How is my Process Water? Improving the Quality of Deinked Pulp

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Contents

Current situation

- **Higher load of various contaminants in the process water**
  - Reduced water consumption in deinking mills
  - Lower recovered paper quality
- **Influence on achieving the target brightness levels**
  - Increasing bleaching chemicals
- **Several reasons**
  - Altered process water quality (more coloured dissolved and colloidal molecules)
  - Flotation less effective, conventional ink particles are less efficiently removed due to unknown interactions disturbing the flotation behaviour
  - Higher content of small ink particles (for example water based inks)
- **Motivation from INGEDE Project 132 10**

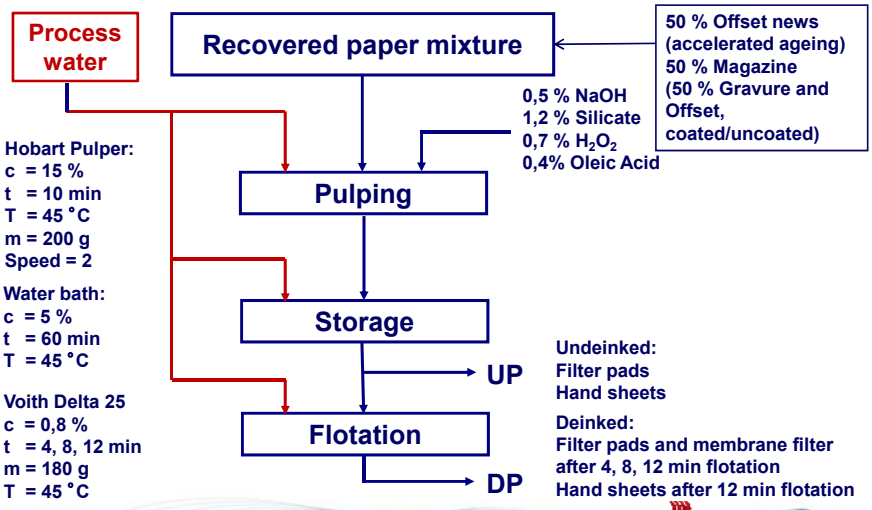
Research targets

- Systematic assessment of **differences in process water quality** and their impact on the deinking result of a recovered paper mixture
- Insights into the influence of **individual process water parameters** on the deinking result of a recovered paper mixture
- Increasing the deinked pulp (DIP) quality and reducing fluctuations in the use of recovered paper for the production of graphic papers by **improving the process water quality** by means of suitable **cleaning processes** in the interests of optimum DIP quality

Test parameters

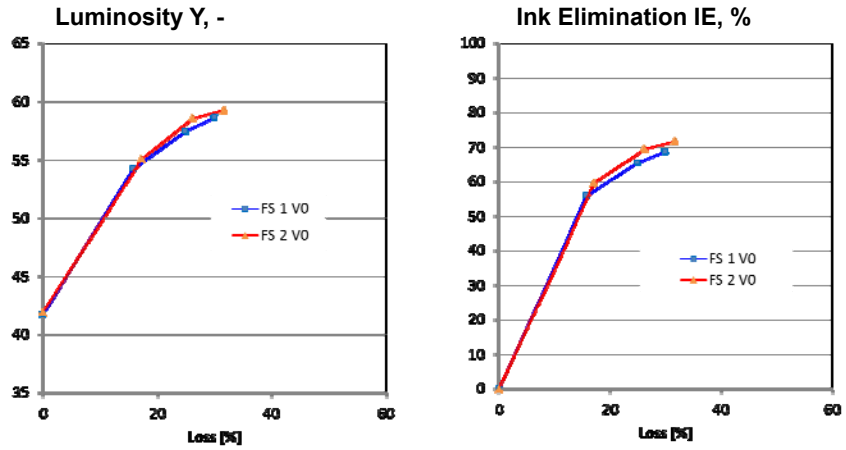
Measurement parameter	sample
Surface tension	remote sample
Cationic demand	wire
Foam volume	total sample
pH	
Conductivity	
Temperature	
Total dry residue	homogenised sample
Total residue on ignition	
Filterable substances	
Dry residue	filtered sample
Redox potential	
COB	membrane filtered sample
Hardness	
Volatile organic acids	
Nonionic surfactants	
Anionic surfactants	
Acetic acid	
Absorbance spectrum	
Deinking parameter with process water according to INGEDE Method 11	filtrate

