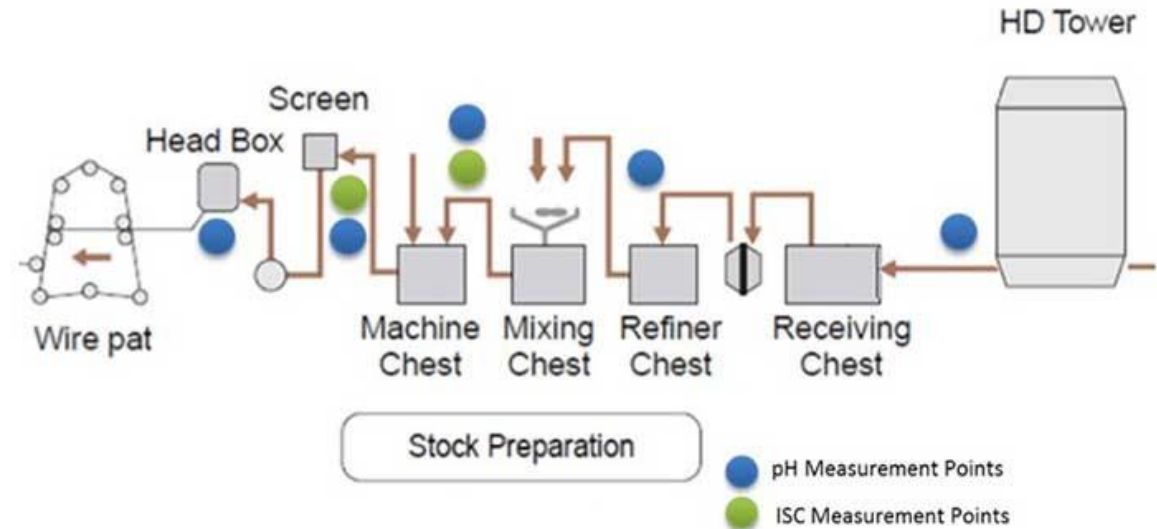
The Yokogawa EXA ISC202 series transmitter is housed in a robust chromated cast aluminum housing, coated with a Epoxy-polyester makes it the ideal 2-wire transmitter for mounting directly on-site, even under tough environmental conditions. Yokogawa has implemented three leading process Fieldbus technologies in their 202 series: HART®, Foundation Fieldbus H1 and Profibus PA. The Yokogawa EXA ISC202 series transmitter is housed in a robust cast aluminum case with chemically resistant coating, cover with flexible polycarbonate window.



Yokogawa Pulp pH Measurement

The Kraft Process is a cyclical, self-sustaining process. As a result of the process, a byproduct called black liquor (tall oil) is formed. There are two different forms of pulping process: Chemical pulping and Mechanical Pulping. Maintaining proper pH measurements in the stock preparation is important for producing quality finished product. The stages will vary depending on the type of paper that the end product will require; however, each will have some form of refining, chemical addition and screening of the pulp.

Typically the pulp is diluted and passed thru a refiner. The pH is typically maintained >8 . Inaccurate pH measurement at the first refiner can have an effect on the strength of the pulp. The purpose of the refiner is to shred and flatten the pulp. After the stock passes thru the refiner it enters a mixing tank where chemical additives are introduced. Once the correct pH is achieved the stock enters the machine chest, where the consistency of the stock is then set. Once the consistency is accurate, the pH is monitored again before the stock is pumped thru the final screening before the stock reaches the headbox. The headbox is the final point to ensure proper pH of the pulp stock before the paper machine. Once the stock enters the paper machine it cannot be corrected.



Yokogawa has extensive experience dealing with the clogging and fouling problems that occur with pH measurements in paper mills. This has led us to select the Model PH97/DP sensor which has a solid state reference resistant to clogging and fouling. The PH97 is designed as a replaceable 4-1 sensor used in conjunction with the Model PH87 retractable assembly. The PH97 includes a pH (glass) electrode, solid state reference electrode, solution ground and a Pt 1000 temperature element. All these components are sealed in a rugged Ryton™ body.

The Model PH87 assemblies are constructed of chemically-resistant titanium and include blowout safety protection utilizing a flared tip design which provides a metal to metal stop during retraction. Integral junction boxes are provided for simple installation and wiring. The retractable assembly is suitable for removal from a process line or vessel at pressures up to 70 PSI without interrupting the flow or draining the tank. The PH87 comes different lengths to simplify proper insertion in the process line or tank.

Liquids

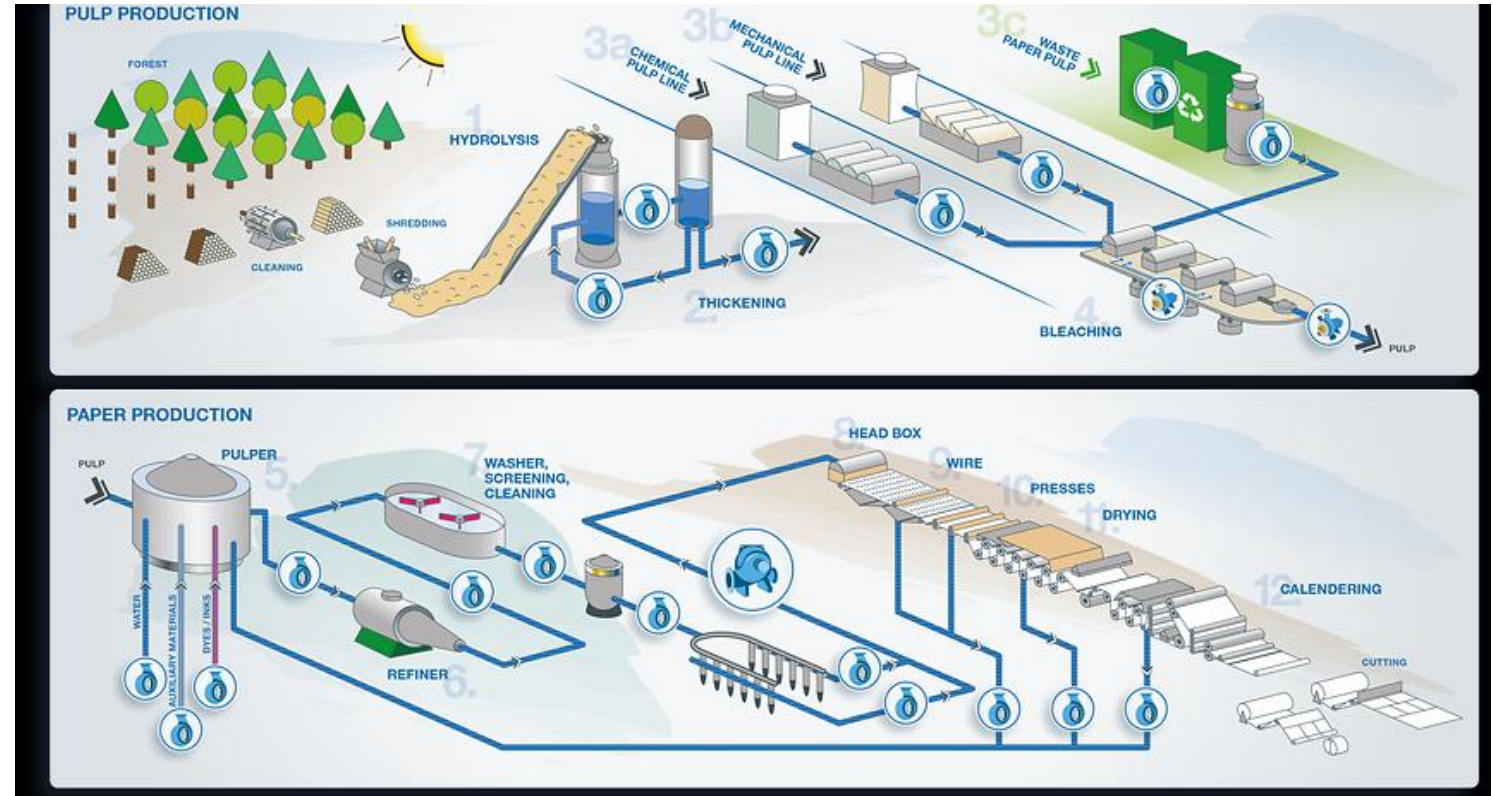
Liquid Products and Suppliers

Process	Suppliers
Black Liquor Filtration	Filtration Group, Nederman
Sludge Dewatering	Andritz, Nederman, Filtration Group
Pumps	Alfa Laval, Flowserve, Andritz, Xylem
Valves	GE, Emerson
Mixers	Sulzer
Treatment Chemicals	Kemira, Solenis, Suez (GE Water), Buckman
Press, Drum, and Belt Filter Media	Filtration Group, Andritz

Specific Examples
Andritz
Chemtreat
Dezurik
Filtration Group
Emerson Fisher Controls
GE
GEA
Nederman
Pall
Solenis
Spraying Systems
Sulzer

