Principles of Enzymatic Deinking (EDT) and Practical Implementation in a Paper Mill (VHP)

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  - Side effects (Heavy dirt/ Stickies/ COD)
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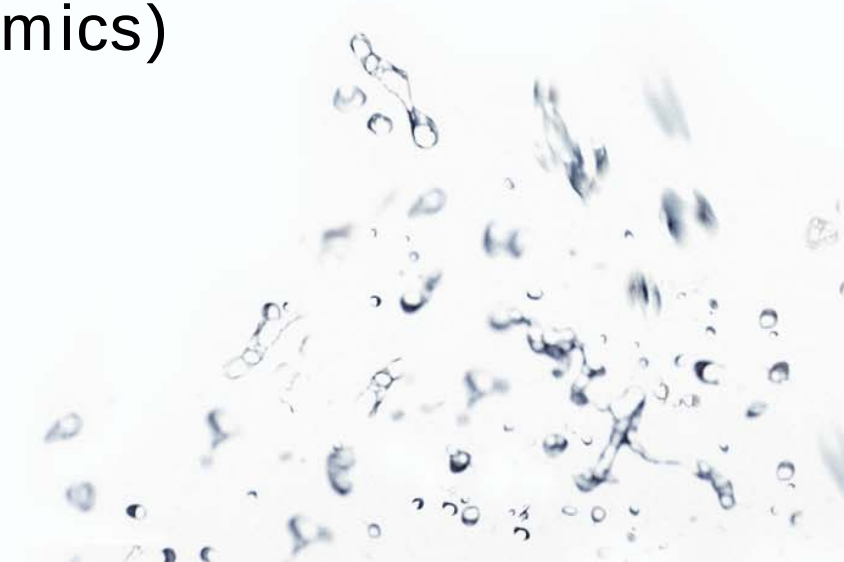
- Final Conclusions