Experimental procedure



Comparision of the results with dilution water (V0)

- Results of deinkability tests of PTS and PMV are comparable



Flotation time: 4, 8, and 12 min

Impact of different process waters (test on day after sampling)

- Investigating the **deinking behaviour** of a recovered paper mix **with different process waters** from paper mills producing newsprint, LWC or recycled paper
- Comparative tests **with fresh water** and two different chemical formulations
- Used abbreviations
  - ZDP = newsprint
  - RCP = recycled paper
  - LWC = LWC paper
  - TF = clowdy filtrate
  - KF = clear filtrate

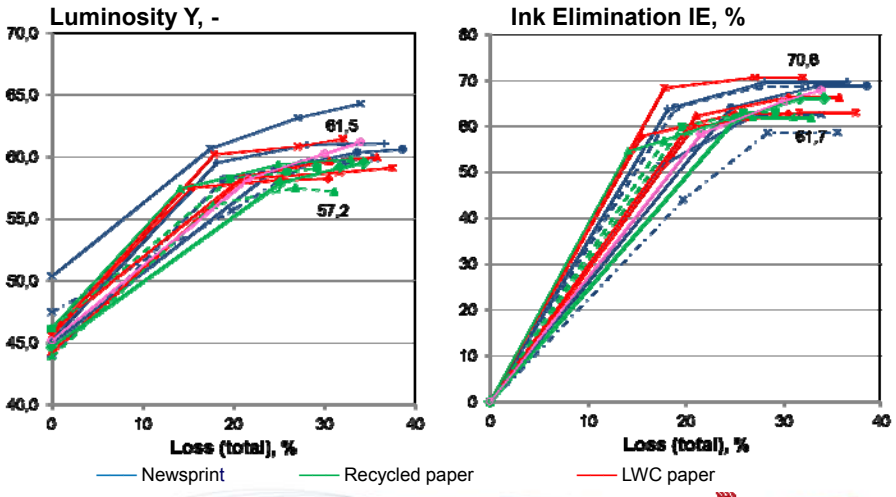
Range of process water quality

- Process water properties of different deinking plants vary significantly

Parameter		Min	Max
pH after shipping	-	7,3 (6,8)	8,5
Solid content	%	0,02	0,87 (3,4)
Ash content	%	46,4	74,9
Conductivity	mS/m	214	593
Redox potential	mV	42	353
Hardness (total)	mmol	1,6	4,2 (7)
Cationic demand	µeq/l	427 (48)	2153
COD	mg/l	897	9613
Organic acids	mg/l	140	1487
Nonionic surfactants	mg/l	2,7	18,1
Anionic surfactants	mg/l	1,2	14,5
Surface tension	mN/m	44,4	59,9
		57,3	64,8

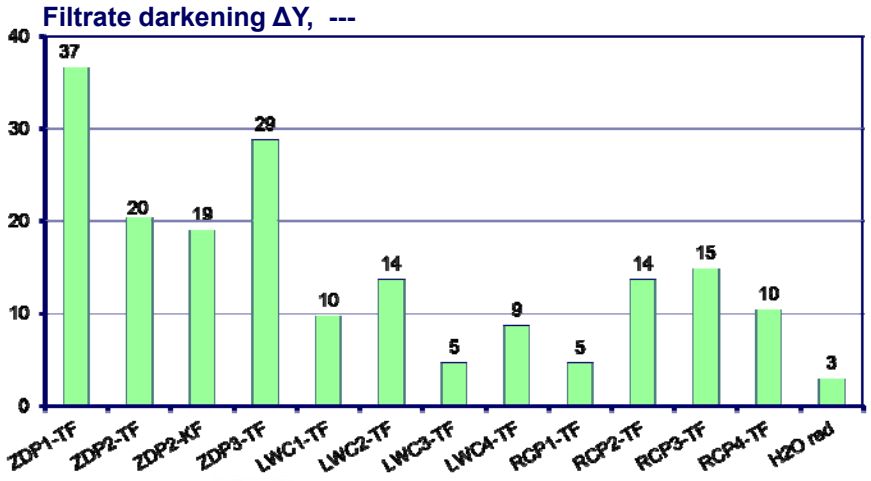
Deinking results with different process water