Andritz

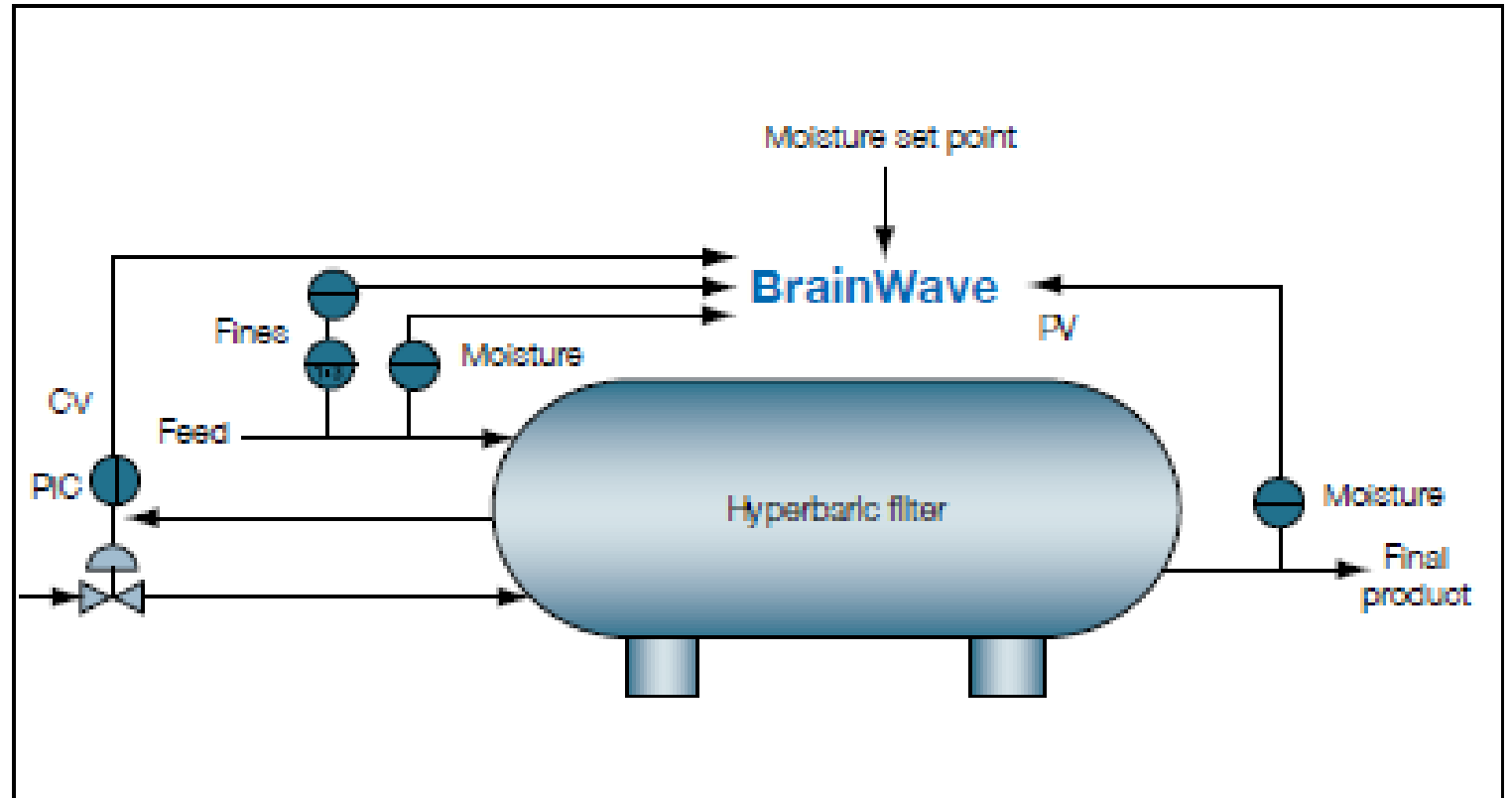
ANDRITZ centrifugal pumps are used as process pumps in many different areas of pulp and paper mills. They pump suspensions at consistencies of up to 8% b.d., offer high efficiencies of up to 90%, and convince customers with their service-friendly and modular design. These pumps are also available with an additional degasser if the medium to be pumped has a high gas content ANDRITZ medium-consistency pumps convey chemical and mechanical pulp as well as secondary fibers with consistencies of up to 16% b.d. and efficiencies of up to 74%. In most applications, they can be operated without an internal or external vacuum pump. The greatest advantage of the ANDRITZ medium-consistency pump, MC series, is its innovative fiber separation system (SMARTSEP). With ANDRITZ SMARTSEP, an additional separation impeller returns fibers reliably to the pump and guides air out of the pump at the same time. This makes it possible to guarantee that there are no fiber losses, particularly in run-up operations and at low consistencies, and an easy control of the degassing valve.



Andritz Brainwave Hyperbaric Filter Control System

One of the main issues in hyperbaric filter control is the over-drying of product, which can increase energy consumption. BrainWave accounts for transport delay times as product moves through the filter to the online moisture measurement sensor. Further improvements to control are possible by monitoring incoming moisture content, either on- or offline, and including this in the control strategy as a measurable feed-forward.

Schematic of moisture control system with BrainWave HB filter



This allows BrainWave to make control corrections as soon as the incoming moisture changes, instead of waiting for the exiting moisture to respond. BrainWave is also able to reduce spikes in air pressure, which cause increased wear and excessive maintenance on equipment. BrainWave accomplishes this by stabilizing the measured moisture content at the filter exit by continuously adjusting air pressure

Chemtreat Water Treatment Control System

- A large Southeast Paper Mill was experiencing poor control with their water treatment supplier who was using pace and chemical verification instrumentation. The mill was experiencing major variances in cycle control, conductivity, P-alkalinity, and phosphate control. ChemTreat installed an advanced version of their ChemTreat Solutions® Control and Monitoring System which included proportional chemical feed pumps, blowdown control based on cycles, and correct chemical feed injection points.
- As a result, the customer is able to precisely control and monitor the chemical and blowdown of their systems at a very tight control range which had never before been seen at this facility. The neat feed of products by the ChemTreat Solutions® Control System eliminated the costly, maintenance-intensive, and inaccurate feed and control system previously used by the incumbent supplier. The ChemTreat Solutions® System also datalogs other critical system parameters such as hardness, silica, sodium, and turbidity to fine tune system performance.
- Evaluation of the ChemTreat Solutions® System was considered a major success. Plant management agreed use of the on-line system was a significant process improvement. As a result, the mill will realize improved treatment results and energy savings of at least \$96,000 per year.

Dezurik Valves for Repulping and Paper Machines

The repulping process (Figure 3) begins as bales of recycled paper delivered to the pulper. Junk trap valves remove sand, metal, staples, glass and rocks directly off the pulper using high-density cleaners. Recycle fiber with high levels of contaminants and abrasive slurries are extremely erosive—standard stainless-steel valves can be compromised in the matter of days. As a result, valves used in this service need metallurgy that will hold up to abrasion such as heat-treating stainless steel to increase the hardness of valve seats, gates and bodies. Other choices include using chrome carbide overlays to provide a protective surface with a greatly increased Rockwell C hardness.

Paper machine (Figure 4) advancements have created ever-increasing speeds, wider webs of paper and more exacting standards of quality. No valve exemplifies the importance of proper valve selection better than the most critical valve on any paper machine: the basis weight valve. If this valve fails, it will immediately shut down the paper machine. Proper basis weight control is integral to the cost of the finished paper product and its variability. Such control is critical in machine operation uptime and can impact lost time that occurs from paper breaks caused by draw variability, retention aids, drying performance and maximum production speeds. These factors all equate directly to operating efficiency and profit.