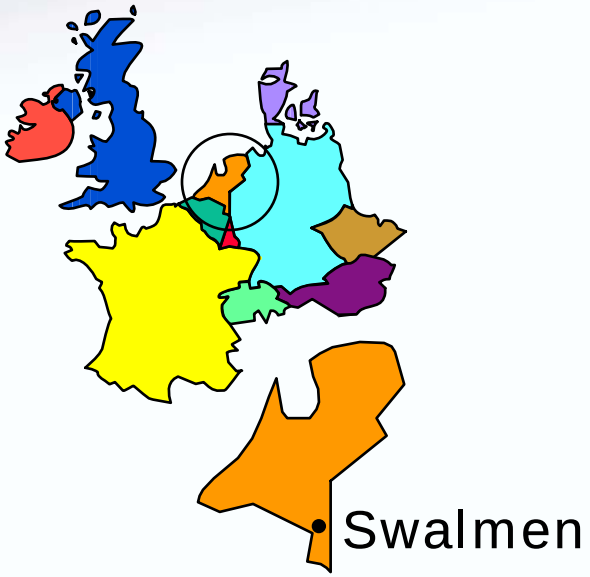


Van Houtum Papier

- Founded in 1935 by the brothers Henk and Johan van Houtum

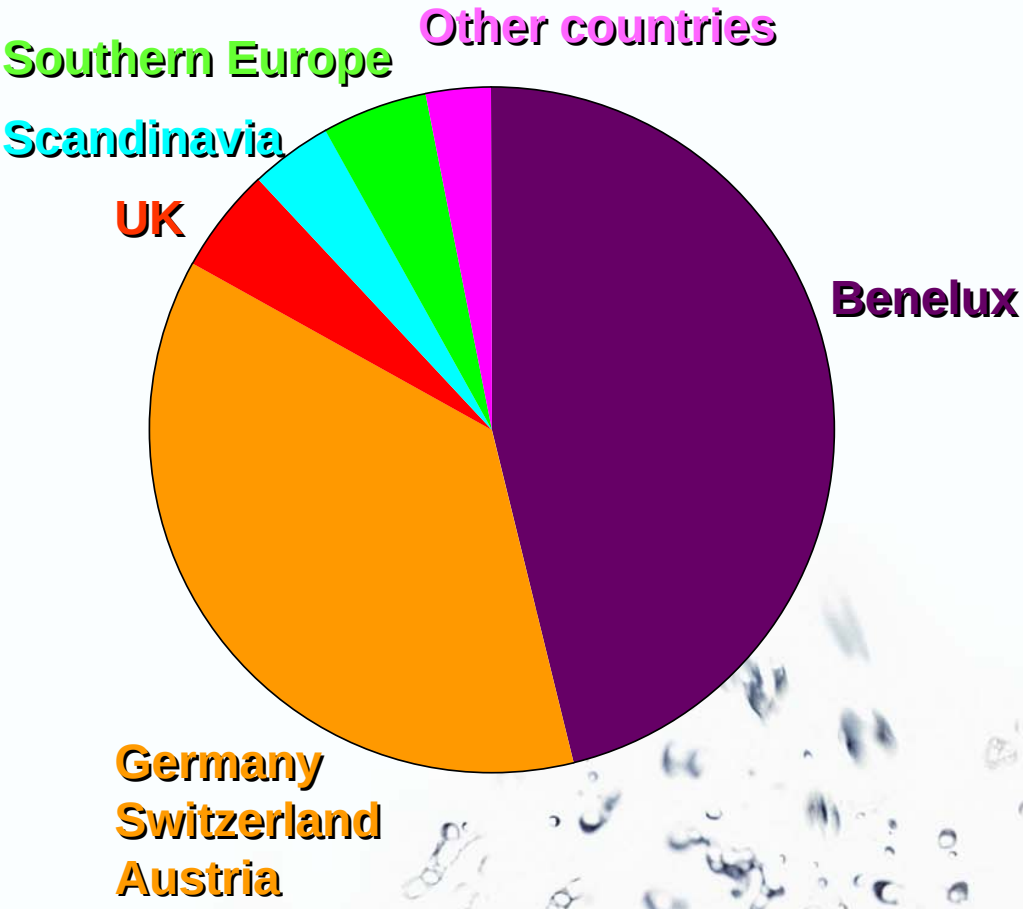
- Still family business: We are independent and flexible, quick response

Sites and key figures



- Turnover : € 50 million
- Capacity : 45.000 tons
- Employees : 230

Markets (geographic)



Paper production

Capacity: 45.000 tons per year

Production

- Stock preparation based on waste paper
- 2 paper machines:
  - -1 Fourdrinier – crepe (PM3)
  - -Crescent former – tissue (PM4)

Converting

- 2 high speed toilet paper lines
- 5 ultra-modern folded towel lines
- 1 high speed wiping roll line
- Fully automatic palletisation