- Deinking results are relatively narrow in bandwidth



Filtrate darkening (12 min flotation)

- Filtrate darkening higher with process waters from mills producing newsprint



Correlation coefficients: process water parameters and ink elimination IE

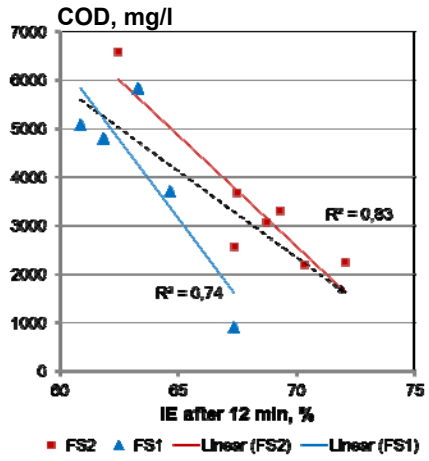
Parameter	All	PMV	PTS
Solid content	-0,31		
Ash content	-0,01		
Conductivity	-0,34		
Redox potential	0,9		
Hardness (total)	-0,62		
Cationic demand	-0,49		
COD		-0,91	-0,86
Organic acids		-0,97	-0,78
Nonionic surfactants		-0,76	-0,96
Anionic surfactants		0,22	-0,81
Surface tension		0,82	0,94

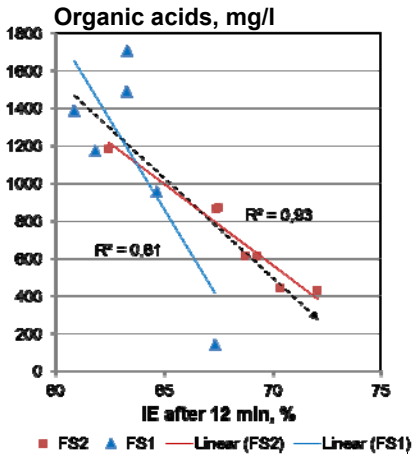
Decrease in ink elimination with

- Decreasing redox potential (microbial load)
- Increasing COD
- Increasing organic acids
- Increasing surfactants
- Decreasing surface tension

COD and organic acids vs ink elimination (IE)

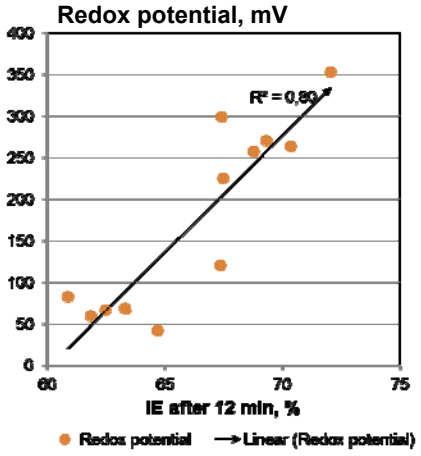
- Increasing ink elimination with decreasing COD and organic acids

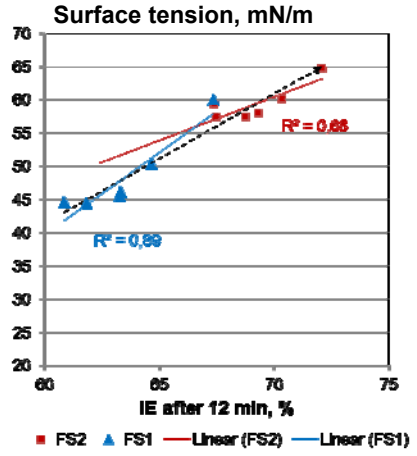




Redox potential and surface tension vs ink elimination (IE)