Todd Greer, Pulp and Paper Manager, DeZurik, writing in *Valve Magazine*

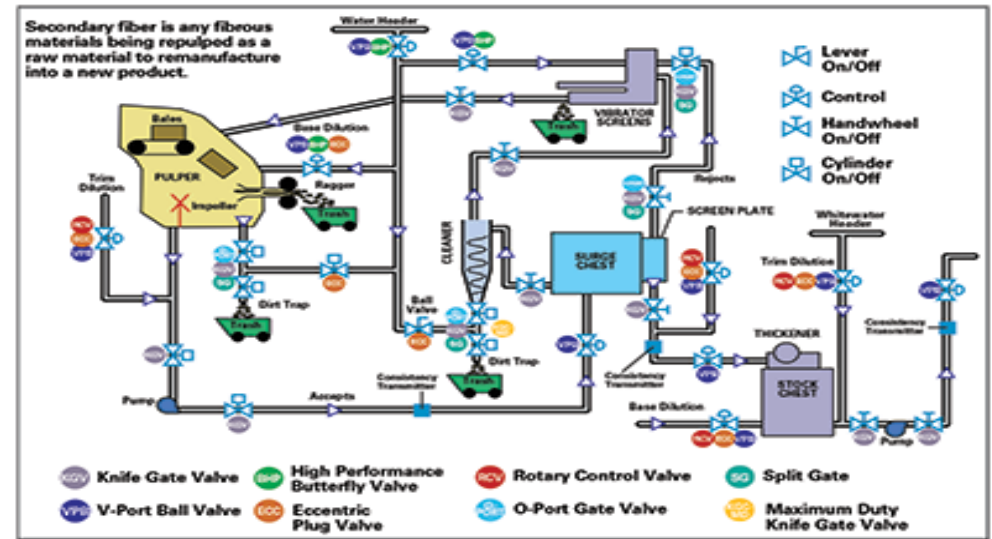


Figure 3. Secondary fiber repulping operation

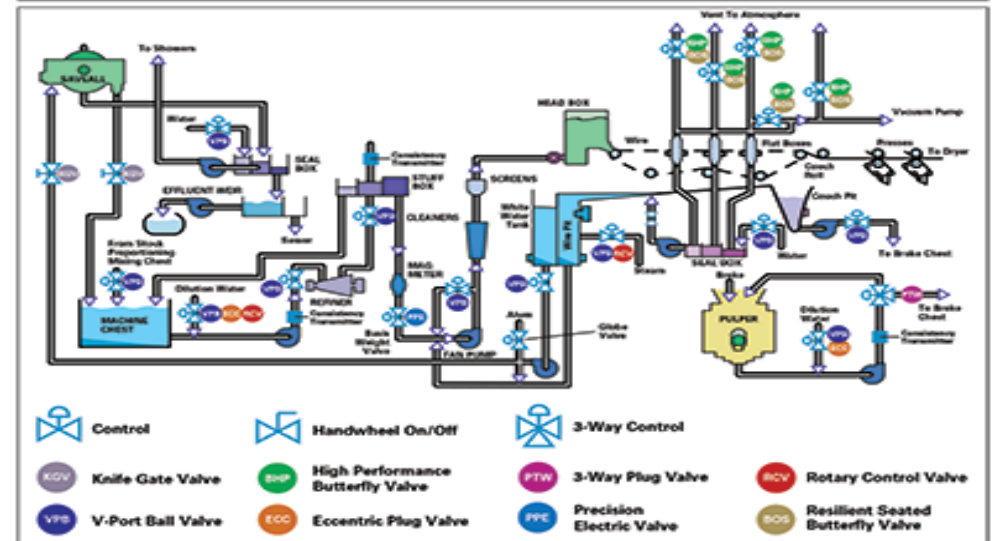


Figure 4. Fourdrinier wet end

Stock Preparation Valves

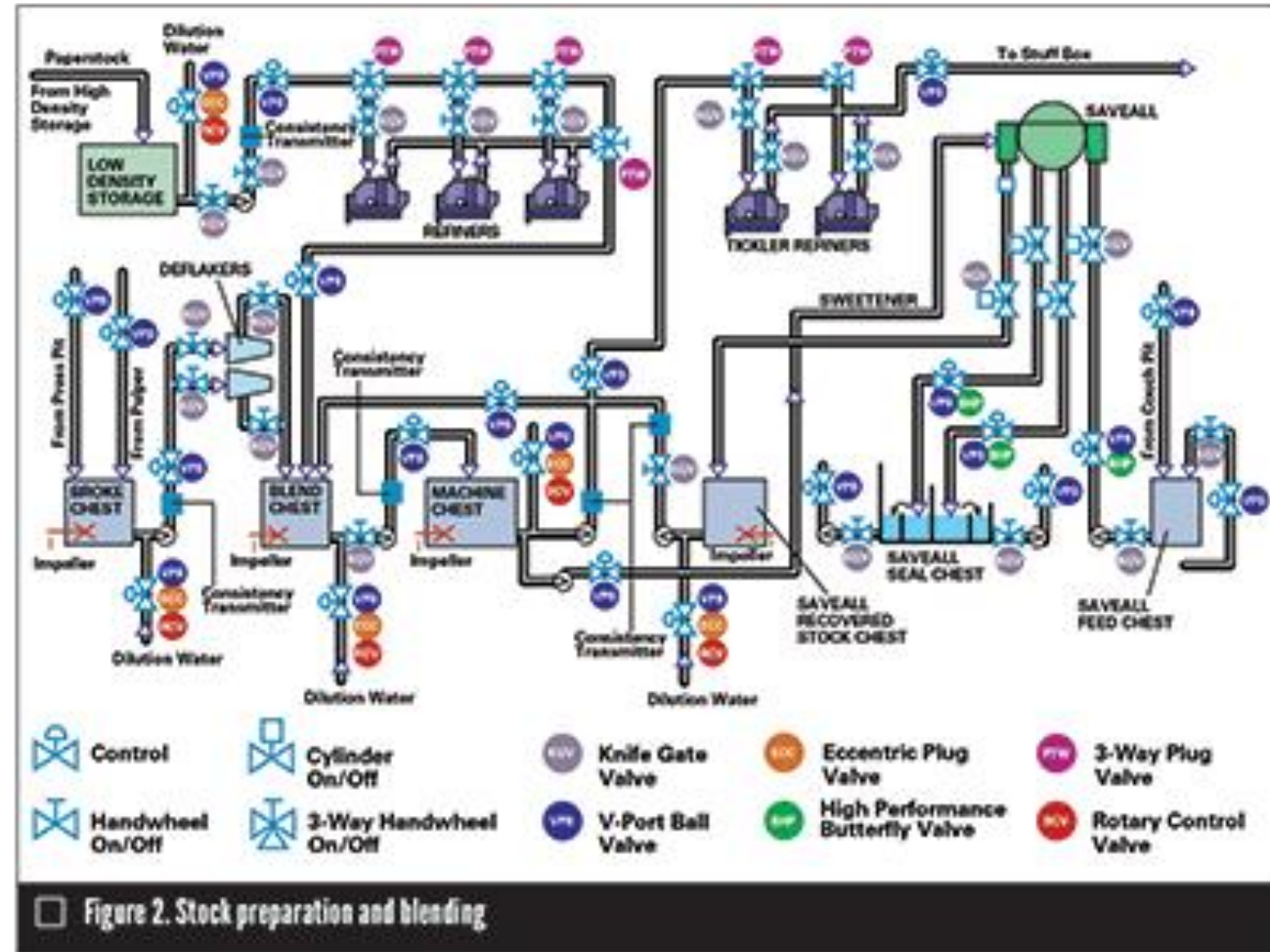
Both stock consistency and freeness are critical application criteria in valve selection.

High-consistency pulp stock is stock in which fiber exceeds 6-8% and has a high freeness rate of more than 500 CSF points. If high-consistency stock in the pipeline is not flowing, it will dewater and inhibit a valve from closing. For this application, an o-port valve is recommended. When an o-port gate valve closes, it removes a cross section of the media in the pipeline to allow the valve to seat. When the o-port is opened, it replaces the cross section back into the pipeline.

Moderate consistency stock ranging from 2-6% with a freeness rate of less than 500 CSF points is handled best by a metal-seated knife gate valve rated for full-reverse pressure. A metal-seated valve in this service will have a longer lifecycle than an equivalent resilient-seated valve because of the rugged metal construction. Metal-seated valves also offer the advantage of not having an elastomer that can fail and color-contaminate the stock. A quarter-turn valve such as a v-port ball with a metal seat will provide a cutting action that keeps the seat face free of fiber buildup so the valve seals tightly.

For consistencies below 2% or general mill white-water applications that require bubble-tight shutoff and bidirectional service, a perimeter resilient-seated knife gate valve is the right choice for on/off service.

For a quarter-turn control valve in this application, a resilient-seated v-ball or plug valve is the right selection.



Todd Greer, Pulp and Paper Manager, DeZurik,
writing in *Valve Magazine*

Filtration Group - Mahle Filters for Pulp and Paper

Pulp & Paper Applications: Retention Aids

- - This is usually a polymeric compound, added to the pulp stock as a bonding agent. It can agglomerate and cause a quality problem in the paper sheet during the forming process. A duplexed ProGuard 2000 Series filter with 100 mesh wire screen elements is a great solution in these applications.

Sizing Starch

- - Wet end sizing starch is also a pulp stock additive, used to make the sheet stronger during forming. Dirty starch, poorly cooked starch, or agglomerations can cause a quality problem on the sheet. Depending on the flow, a 60-100 mesh wire or slotted media in a duplexed filter is the best solution here. Alum - This additive is primarily for pH control. Because Alum can precipitate or crystallize during flow through piping, it is best to filter this additive with a tubular filter. Alum is normally very low flow, so the ProGuard 1000 Series unit, with a 100 mesh screen works best. There are many other applications, such as D1 water, boiler feed water, dye, trim squirt and shower nozzle protection on the paper machine where manual ProGuard filters can be used to raise the quality of the paper product or to prevent the fouling of equipment.

Filtration Group - Lubricant, Back Up Power Fuel Conditioning and Hydraulic Fluid Filtration

The pulp and paper manufacturing process can be particularly taxing on turbine lubricants. Filtration Group (Kaydon) provide solutions that minimize the impact of high levels of moisture, heat and dirt that are inherent in the paper manufacturing process.

KL1, 858 and Turbo-TOC© oil conditioning systems, each driven with cutting-edge coalescing technology, produce unmatched performance that:

- Keeps your turbine equipment on line longer.
- Protects expensive and difficult-to-replace bearings and gears from premature failure.
- Makes downtime schedule more predictable.
- Holds the line on maintenance and replacement parts costs.
- Extends the lifespan of increasingly expensive lubricants.

Emerson Pentair Valve

- With the acquisition of Pentair-Tyco Valves the valve sales of Emerson are now \$3.6 billion per year. Total valve sales to the pulp and paper industry are \$3 billion /yr. Emerson valve sales to the pulp and paper industry are estimated at \$110 million/yr.
- Pentair sells a wide range of valves to the pulp and paper industry including specialized valves such as the RO gate valve.
- The RO gate valve in sizes from 2” to 36” is designed for pulp and paper applications and can handle a range of slurries at varying pressures and temperatures
- As shown on the next slide a wide range of Fisher control valves are used in pulp and paper processes.

Fisher Control Valves

Cooking

- 1 Caustic Addition
- 2 Digester Liquor Level Control
- 3 Digester Switching
- 4 Digester Blow
- 5 Gas Relief

Pulping

- 6 Brown Stock Rejects
- 7 Medium Consistency Pump Discharge

Bleaching

- 8 Chlorine Dioxide Addition

Recovery

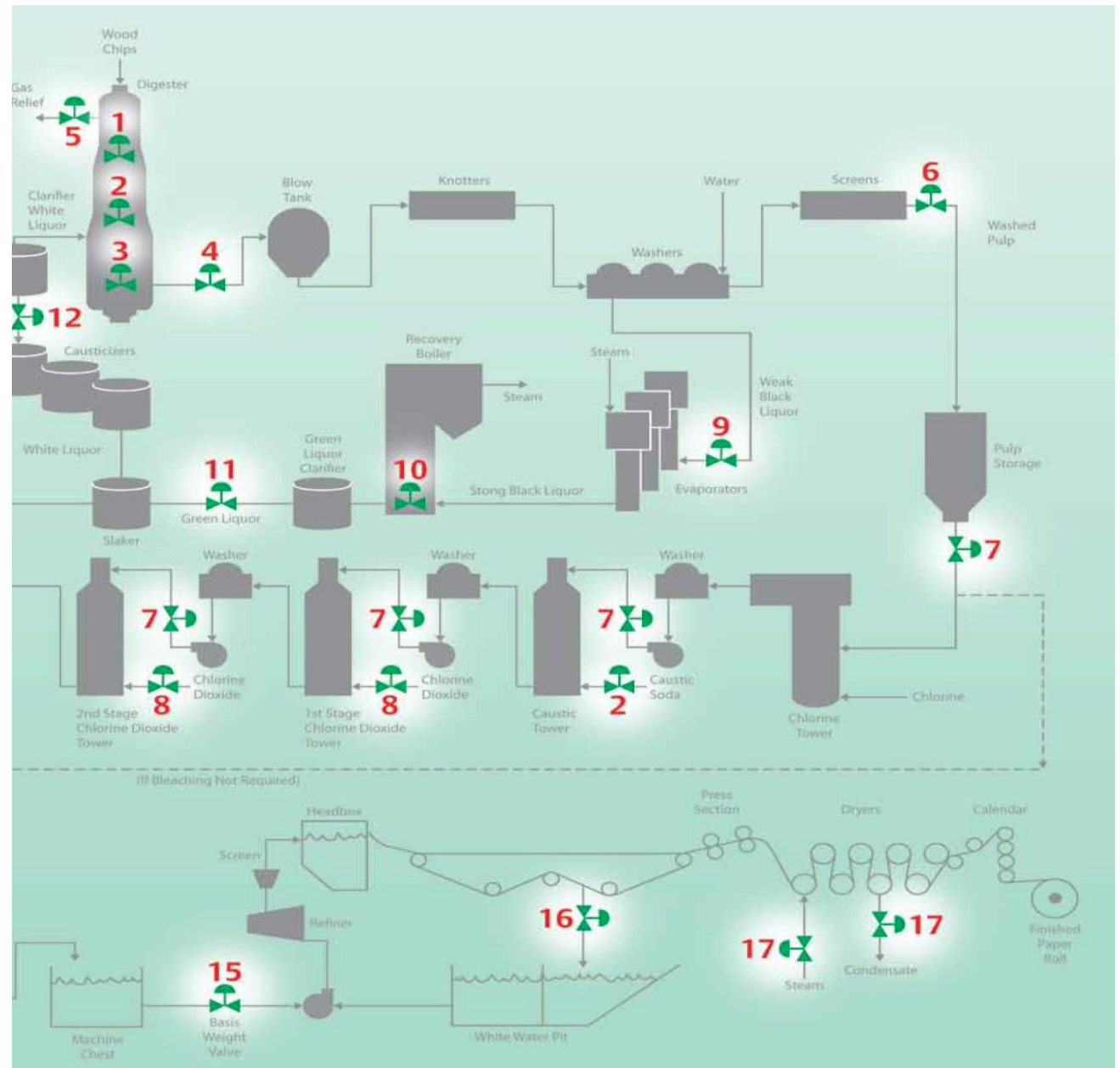
- 9 Black Liquor Evaporation
- 10 Black Liquor Guns

- 11 Green Liquor Dissolving Tank Density
- 12 White Liquor Pressure Filter Switching

- 13 Lime Mud Underflow

Paper Machine

- 14 Paper Additives
- 15 Basis Weight
- 16 Vacuum Box
- 17 Dryer Steam and Condensate Return



GE Valves for Pulp and Paper

- GE spent \$3 billion on Dresser Masoneilan and became a major valve manufacturer with valve sales of more than \$1 billion in 2016. The total valve sales to the pulp and paper industry are \$3 billion per year but this is not a major target market for GE. The valve group is part of GE Oil and Gas. Estimated valve sales by GE to the pulp and paper industry are \$15 million/yr.
- Some of the valves have been designed for the pulp and paper industry. The Masoneilan V-Mx 36005 series of high capacity rotary ball valves are designed to handle the high viscosity fluid applications. It is supplied in sizes up to 12”.