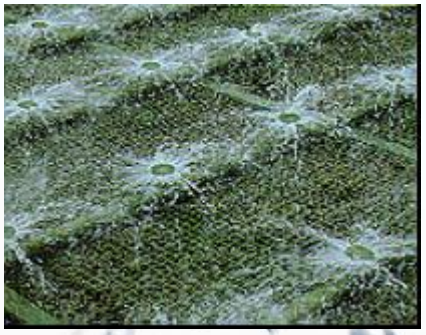
Sustained development

Raw Material

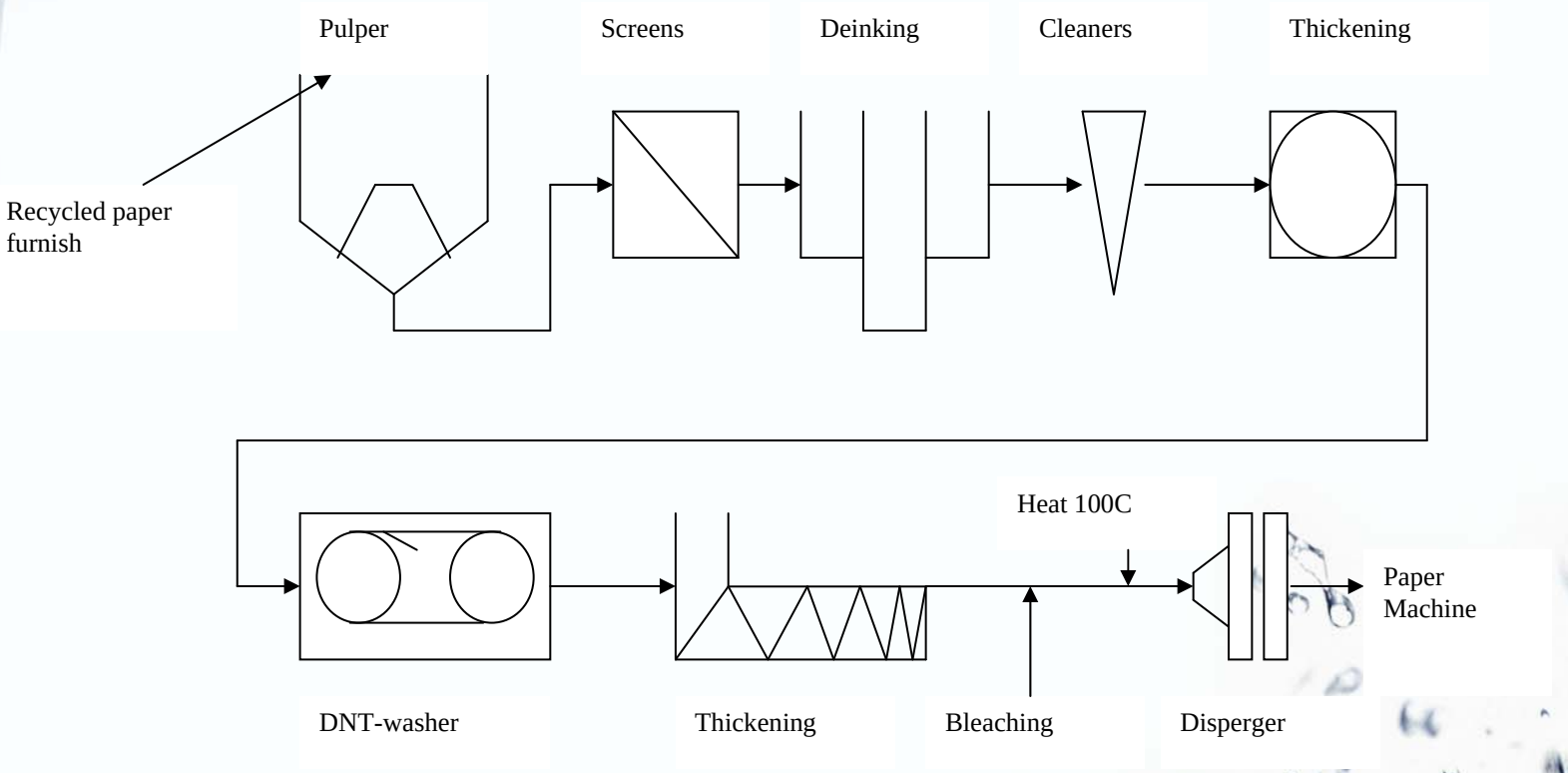
- 100% waste paper as raw material
- 15 ktons of waste per year (rejects) = raw material used in the building material industry and power plants

Water

- Low water consumption (12 m3/ton)
- Biological water treatment



Schematic overview stock preparation

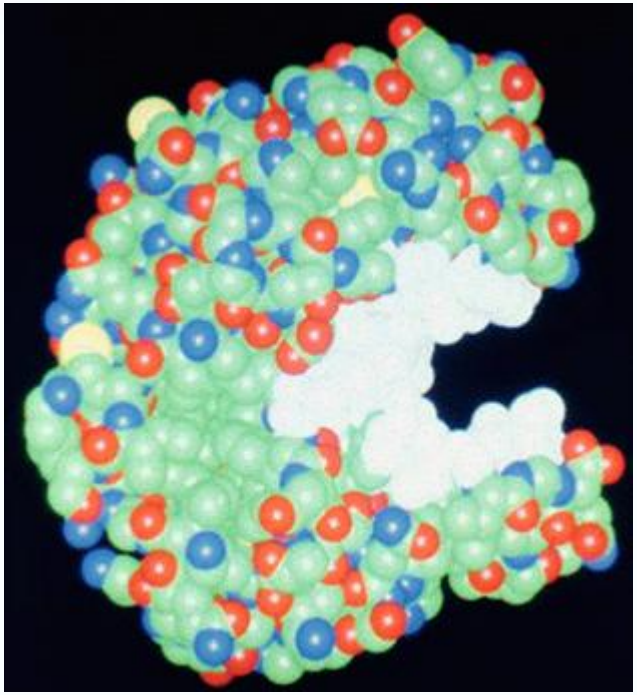


Contact: VHP with EDT

- First contact in Grenoble (France) during CTP/PTS Deinking Symposia (2000)
- Visit EDT at VHP (Project proposal)
- Deciding start project in Brussels during Pira Recycling Technology conference (2001)