- Increasing ink elimination with increasing redox potential and surface tension





Range of process water parameter with increasing ink elimination (12 min flotation)

	pH after shipping	Redox potential	Hardness (total)	COD	Organic acids	Surface tension	Y 12 min	IE 12 min
	-	mV	mmol/l	mg/l	mg/l	mN/m	-	%
RCP4-TF	6,8	60	7	4779	1172	44,4	57,2	**61,8**
RCP2-TF	7,7	67	3,1	6580	1184		56,7	**62,5**
RCP3-TF	7,7	69	3,5	9613	1487	45,6	59,8	**63,3**
LWC2-TF	7,7	68	3,2	5829	1707	46,1	58,2	**63,3**
LWC4-TF	7,4	42	3,6	3704	954	50,3	59,1	**64,7**
average	**7,5**	**170**	**3,4**	**4070**	**874**	**54,6**	**59,4**	**66,4**
LWC3-TF	7,5	121	4,2	897	140	59,9	60,0	**67,4**
RCP1-TF	7,7	299	3,5	2568	867	59,2	59,5	**67,4**
ZDP2-KF	7,4	258	2,5	3070	614	57,4	59,6	**68,8**
ZDP2-TF	7,3	271	2,7	3300	612	57,9	60,6	**69,3**
ZDP3-TF	7,3	264	2,4	**2198**	**443**	60	61,1	**70,3**
LWC1-TF	8,5	353	1,6	**2228**	**432**	64,8	61,5	72,1

Critical process water parameter

- pH < 7
- Redox potential < 170 mV
- Surface tension < 50 mN/m
- COD > 4000 mg/l
- Organic acids > 800 mg/l

Purification experiments

- **Centrifugation:**

  Centrifugal speed: 2500 min^{-1}

  Run: 660 ml min^{-1}

  Sieve # 240-48506 (120 µm mesh)

  45 l of process water was centrifuged without interruption

- **Filtration:**

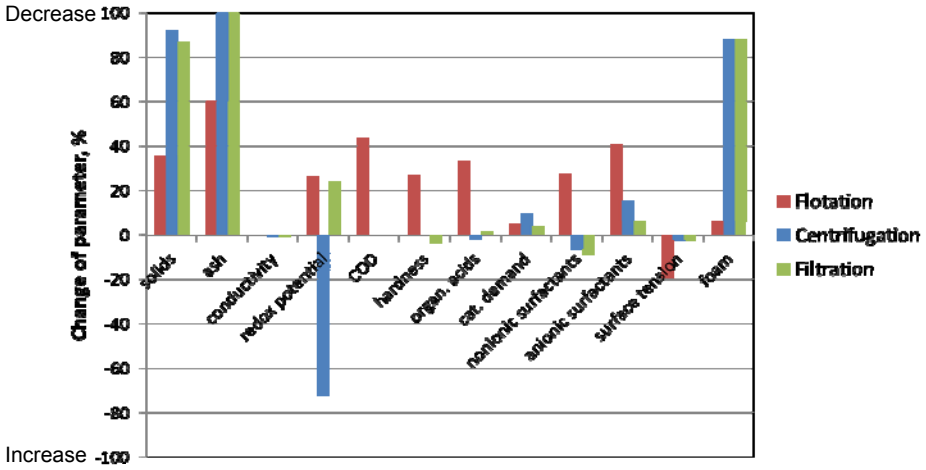
  Use sieve with 0.22 mm × 0.14 mm pore size,

  Sieve was replaced after filtration every 2 l of process water

- **Flotation:**
  Voith Delta Cell, T = 45 °C, t = 12 min, no addition of chemicals
  Loss: water 19 %, solids 65 %

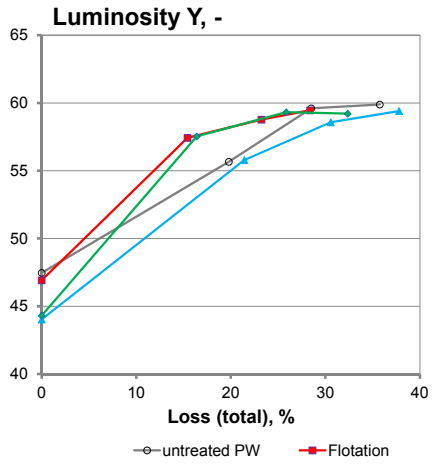
Purification experiments – change in process water parameters