GEA Heat Exchangers for Pulp and Paper

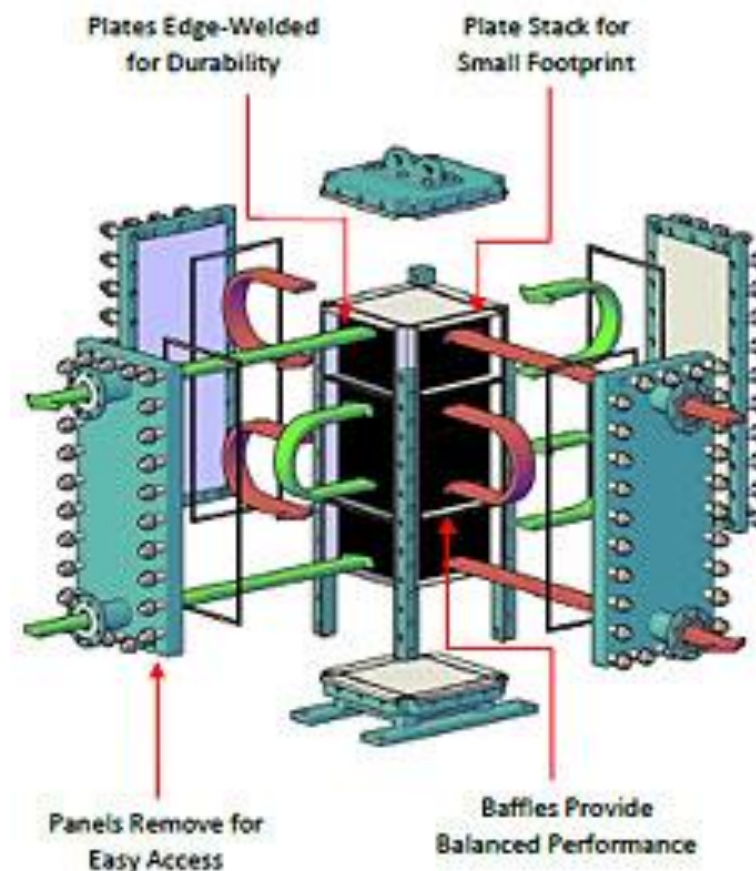
Plate heat exchangers used to transfer heat or cold are one of the central components in process engineering and are used in pulp and paper.

GEA ViEX draws on decades of international process experience and heat exchanger expertise to ensure it engineers GEA ViEX compact heat exchangers to meet process requirements instead of expecting the process to meet the needs of a standard compact heat exchanger.

Heat exchangers are designed for a long, low-maintenance lifetime and with easy access for regular servicing.

Uses include

- Energy recovery from black liquor
- utility fluids
- Production of hot water
- Fuel heaters (natural gas, heavy fuel oil)
- Kettle (evaporator-condenser, heat transfer oil, superheated water)



GEA Collaboration to improve Microfibrillated Cellulose Process

- The Centre Technique du Papier is located in Grenoble (France) and is the French technical center (Pulp, Paper, Board, Printing and Processing) for Applied Research, Consultancy, Testing Laboratories and Training Courses. CTP helps industrialist for innovative products & processes at lab and pilot scales and develops knowledge with high level of Scientific Expertise.
- A dedicated team of engineers and highly qualified and competent technologists at CTP worked for several years in the development of microfibrillated cellulose production and use for different new applications, including for papers and boards.
- For its research projects and the design of its NaMiCell pilot plant, CTP conducted an extensive review on the different technologies available on the market for converting lignocellulosic fibres into microfibrillated cellulose (MFC), taking into account the properties of cellulosic fibres and the viscosity of the produced MFC suspension (gel-like structure). After some preliminary tests, CTP decided to invest in a high-pressure homogeniser and choose GEA high-pressure homogenising technology for continuing its research activity on this promising topic.
- The reasons that led to CTP to adopt GEA homogenizers are different, but some of the main reasons are due to the robustness of the proposed technology against abrasive cellulosic products and to the easy use of the technology, especially in conducting the machine and changing of spare parts. Another important advantage is the homogenizer technology to be scaled-up for a continuous industrial production. this last point is crucial for CTP missions towards the industry to transfer the applied research to the industrial reality.
- In order to adapt the GEA technology to the cellulose material and production environment, the close collaboration between CTP and GEA proves once again a winning in the technology world homogenization, bringing the company to a leadership position in the field of cellulose.
- GEA Industrial homogenizers are machines made by two essential elements: a compression block, which to pump the product in high pressure and a homogenizing valve, able to micronize dispersed particles down to the order of micrometers and nanometers, depending on product's characteristics and the desired results.

Nederman Filter Media and Filters for P&P

It is critical in the chemical pulping process that the caustic used to dissolve the pulp be recovered due to environmental and economic considerations. If a plant utilizes pressure vessels for recausticization, they will need to properly control the clarity of the liquor coming off the units. This can be accomplished by using candle filter bags with different finishes and membranes. The cake dryness off of the lime mud and Dreggs filters is important due to the high cost of energy used to dry the lime in the kiln. Below is a partial list of areas in which Menardi has supplied filtration expertise to solve problems:

- Dreggs (final caustic recovery)
- Lime mud (caustic recovery)
- Recausticization (white liquor filtration and lime mud washing)

Common problems Menardi liquid filtration products solve:

- Clarity
- Cake dryness
- Reduction in installation time
- Cake discharge
- Throughput

Menardi liquid filtration products/services for pulp and paper:

- Mikrotex® expanded PTFE membrane candle filters
- Candle filters metal perforated tubes
- Woven polypropylene rotary vacuum drum filter cloth
- EPDM caulking cord
- Pneumatic caulking cord installation

Pall Filters for Bleaching and Paper Machines

Pulp Bleaching ClO₂ and Paper Chemical Preparation Filtration Solutions: Pulp bleaching generator and paper chemical preparations require pure chemicals to ensure a high-quality product. We provide filter solutions to help ensure high-quality outcomes at high efficiency and low cost.

Pall Ultipleat® filters are designed to improve the reliability, efficiency, and effectiveness of pulp and paper bleaching chemical machinery. The crescent-shaped pleat design allows for a large amount of filter surface area to be packed into a smaller space. This allows it to be up to 50% smaller than comparable filter systems, helping bring down maintenance and installation costs. More, Ultipleat® filters require up to 40 times fewer elements to change out, have higher flow rates per filter cartridge, are coreless and have an all-plastic construction to minimize waste disposal, are absolute rated filter medium for reproducible performance, and have inside-to-outside flow configuration so all debris stays within the filter.

Increase Paper Machine Capacity with Premium Fluid Filtration Solutions for Pulp and Paper

- The machinery and equipment in operation in pulp and paper mills is highly dependent on the proper control and maintenance of fluids to desired operating conditions. From hydraulics to lubrication, recycled waters and ClO₂ generators to boiler feed water, the reliability and availability of a pulp and paper mill can be improved by the proper selection of filtration technologies – technologies that ensure consistent levels of contamination control throughout the paper manufacturing process. Maintaining a specified level of fluid cleanliness is critical to the operation and reliability of the systems involved.
- Pall pulp and paper machine process fluid filters are designed to provide the highest level of protection from beginning to end of service life. Technically-advanced products for monitoring water and particulate contamination levels on-line are specifically designed to help paper machines achieve increased uptime, lower maintenance costs and high capacity. For industrial manufacturing processes and mobile equipment, achieve the process improvements and cost savings with their unique capability to take responsibility for the cleanliness of an operation.

Samson Valves to Control Fibrous Flow

Samson supplies control valves to regulate the fibrous flow of the raw materials and the flow of vapor, which is used as the energy transfer fluid. Samson products ensure efficient processes during the mechanical and chemical treatment of the pulp. Thanks to their high control accuracy, the fresh water required for the processes is used economically and waste water treatment does not burden the environment or resources.

In the paper machines, Samson products are involved in the entire steam and condensate system, the exact control of the basis weight and humidity profile as well as the optimum drying of the paper webs. Innovative valve accessories, such as smart Samson positioners. Positioners for integral attachment, ensure the safe exchange of data in the process and allow for predictive maintenance.

Solenis Chemicals for P&P

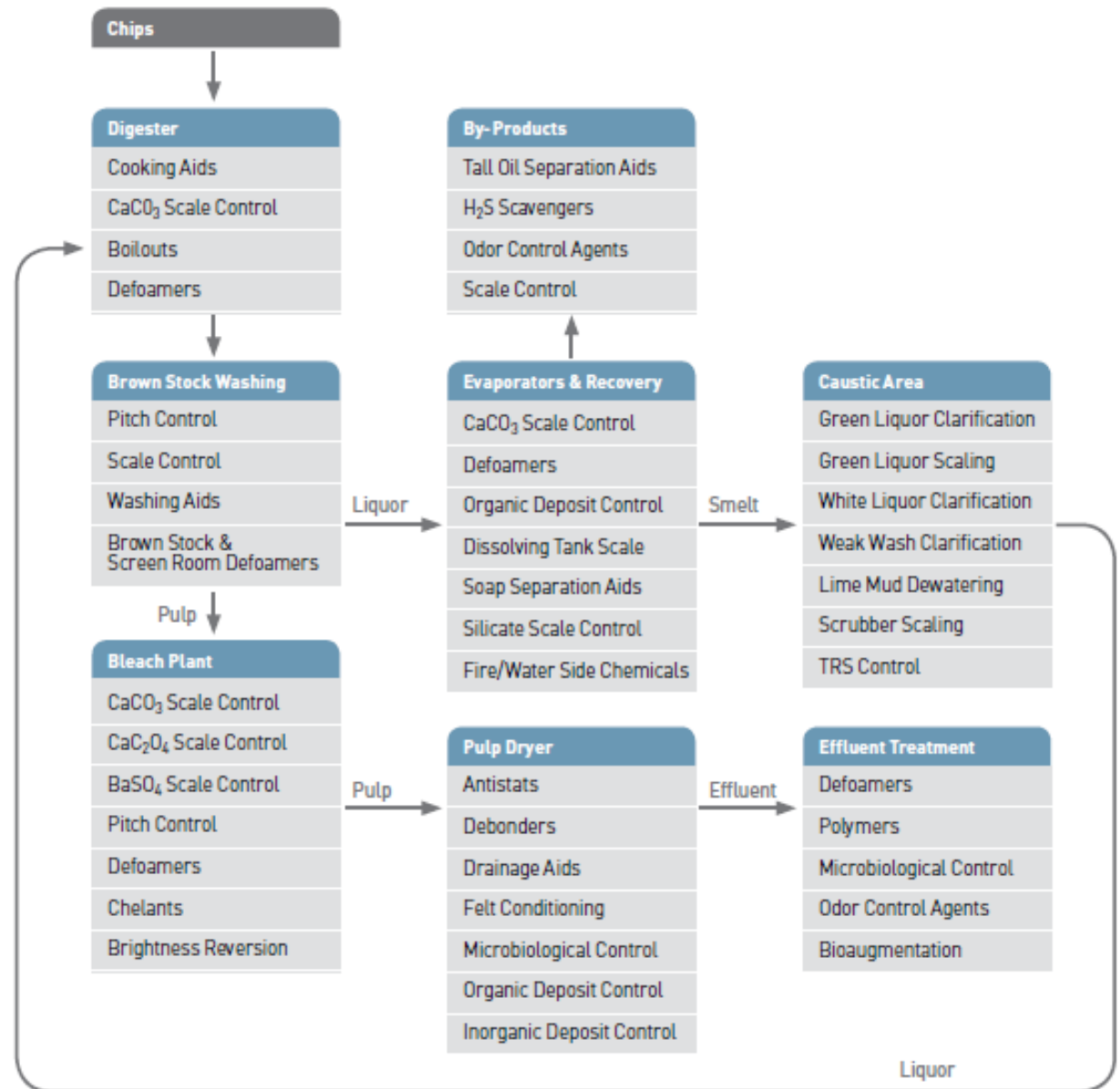
Solenis offers a number of products that improve pulping efficiency and pulp quality, including cooking aids, washing aids, pitch and scale control products, brown stock defoamers, and specialty programs.