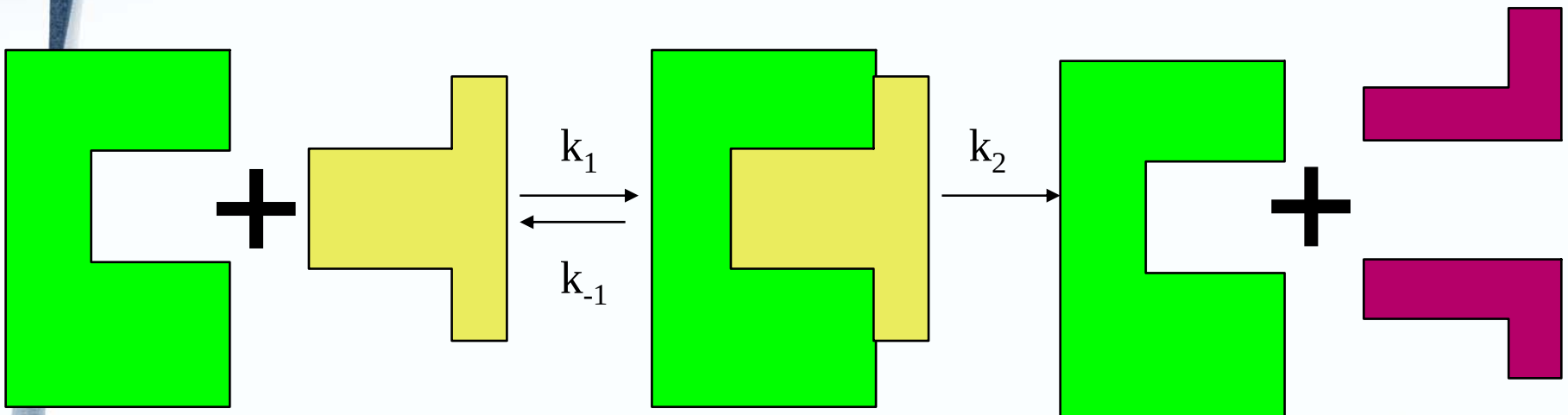
- Project subsidies by Dutch government (Novem)

What are Enzymes?



- Not alive, but produced by living organisms
- Biological catalysts
- Unique activities
- Produced by fermentation
- Safe to handle and use
- Growing range of pH applications