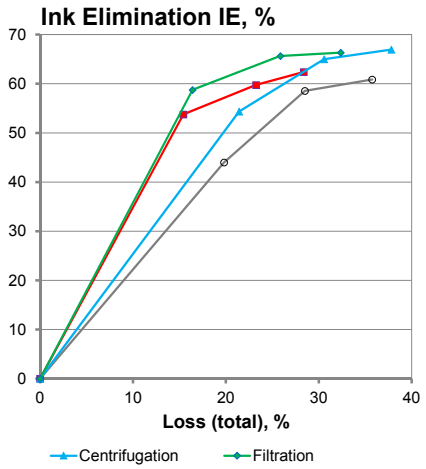
- Flotation more efficient regarding change in COD, organ. acids, and surface tension



Purification experiments – luminosity and ink elimination

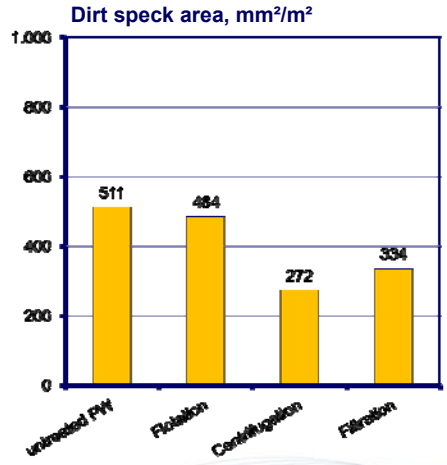
- Improvement of ink removal low, but increase in selectivity by flotation or filtration

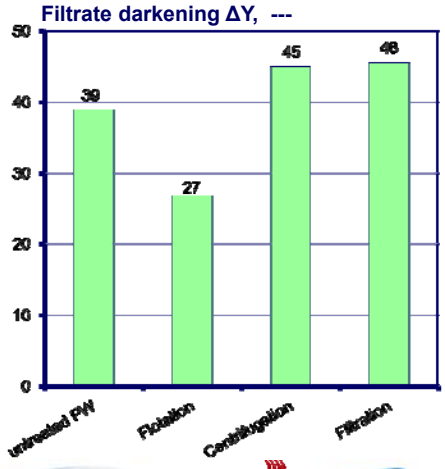




Purification experiments – dirt specks and filtrate darkening (12 min flotation)

- Centrifugation and filtration more effective regarding dirt speck reduction, flotation more suitable for filtrate darkening





Process water parameters before and after purification

		Untreated PW	Flotation	Centrifugation	Filtration	Critical parameter
pH		7,2	7	7,6	7,5	< 7
Redox potential	mV	83	61	143	63	**< 170**
COD	mg/l	5080	2853	3740	3740	> 4000
Organic acids	mg/l	1302	865	910	880	**> 800**
Surface tension	mN/m	44	53			< 50
Selectivity (L)	-	1,7	2,2	1,8	2,0	
Selectivity (FL)	-	2,7	4,1	2,7	3,9	

$$\text{Selectivity (L)} = \frac{\text{Ink Elimination IE}}{\text{Total loss}}$$

$$\text{Selectivity (FL)} = \frac{\text{Ink Elimination IE}}{\text{Fiber loss}}$$

Summary I

- Investigations on the **influence of the process water** properties on the deinking potential
  - **Storage of process water** can impact both process water characteristics and deinking potential
  - Process water **properties** of different deinking plants **vary** significantly. Deinking results are relatively narrow in bandwidth

- **Better ink removal** at
  - higher pH, redox potential and surface tension
  - lower hardness, COD, and organic acid content ,

Summary II

- Purification experiments by **centrifugation**, **filtration** and **flotation** of process water
  - Centrifugation and filtration more effective regarding **dirt specks** reduction, flotation more suitable for **filtrate darkening**
  - Flotation of process water more efficient regarding change in **COD**, **organic acids** and **surface tension**
  - Despite the change in process water parameters by the purification processes, the **improvements** in deinking properties **are comparatively low**
  - But the selectivity of ink removal could be increased by the **flotation and filtration techniques**. This is to be considered positive in view of the losses obtained by the ink removal

Thank you for your attention!

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