Solenis offers scale control chemistries—that are based on the industry leading Drewfax product line. When properly applied, these scale inhibitors provide a number of benefits:

- Control of scale buildup on washer vats, mats, and/or slides, reducing the potential for increased dirt count
- Improved washing efficiency, reducing bleach plant chemical usage
- Reduced digester scaling, maximizing productivity between acid cleanings

To ensure total optimization of pulp mill technology, Solenis also provides an advanced portfolio of monitoring and control systems that consists of three components:

- Data collection systems
- Windows*-based data management software
- State-of-the-art analyzers and controllers



Spraying Systems provides controls with easy integration to plant control systems resulting in efficiency gains in coating and moisturizing. How much of the guidance is in this software vs the plant control system?



Spray Controllers Optimize Automatic Nozzle Performance

A spray controller can be added to any of our showers to optimize spray nozzle performance, lower operating costs and automate operation. More critical operations such as coating and moisturizing tend to experience the greatest efficiency and performance gains resulting from precise control of our automatic spray nozzles.

Spray control benefits:

- Line speed following
- Zone control of nozzles
- Separate control of liquid, air and fan air pressure to ensure proper flow rate, spray angle and drop size
- Maximize nozzle cycle times
- Automatic clean-out cycles to minimize nozzle plugging
- Improve troubleshooting of spray performance
- Operator notification or shut-down on specified faults
- Easy integration with existing plant control systems

AutoJet
TECHNOLOGIES
From *Spraying Systems Co.*

Spraying Systems PulsaJet® Manifold for Precision Spray Control Applications

Features and Benefits

- Modular design and construction
- Achieve Pulse Width Modulated (PWM) flow control when used with a wide range of AutoJet® modular spray systems or PWM spray control panels
 - PWM flow control involves switching electrically actuated nozzles on and off repeatedly at a controlled rate. This allows easy and precise adjustment of flow rate without adjusting spray pressure or affecting spray integrity, reduces misting, decreases nozzle clogging and more
- Ideal for zoned-control applications
 - Adjust sprays as needed to accommodate multiple widths
 - Eliminates overspray and waste of costly chemicals

Specifications

- Manifold length: 20' (6 m) maximum
- Spray height: 8" (203 mm)
- No. of nozzles per header: 12 maximum
- Nozzle spacing: Adjustable
- Nozzle compatibility: PulsaJet automatic spray nozzles
- Materials of construction:
 - Manifold: Anodized aluminum
 - Wetted components: Varies based on options. See specification sheet
 - AA10000AUH-03 PulsaJet nozzle: stainless steel, Viton®, PTFE, PPS, Peek™
 - AA250AUH-VI PulsaJet nozzle: PPS, Viton, stainless
 - Viton® is a registered trademark of DuPont Performance Elastomers PEEK™ is a trademark of Victrex, plc

With process management systems the performance of stainless vs PEEK nozzles will be constantly reported and better materials choices will be made in the future



Sulzer, Recycled Fiber Line, Paper Machine, Water, and Power

Recycled fiber line

- Pulping, screening & cleaning, flotation, washing, bleaching
- Pumping of unsorted stock - AHLSTAR N Range and AHLSTAR A Range
- Stock pumping - AHLSTAR A Range
- Pumping of foam/air containing liquids - AHLSTAR A Range and AHLSTAR N Range
- Sludge pumping - AHLSTAR N Range and AHLSTAR A Range
- Medium consistency (MC®) stock pumping and transfer - MC® Pumping System
- Tower discharge pumping systems - MC® Discharge Scraper
- Agitation and mixing of stock/other liquids in tanks and towers - SALOMIX® SL/ST, SALOMIX® L Series, Scaba Side-mounted agitators, Scaba Top-mounted agitators
- Charging or discharging of stock towers - SALOMIX® special products TES, GLI, VULCA
- Performance Improvements – Pump Expert Services

Paper and board machine

- Stock preparation, PM approach system, broke system, white water system, vacuum system, condensate system, shower water system
- Stock pumping - AHLSTAR A Range and AHLSTAR N Range
- Headbox feed - ZPP, Z22, AHLSTAR A Range
- High pressure waters - MBN Multistage Pumps
- Air containing liquids - AHLSTAR A Range
- Pumping from seal pits - AHLSTAR A Range, AHLSTAR NV, NK
- Agitation and mixing of stock/other liquids in tanks and towers - SALOMIX® SL/ST, SALOMIX® L Series, Scaba Side-mounted agitators, Scaba Top-mounted agitators
- Charging or discharging of stock towers - SALOMIX® special products TES, GLI, VULCA

Water and effluent treatment

- Sludge pumping - AHLSTAR A Range and N Range
- Pumping from deep seal pits - AHLSTAR A Range, AHLSTAR NV, NK Range
- Agitation and mixing of waste water applications - SALOMIX® L-series, Scaba Top-mounted agitators
- Submersible pumping – XFP 1.3-30 kW, XFP 30-400 kW, AFLX, VUPX, RCP Ranges
- Submersible mixing – XRW Range
- Submersible aerators – TA, TAK, OKI Ranges
- High speed turbocompressors - HST™ Turbocompressor

Power plant

- Boiler feed pumps – MBN, MC, MD, ME Ranges
- Main condensate pumps – TTMC, MBN Ranges
- Other condensate pumps – AHLSTAR A Range
- Main cooling water pumps – Vertical Pumps
- Other cooling water pumps – AHLSTAR A Range
- Flue gas desulphurization pumps – AHLSTAR A, W Ranges, material 654 SMO
- District heating pumps – ZPP, Z22, AHLSTAR A Range
- Auxiliary pumps – AHLSTAR A Range

Sulzer- Pumps and Mixers for Pulp and Paper

Chemical pulp fiber line

Cooking, washing, screening, oxygen delignification, bleaching

Digester feed and circulation - [AHLSTAR E Range](#)

Black liquor pumping - [AHLSTAR A Range](#)

Stock pumping - [AHLSTAR A Range](#)

Digester liquor feed - [LSP/LST High-pressure low speed](#)

Soap pumping - [AHLSTAR A Range](#)

Medium consistency (MC[®]) stock pumping and transfer - [MC[®] Pumping System](#)

Semi-MC[™] consistency range washer feed – [KCE](#), [AHLSTAR A](#)

Chemical mixing into stock - [SX Chemical Mixer](#)

Tower discharge pumping systems - [MC[®] Discharge Scraper](#)

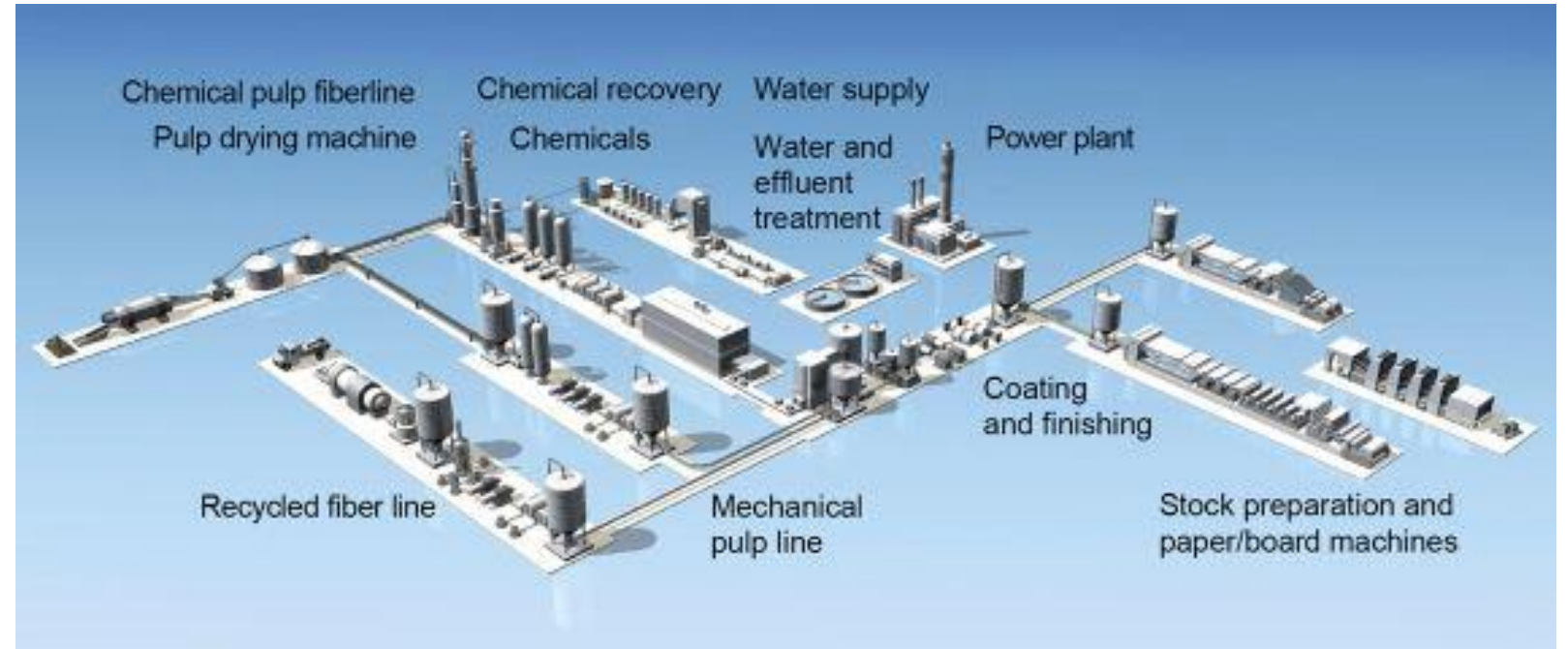
Pumping and controlled flow splitting- [MC[®] Discharger](#)