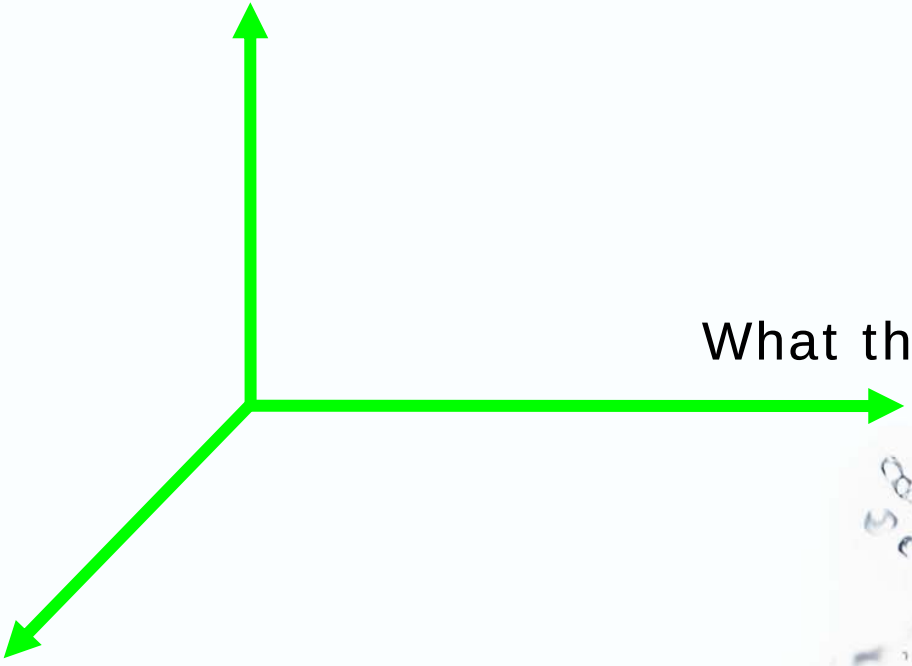
Lock and Key Model



Enzyme | Substrate | Enzyme-Substrate Complex | Enzyme | Products

Axes of Development in Enzymatic Research

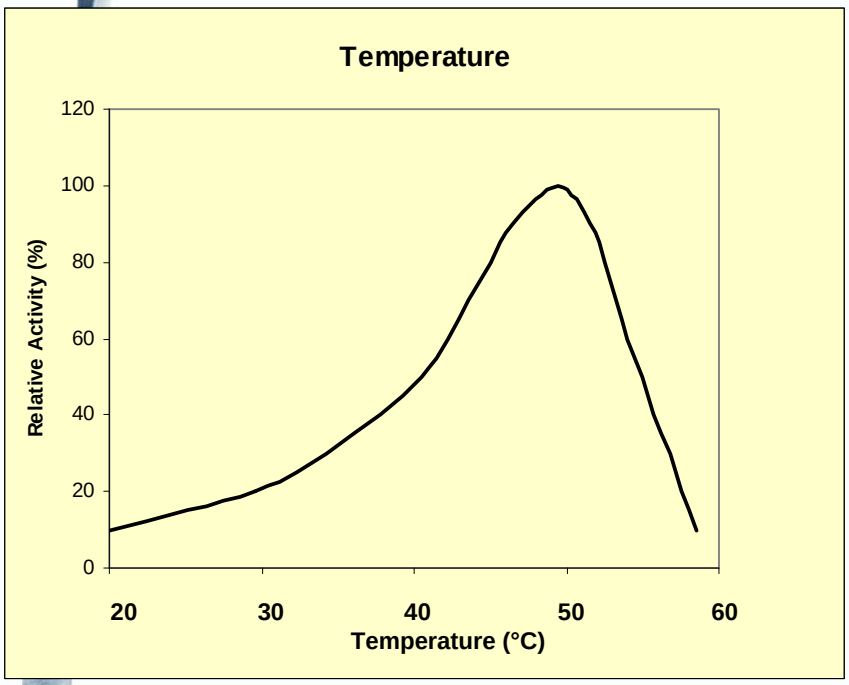
How economically the enzyme can be produced

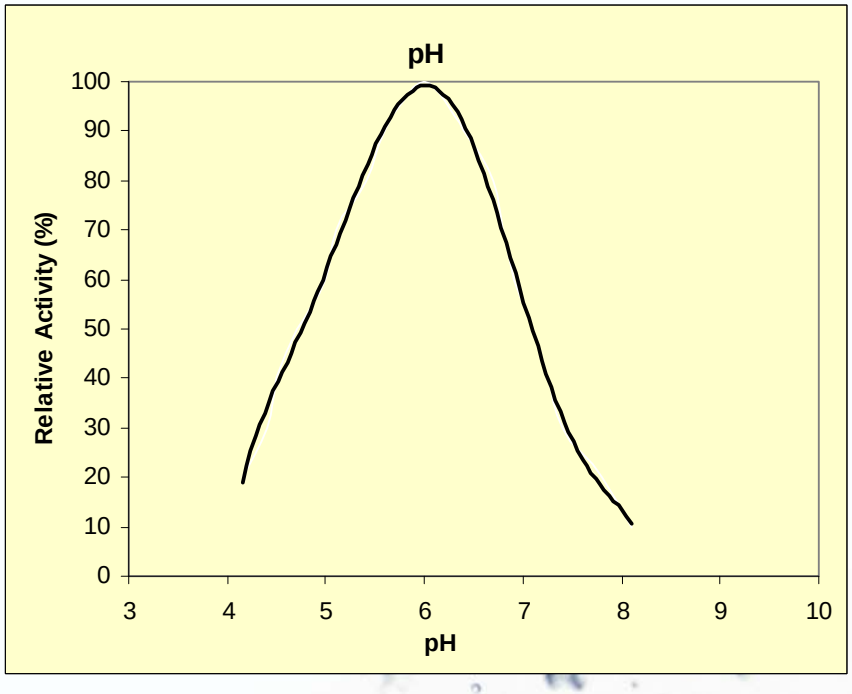


What the enzyme does

How tolerant/stable the enzyme is (e.g., temperature, pH)

Enzymatic Activity vs. Temperature and pH





EDT Mill Analysis and Product Development Process

Understand mill situation	Analyze mill performance	Develop mill treatment and validate improvement	Conduct mill-scale trial
-process flow -conditions -current treatments -desired improvements	-stock and water analysis -final product	-EDT product -application conditions -controlled comparative assessment	-mill-scale validation -optimization

Enzymatic deinking project

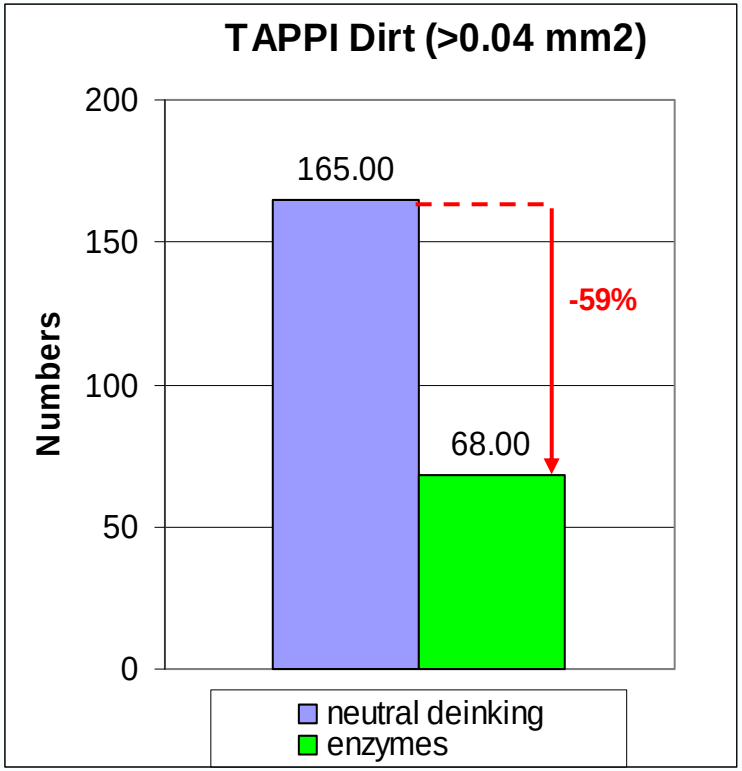
- Phase 1: Laboratory trial
  - “Blue Print” stock preparation VHP with neutral deinking agent
  - Determine custom-made enzyme-mixture for VHP
  - In the Laboratory a comparison between neutral deinking agent and the VHP enzymes
- Phase 2: Short mill trial (2 weeks)
  - Optimisation furnish
  - Optimisation stock preparation
- Phase 3: Long mill trial (2 months)
  - Side effects
  - Determine economics