Agitation and mixing of stock/other liquids in tanks and towers - [SALOMIX[®] SL/ST](#), [Scaba Side-mounted](#)

Charging or discharging of stock towers -

[SALOMIX[®] TES](#), [GLI](#) and [VULCA](#)

[Performance Improvements – Pump Expert Services](#)



Pulp drying machine

Approaching system, cleaning system, drying machine, vacuum system, broke system, white water system

Stock pumping - [AHLSTAR A Range](#)

Headbox feed – [ZPP](#), [Z22](#), [AHLSTAR A Range](#)

High pressure waters - [MBN Multistage Pumps](#)

Air containing liquids - [AHLSTAR A Range](#)

Pumping from seal pits - [AHLSTAR A Range](#)

Agitation and mixing of stock/other liquids in tanks and towers - [SALOMIX[®] SL/ST](#), [SALOMIX[®] L Series](#), [Scaba Side-mounted agitators](#), [Scaba Top-mounted agitators](#)

Charging or discharging of stock towers - [SALOMIX[®] special products TES](#), [GLI](#), [VULCA](#)

Sulzer Chemical Recovery and Mechanical Pulp Lines

- **Chemical Recovery**
- Evaporation, recovery boiler, white liquor preparation
- Liquor circulation - [AHLSTAR A Range](#)
- Pumping of lime milk and lime mud - [AHLSTAR W Range](#)
- Pumping from deep seal pits – [AHLSTAR A Range](#), [AHLSTAR NV Range](#)
- Boiler feed – M Series, [MBN](#)
- Agitation and mixing in white liquor preparation - [SALOMIX® SL/ST](#), [SALOMIX® L Series](#), [Scaba Side-mounted agitators](#), [Scaba Top-mounted agitators](#)
- Green liquor dissolving tank – SALOMIX® SLH, [Scaba Side-mounted agitators](#), [Scaba Top-mounted agitators](#)
- Ash mixing tank - [SALOMIX® L Series](#), [Scaba Top-mounted agit](#)
- **Mechanical Pulp Line**
- Refining, grinding, CTMP, screening, reject handling, bleaching
- Liquids containing large solids and big particles - [AHLSTAR A](#) and [N Range](#)
- Stock pumping - [AHLSTAR A Range](#)
- High pressure waters - [MBN Multistage Pumps](#)
- Medium consistency (MC®) stock pumping and transfer- [MC® Pumping System](#)
- Chemical mixing into stock - [SX Chemical Mixer](#)
- Tower discharge pumping systems - [MC® Discharge Scraper](#)
- Pumping and controlled flow splitting- [MC® Discharger](#)
- Agitation and mixing of stock/other liquids in tanks and towers - [SALOMIX® SL/ST](#), [SALOMIX® L Series](#), [Scaba Side-mounted agitators](#), [Scaba Top-mounted agitators](#)
- Charging or discharging of stock towers - [SALOMIX® special products TES](#), [GLI](#), [VULCA](#)
- [Performance Improvements – Pump Expert Services](#)

Xylem Ozone Systems for Bleaching and Wastewater

- Uses for ozone in a pulp and paper mill may start with pulping and bleaching, but they don't stop there. Ozone's benefits for wastewater treatment begin in the bleaching process, as ozone does not create the adsorbable organic halides (AOX) formed by chlorine and chlorine dioxide, so the influent to the wastewater treatment system is of higher quality and lower toxicity.
- Ozone can breakdown difficult to treat COD into components with increased biodegradability, improving the removal rates in biological processes. Ozone coupled with biofiltration is particularly effective in treating pulp and paper processing wastewater and helping plants stay in compliance with treatment requirements. This combination is the BAT to remove difficult to treat COD remaining in the final effluent, when compared to conventional tertiary treatment techniques based on coagulation and flocculation. Even the oxygen generated when ozone breaks down, can be used in the biological treatment units to improve overall efficiency. Used as a final polishing step, ozone breaks down color and odor components and effectively disinfects the final discharge.
- Ozone has been used to reduce sludge volume and improve the sludge volume index, reducing disposal costs. It can disinfect cooling water, replacing biocides. Ozone can even reduce the overall fresh water usage by a mill by allowing treated water to be recycled to the process.
- Xylem has been collaborating with pulp and paper manufacturers for over two decades, to incorporate the most advanced, energy efficient and easy to operate ozone systems into their processes. Xylem's Wedeco brand developed the Z-Compact System specifically to address the needs of the pulp and paper industry, combining reliability and energy efficiency with a compact configuration and plug and play systems for quick installation and start up.

Xylem Ozone Systems in Use at Fibria

- Fibria, the world's largest pulp company, runs two lines that use ozone to bleach pulp at its Jacarei, Brazil pulp and paper mill. One line, operated by WTA Cellulose, performed flawlessly with an overall availability rate of 99.8 percent, meaning it was able to provide ozone whenever it was needed. The second line, operated by a different company, frequently missed its target availability rate. Fibria sought bids for a new contract to achieve more reliable performance and also to optimize its production operations. WTA Cellulose submitted a bid using its secret weapon for reliability – a WEDECO ozone system. They won the contract. Fibria's bleaching line is now equipped exclusively with Xylem's WEDECO ozone systems.
- Ozone is a form of elemental oxygen and a very reactive gas with many commercial and industrial uses. It is often used as a more environmentally friendly alternative to chlorine or chlorine dioxide to bleach wood pulp in the manufacture of high-quality, white paper. Due to its high reactivity, ozone is very unstable and cannot be stored. It therefore has to be generated at the point of use. Ozone is produced from industrial oxygen in special ozone generators.
- Xylem is the leading manufacturer of ozone systems for bleaching cellulose pulp. WEDECO brand ozone generators are the overwhelming choice of design engineers and end-users worldwide where reliable and efficient production of large ozone quantities is required.
- Xylem installed a Z-Compact System, specifically designed for pulp and paper mills at the Fibria plant. "Many companies supply ozone generator systems, but very few are able to meet the specific requirements of pulp and paper applications," says Dr. Jean-Christophe Hostachy, Director Pulp and Paper for Xylem's Wedeco ozone systems unit. "Our Z-Compact System can be perfectly adapted to pulp mill constraints such as space limitation and aggressive ambient onsite air conditions."
- The ozone is used at the Fibria pulp mill to bleach 3,600 tons of eucalyptus pulp per day. The pulp is used as raw material for producing different paper grades in several other Fibria paper production plants. Fibria exports the paper to several countries including China and the United States.
- "Because of our in-depth expertise in pulp bleaching applications, combined with our efficient and highly reliable ozone systems, our customers recognize us as a premier solution provider," says Franz-Josef Richardt, Manager of Ozone Sales Support for WEDECO products and a specialist for pulp bleaching applications. "With this project, we again have designed a system tailor made for our customer's needs that combines the best environmental performance and process efficiency at the best cost."

Wisconsin Rapids Mill uses Xylem Underdrains and Media Retainers

NewPage paper facility uses Type S underdrains with Leopold I.M.S 200 media retainers to increase the facility's capacity and effluent water quality. These increases lead to fewer plant shutdowns.

Suitable for drinking water plants and desalination plants
Provides even backwash distribution to deep clean filter media

More driving head results in longer filter runs

Reduces construction costs reducing vertical footprint by 11-14 inches (28-35 cm) by eliminating gravel support allowing for the same media depth in less vertical space

Physically rigid design reduces flexing and withstands pressures up to 15 psi

Precision-engineered 0.2 mm slots support media down to 450 microns



Xylem Cross Flow Membranes used in Multiple P&P Applications

- PCI supplies RO, UF, NF, and MF systems for the following applications in pulp mills
 - Bleach effluent processing for color, OD/BOD and toxicity removal
 - Mechanical pulping effluent prior to recycling processes
 - Chemical pulping effluent prior to recycling processes
 - Evaporator acid condensate for effluent treatment and water recycle
 - Deresining of pulp washwater
 - Debarking water for color/COD removal
- Aqueous ultrafiltration plant consisting of 1784 PCI 3.6 m long B1 modules giving a total membrane area of 4740 m² is installed in the Stora Nymölla AB pulp and paper mill, Sweden, where it reduces 300 tonnes/ hour of bleach plant effluent to 6 tonnes/hour

Filtration Group Clear Edge Synthetic, Spiral, and Metal Belts and Cloths for Pulp and Paper

Clear Edge synthetic, spiral and metal fabrics meet the washing, bleaching, fibre capture, chemical treatment and PMC dryer needs of the pulp and paper industries

- Technical Fabrics available in Polyamide (nylon), polyester (PES), polypropylene (PP), PPS, PVDF, PFA, FEP, PEEK antistatic and others
- Azurtext™ and Primapor™ coated media
- Monofilaments, multifilaments, spun and specialty yarns in a variety of widths
- Filter fabrics ranging in weight from 1 oz/yd² to 50 oz/yd²
- Screen fabrics from 1 to 5,000 micron opening

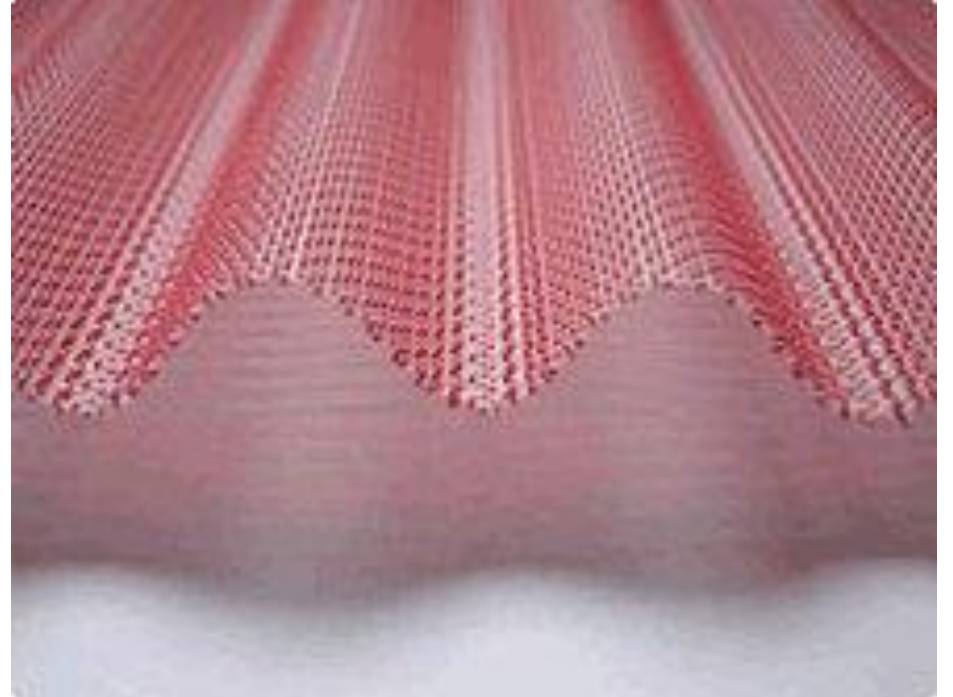
Valmet Disc Filter Bags

All Valmet disc filter bags – regardless of the material – are designed and made to fit in demanding applications. To ensure absolute precision they use a computer-controlled laser cutter with coded dimensions. In addition to tight and hardwearing stitches, the fabric edges are non-fraying. These fabrics incorporate everything from a perfect fit to the best materials and a long lifetime – everything needed in a disc filter bag to increase filter capacity.