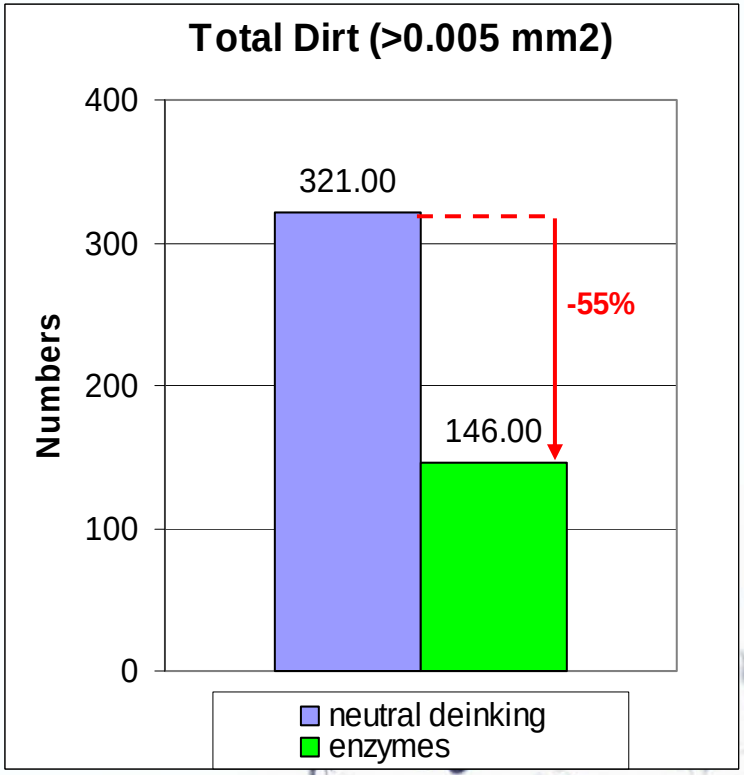
Phase 1: Laboratory trial

- “Blue print” analysis shows bad dirt removal, minimal brightness development and wrong water dillutions.
- A mixture with several different enzymes was tested on VHP recycled paper furnishes. The best mixture is selected.
- The determined enzymes are compared with neutral deinking agent (anionic tenside).
  - Dirt removal
  - Brightness
  - ERIC Ink Concentration

Phase 1: Laboratory trial (results)