The WavSar bag is designed for all kinds of disc filter sectors. WavStar's secret lies in its unique fabric corrugation. This solution increases the sector surface area by 29%, enhancing capacity by 10 to 25%. The corrugation also facilitates filter cake removal.

Key benefits

- high capacity
- high pulp discharge consistency
- improved filtrate quality
- cost effective retrofit
- easy maintenance and service



Valmet Pulp Dewatering Wires and Fabrics

TwinStar is Valmet's product family of high-quality monofilament wires for pulp dewatering. The extensive product range includes various applications such as:

- Dewatering of stocks from hard and softwood, mechanical or chemical pulp, bleached or unbleached
- Dewatering of waste paper
- Municipal sewage and industrial waste water treatment

TwinStar highlights

- Trouble-free start-up
- Long life: excellent stability, wear-resistant designs, extremely strong edge treatment
- Optimum drainage
- Operational reliability

Valmet's **FiberStar SL** is a single-layer shrink fabric designed for drum filters used in chemical and mechanical pulping as well as for recycled fiber. In addition to boosting production, its key benefits are:

- Excellent drainage -> high dry content
- Shrinking starts at low temperatures
- Extremely high shrinkage force -> long lifetime
- Unique woven seam structure -> low profile and high strength
- Metal-like structure -> stays clean and runs longer
- No shrinking in axial direction - > easy to install
- No need for welding -> quick installation

Gases

Examples of Emission Processes and Suppliers

Process	Supplier Examples
Bark Boiler Exhausts	Filtration Group, GE-Alstom, Andritz, B&W, Daikin
Recovery Boiler Exhausts	GE-Alstom, B&W
HVAC Including Odors	Filtration Group ,TM, Freudenberg, Daikin
Lime Kilns	Filtration Group, GE –Alstom, B&W, Daikin
Compressor and Engine Intakes	Filtration Group, Fruedenberg, Clarcor
Compressed Air Filtration	Freudenberg, Parker, Filtration Group
Burners	GE-Alstom, B&W
Heat Exchangers	Alfa Laval

Specific Examples
Festo
Filtration Group
Freudenberg
GE
TM Systems

Festo Controls at Emin Ledier

The company Chleq Frote is the engineering office responsible for designing pneumatic control solutions for a new pulp and paper plant of the end user Emin Ledier. Chleq Frote relied on the knowhow and experience of Festo for developing suitable control cabinets.

Task

- High performance solution with low air leakage and which is easy to maintain
- Control cabinets to drive 4, 8 or 16 valves
- High but adjustable flow rate necessary
- Request to be able to change individual valves without switching off the pressure
 - Economic

Solution

- High flow rate by using ISO valves with individual connections
- Each solenoid equipped with flow regulator to adjust the air flow
- Special performance due to usage of pressure booster for the large drives
- Customized shut-off plate for each valve so as to be able to change individual valves in operation mode (Hot Swap)

Filtration Group (Purafil) Air Filtration for Corrosion Protection

Due to “lead-free” legislations, airborne contaminants affect electronic components found in process control equipment, computers, process monitoring, and data collection systems. Purafil helps prevent corrosion on electronic equipment with the following products.

Compression_Intake Filter (CIF)

Corrosive Air System (CA)

Deep Bed Scrubber for Corrosion Control (DBS)

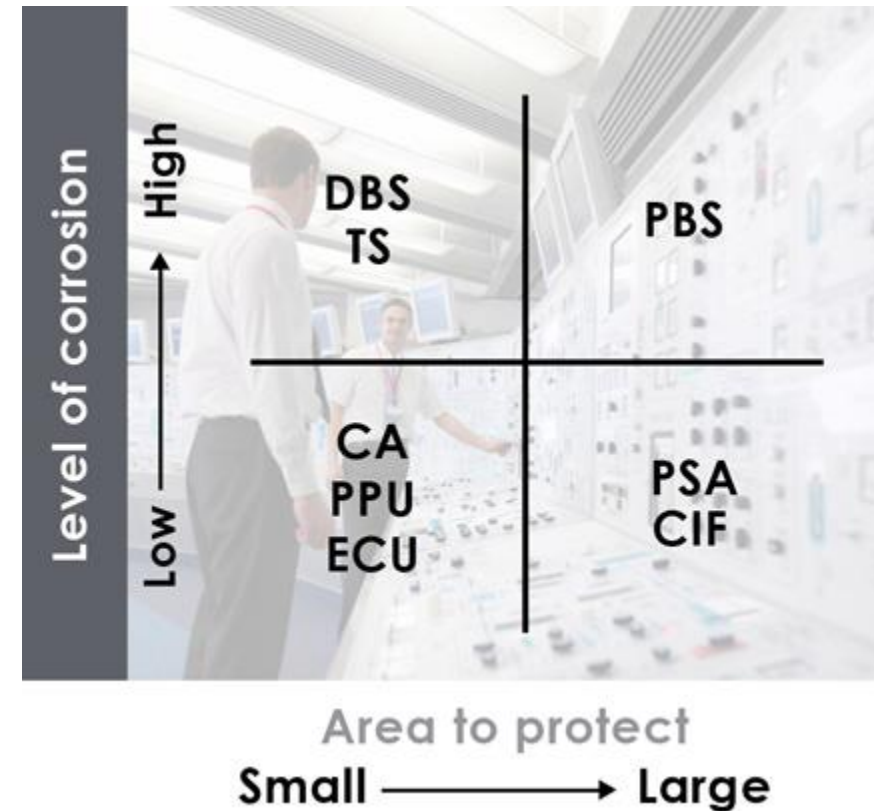
Electronic Cabinet Unit (ECU)

Parallel Bed Scrubber for Corrosion Control (PBS)

Positive Pressurization Unit (PPU)

Purafil Side Access (PSA)

Tub Scrubber for Corrosion Control (TS)



Freudenberg Supplies Pellets for Air Contaminants

Particularly at risk are sensitive areas such as electronic equipment, control rooms, process control systems and compressors. The negative effects of the corrosion of the copper and silver components of these devices include a loss of process efficiency, additional maintenance costs, expensive repairs and unplanned downtime.

Freudenberg provides protection against corrosion by contaminant gases that are released during the main process steps in papermaking:

Sulfate process

This alkaline process is currently dominant in pulp production and is used for both hardwood and softwood. The removal of lignin is caused by hydrogen sulfide ions (HS⁻) in a caustic medium. Within this process, both sodium hydroxide (NaOH) and sodium sulfide (Na₂S) are used, which in turn produce hydrogen sulfide (H₂S) and mercaptans. Once released, the H₂S causes corrosion and must be filtered out of the air.

Sulfite process

Comparatively rarely employed, this acidic method is used in the digestion of spruce, beech and eucalyptus. The removal of lignin is achieved by a sulfonation. Via sulfur dioxide, lignosulfonates are produced (salts of lignin). The flue gas containing sulfur dioxide (SO₂) represents a particular risk to machines and processes. We reliably remove this gas from the air using special media.

Wastewater odors: Pellets are also supplied to remove odors in wastewater from pulp and paper operations

Pollutant gases in the pulp and paper industry

Pollutant gases	Process	Viledon® ChemControl pellets
Hydrogen sulfide (H ₂ S)	Lignin removal (sulfate process) wastewater treatment	CCP 104, CCP 108, CCP 210, CCP 310, CCP 810
Mercaptans	Lignin removal (sulfate process)	CCP 104, CCP 108, CCP 210
Sulfur dioxide (SO ₂)	Lignin removal (sulfite process)	CCP 104, CCP 108, CCP 210, CCP 310, CCP 810
Sulfur oxide	Bleaching of waste paper Bleaching of wood pulp	CCP 104, CCP 108, CCP 210, CCP 310
Chlorine (Cl ₂)	Bleaching of pulp	CCP 310, CCP 510, CCP 610
Chlorine oxide (ClO _x)	Bleaching of pulp	CCP 310, CCP 510, CCP 610
Ozone (O ₃)	Bleaching of pulp	CCP 310, CCP 610

Bleaching of wood pulp

Sodium sulfite (Na₂SO₃) is often used in the bleaching of wood pulps. This produces sulfur dioxide, which is responsible for the corrosion of nearby electronic devices.

Bleaching of pulp

Among other chemicals, chlorine (Cl₂), chlorine oxide (ClO_x) and ozone (O₃) are used for the bleaching of pulp. Chlorine-free bleaching with ozone is more environmentally friendly, but leads also to the release of a corrosive and toxic gas.

Bleaching of waste paper

Dithionite is usually used in the bleaching of waste paper. This in turn releases sulfur gases that should be seen as the cause of corrosion.

GE Turbine Control System for Recovery Boiler

A key mill for a U.S.-based pulp and paper manufacturer operates two steam turbines that accept steam from a recovery boiler and step down the steam pressure to header levels vital to the plant's paper machines and evaporators. Leftover steam is then used to generate power for the mill. The second of the two turbines is a 40 MW unit that is critical to operations; if it were to experience an unplanned outage, it would cause a complete shutdown of all plant activities. This unit was operating with a Mark* II turbine control system, but support options and parts were limited. The company needed to upgrade the critical turbine to a modern solution with more support options available, while improving overall reliability.

Solution

- GE's Mark VIe and EX2100e technology allowed the mill to move its control logic from hardware to software form. The software is very durable, consistent, and provides easier diagnostics to investigate where a hardware problem may have occurred, which improves system availability by reducing the mean time to repair. The GE team also removed the mechanical overspeed trip bolt and replaced it with an electronic version, plus a triple-redundant trip solenoid arrangement with full online test capability.

Payback

- Upgrading to the Mark VIe and EX2100e led to less required maintenance, improved access to support and parts - and the ability to integrate third party monitoring and control systems into the turbine control. The GE team performed a complete upgrade within the strict timeline the company had outlined to reduce upgrade costs and prevent unnecessary downtime at the plant. In the longer term, the installation is expected to lead to fewer total outages at the mill, saving the company significant maintenance costs.

Benefits: Following the installation of the GE's Mark VIe and EX2100e, the paper company received a variety of additional benefits, including:

- **Improved plant operations**, providing better reliability and availability to help the mill maintain revenue by meeting production needs and quotas.
- **Common Human Machine Interface (HMI)** and improved training, testing and parts support.
- **High visibility into control code**, shifting away from strictly a "black box" approach.
- **Improved availability of spare parts and a suite of flexible life-cycle management options.** The upgrades also reduced the need for custom code within the system.

GE Precipitators and Scrubbers in Pulp and Paper

- GE acquired the APC operations of Alstom. This includes the electrostatic precipitator operations original developed by Flakt who has 50 years of experience supplying precipitators for recovery and power boilers in pulp and paper. The company also has supplied more than 80 ESPs for lime sludge kilns and about 50 scrubbers for recovery boilers. Flakt initiated remote monitoring and support for precipitators in the 1980s. The value of remote support is well documented. So incorporation of this system into a plant process management system is very desirable.
- GE (Alstom) supplied an Electrostatic Precipitator (ESP) to Suzano Papel e Celulose* for its pulp and paper plant, located in Mucuri, in the Brazilian state of Bahia. In 2011 Alstom was awarded four Environment Control Systems (ECS) projects by Suzano's contractor CBC. This project became operational in the second quarter of 2013.

Alstom's ESP technology enables the capturing of particles in the flue gas derived from the burning of biomass, reducing the industry's impact on the environment. The Mucuri plant burns biomass waste from its pulp and paper production to produce steam and generate electricity. The off-steam is then used in the plant and therefore further improves the efficiency of the installation.

- The pulp and paper air pollution control system market is around \$200 million per year including service and repairs. The estimated GE share is around \$10 million

Stora Enso Ventilation Improvement with TM Systems

Goals

The investment aimed to improve the machine hall ventilation, to even out the temperature differences and to increase the performance of heat recovery in the ventilation. The goal was also to create savings in energy usage by decreasing the steam usage in supply air heating.

Solution

The air balance of the machine room was improved by installing new supply air units. At the same time, the heat recovery system was rebuilt by adding a modern heat recovery tower, which included new hood exhaust system, supply air system and heating of process and glycol water. Over 10 MW energy could be recovered.

At the same time we changed the mist collector in the wire cleaner, and by doing so, we reduced the moisture load in the wet end.

Qualifications

"We evaluated the solutions offered by various suppliers and decided to start cooperation with TM System Finland Oy, who offered the best solution in terms of price and quality."

Result:

"The solution has met our expectations. We are already seeing clear energy savings. Our goals for ventilation improvements have also been met.

Timetable

Cooperation started at the end of 2012. The schedule was tight and TM Systems took care of the technical planning of the process swiftly. The project was executed in 2013.

jani.korvela@tmsystems.com

Testimonial by: Pasi Lampinen, production manager, Stora Enso, Imatra

IVI Turnkey Ventilation Systems for Converters

Some of the biggest names in the pulp, paper, tissue and paper converting industry rely on IVI's turnkey ventilation, plan and spec, process air and dust collection systems. A custom pulp and paper ventilation solution built for your unique manufacturing environment can improve operating efficiency and provide long-term maintenance and replacement costs by:

- Reducing the amount of energy the overall system uses
- Reducing corrosion and deterioration
- Minimizing fiber and dust buildup
- Curtailing moisture buildup in the operating environment
- Preventing combustion-related fires

- **Pulp and Paper Industry Regulations**

- Energy and emission regulations, as well as customer demand, continue to challenge the pulp and paper industry to increase energy efficiency and improve operating environments. IVI knows you need a partner who is knowledgeable in both regulations and customer demand, that's why our team is trained and stays up-to-date on codes and standards from the National Fire Protection Agency (NFPA), Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA) and Factory Mutual standards.

- **Pulp and Paper Projects**

- A few examples of projects in the pulp and paper industry include:
- Large tissue machine ductwork fabrications including installation
- Explosive dust collection systems
- Fully installed, turnkey process air systems
- Wet-end fume and saveall systems
- Custom mezzanines

Powders

Powders

Process	Sample Suppliers
Blowers For Pneumatic Conveying	Colfax, Gardner Denver
Bin Collectors	CECO, AAF, Parker, Filtration Group,
Pneumatic Conveying Systems	Airtrim, Noltec, Clyde Bergemann
Cyclones	CECO
Screens	
Silos	Kopar, Clyde Bergemann, kWS
Mechanical Conveyors	Kopar, KWS
Screw Conveyors	Kopar, KWS
Rotary Feeders	Kopar, KWS

Clyde Bergemann Material Handling in P&P

Products

- Fly and bottom ash systems
- Lean and dense phase pneumatic conveying solutions
- Sorbent injection technology
- Fuel feed and injection
- Dry and wet bottom ash systems
- Slurry systems
- Silo storage and discharge systems

References: Boise Cascade, Georgia Pacific, CBSK,
Torraspapel

Kason - Wood Preparation Screens

1. Hydraulic Barkers: Kason's are used to clarify and remove suspended solids from recirculated water that could cause serious damage to very high pressure (1000 psi or more) pumps used in this barking process. Screens from 24-46 mesh are employed and capacities up to 750 GPM are reported. Removal of bark fines and other material also reduces solids build-up in log ponds.
2. Barking Drums: Effluent from scraper conveyors is normally high in bark solids because it is impractical to use inclined stationary screens with openings smaller than 3/8". This effluent can pass to Kason's operating in a secondary clarifying position with screens as fine as 100 mesh. Kleen Screen rings must be used to eliminate blinding and capacity will be up to 400 GPM depending upon the nature of the bark solids. Water-driven logs having high pitch content will lead to serious screen blinding problems even on coarse screens, e.g. 10 mesh. Kason's are less expensive to install and operate than rotary screens and result in much cleaner effluent. Secondary screening of bark effluent can result in: a) Significant stream pollution reduction effluent averages 0.015% consistency. b) Eliminating annual dredging. c) Sale of fine bark collected as furnish in the manufacture of board and cheap wrapping papers, such as car liner.
3. Bark By-Products: The Kason has been effectively used in bark by-product processing. One company, for example uses a two-deck 72" Kason closed circuit with a briquetting press.

Kason Screens - Cooking Liquor

- 1. Clarification of Waste Sulphite Liquor: A Kason with 100 mesh screen will remove approximately 70% of suspended solids present in waste sulphite liquor and a 48" diameter unit will handle approximately 250 GPM. Screening will reduce stream pollution, and where exchangers are used to recover heat, it will reduce down time for cleaning (particularly on plate-type exchangers).
- 2. Clarification of Black Liquor Prior to Evaporation: Kason's with 80 mesh screens remove fiber carried over from washers and definitely improve evaporator operation. The quantity of fiber to be removed is very small and capacities of approximately 400 GPM are possible on a 48" diameter unit. Feeding the screen under gravity conditions does require the 360° discharge is achieved with Kascade deck design, greatly increasing the capacity of this Kason Separator handling shower water. installation of a surge tank and an extra pump in the system.
- 3. Secondary Classification, Slaked Lime: Kraft mill causticizing plants normally employ a continuous lime slaker that incorporates a classification and washing section for grit. Fine grit and agglomerates of slaked lime may remain suspended and pass on to the causticizer. A Kason with an 80 mesh screen will clarify slaker output at approximately 150 GPM reducing abrasion on valves and pump

Kason Screens - Fiber Recovery

- 1. Knotting: Kason's are competitive with conventional knotter screens for chemical pulp. The application is recommended for sulphite stock and a 48" diameter unit will handle 75 tons or more per 24 hours. The industry is moving towards pressure screens for sulphate or soda stock and this type of screen offers many known advantages.
- 2. Reject Dewatering: A very large number of units are installed on dewatering rejects to produce regulated, high consistency feed for refiners. A 48" diameter unit will handle up to 20 tons per day accepting feed from 0.5 to 1.0% and discharging rejects at 6 to 12% consistency. 20 mesh screens are most frequently employed and white water losses are negligible. Rejects are being thickened in ground wood, sulphite, high yield sulphite and kraft mills. Light weight and small space requirement combine to allow for simple installation and rejects are normally gravity fed directly to the refiner. Higher consistency can be obtained than that possible from rotary type drainers, deckers, inclined screens or perforated bottom drag conveyors, and installed cost is usually less. In high yield sulphite plants Kason's dewater centrifugal screen rejects and allow for separate refining rather than mixing with partially refined stock on interstage vacuum washers. Cyclone rejects are dewatered by Kason's where they can be used in board or other lower grade products.
- 3. Shower Water Clarification: Paper machine economizer water picks up fibre and cannot be used on felt showers because of its tendency to block nozzles. Screening at approximately 80 mesh will allow use of this hot water for showers and a 48" diameter Kason will handle approximately 550 GPM.

Kopar Conveying Mill Powders and Combustion Ash

- Kopar's involvement in the Pulp & Paper Industry includes two separate lines of equipment. One is related to conveying and transferring many types of ingredients used in pulp and paper production, such as, soda, granulates, magnesium oxide, starch, magnesium oxide, magnesium sulfite, bentonite, pigment and kaolin, for instance.
- The other line is about handling and conveying fly or bottom ash when the installation is burning materials and thus producing heat and energy. In both cases, the processes needs silos for storage in addition to conveying systems. Both are part of Kopar scope of supply.

KWS Conveyors, Feeders, Bins

- Paper products are made from wood pulp, cellulose fibers or recycled newsprint and paper. Wood chips and many different chemicals are used in the paper making process. These bulk materials are conveyed, metered, elevated and stored using equipment made by KWS. The equipment is ideal for the pulp and paper industry. They regularly manufacture using corrosion-resistant alloys such as 317L and Hastalloy. Tree bark is a by-product from the paper making process and is used as a fuel to fire boilers for the pulping process. The bark is extremely abrasive and requires special design considerations. KWS designs and manufactures bark bins and live-bottom feeders using chromium carbide surfaced plate to resist abrasion.



Pulp & Paper Empowering IIoT with IIoW

The pulp and paper industry is implementing IIoT and Remote O&M. As it does so it also needs to organize the wisdom of all the component suppliers so that IIoT will be empowered by IIoW. With IIoT it is possible to maximize the efficiency of an existing pump and drive. However, interaction with the valve and pump suppliers is needed so that they can make their products even better for each specific unique application.

The suppliers of management systems need to better understand the capabilities of the component suppliers. The component suppliers need first to identify the specific opportunities and work toward providing each customer with the best products to fit his needs.

With cloud based management systems utilizing data analytics there will be the equivalent of continuous white papers on each component. This knowledge will encourage purchasers to buy the best products rather than the ones with the lowest cost.

Mcilvaine is providing a program built around specific forecasting of each component along with the broader analysis of the IIoT and Remote O&M opportunity .