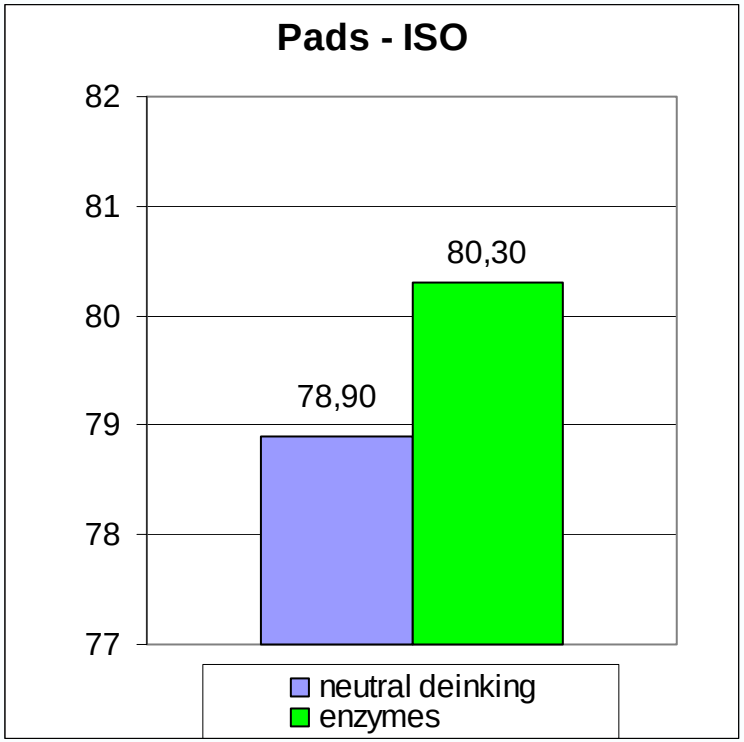
- Dirt removal

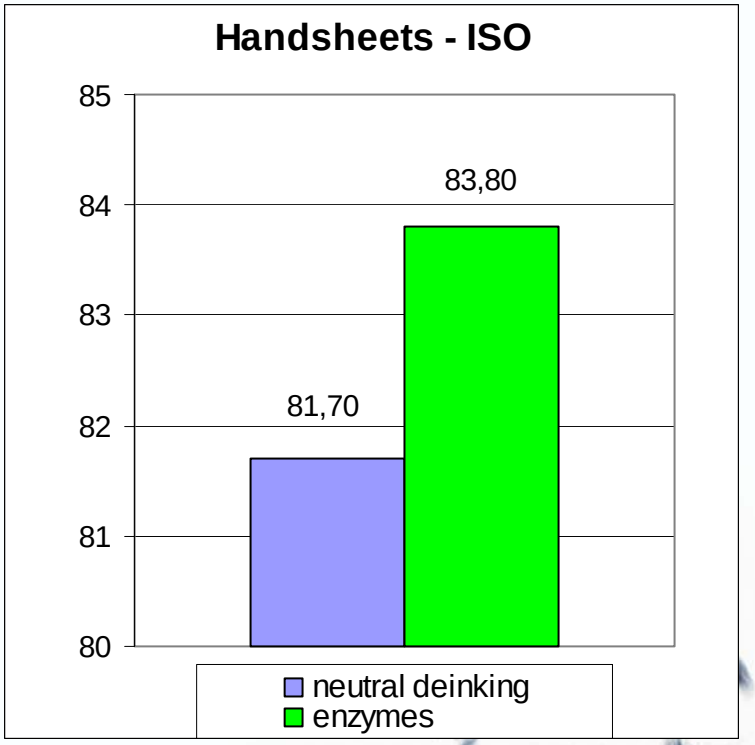




Phase 1: Laboratory trial (results)

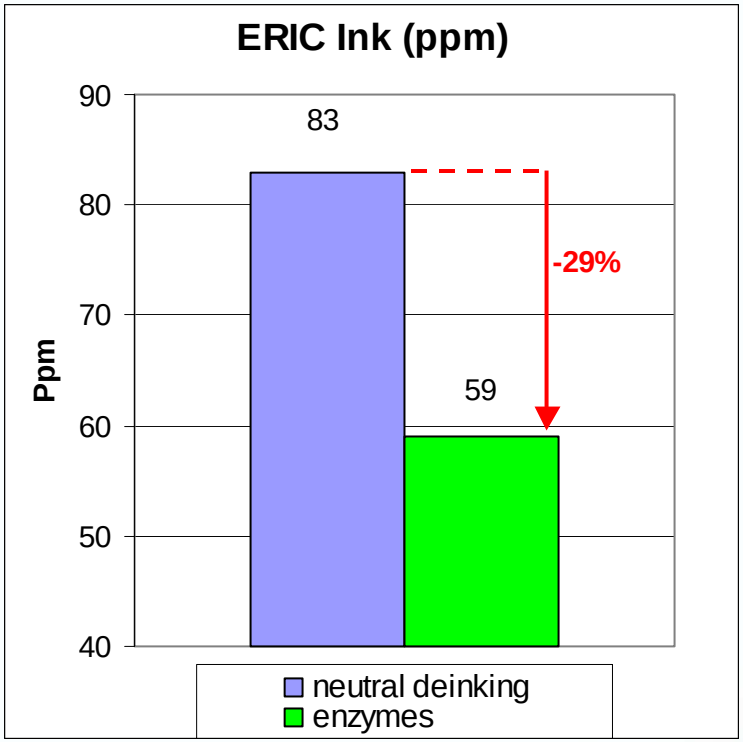
- Brightness development





Phase 1: Laboratory trial (results)

- ERIC Ink Concentration



Phase 2: Short trial at VHP

- Objectives:
  - Improve dirt count, stabilize brightness by changing the furnish grade (cheaper).
  - Same or better quality paper
  - Reduce overall mill costs
- Wastepaper grades used at VHP
  - MOW
  - Light coloured ledgers
  - Extra Light coloured ledgers
  - Wood free White letters
  - Printed Sulphate board

Phase 2: Short trial at VHP

- Product grades vs furnish mixture
  (before short term trial with enzymes)

	Naturel	Naturel +	RC	LC	RC+
Target Brightness ISO	50	61	67	71	77
MOW	100%	34%	25%	20%	
Light coloured ledgers		66%	75%	80%	33%
Extra light coloured ledgers					17%
Wood Free White Letters					17%
Sulphate board					33%

Phase 2: Short trial at VHP

- Dosing enzymes in pulper
- Changing setting deinking cell (foam layer more compact and less high).
- Brightness increases with same furnish
- Better dirt removal, measured after deinking with inline dot-counter.
- Determine new furnish-mix for the two major products: Naturel+ and RC+ (80% production)

Phase 2: Short trial at VHP

- Product grades vs furnish mixture
  (changes furnish Naturel+ and RC+ with enzymes)

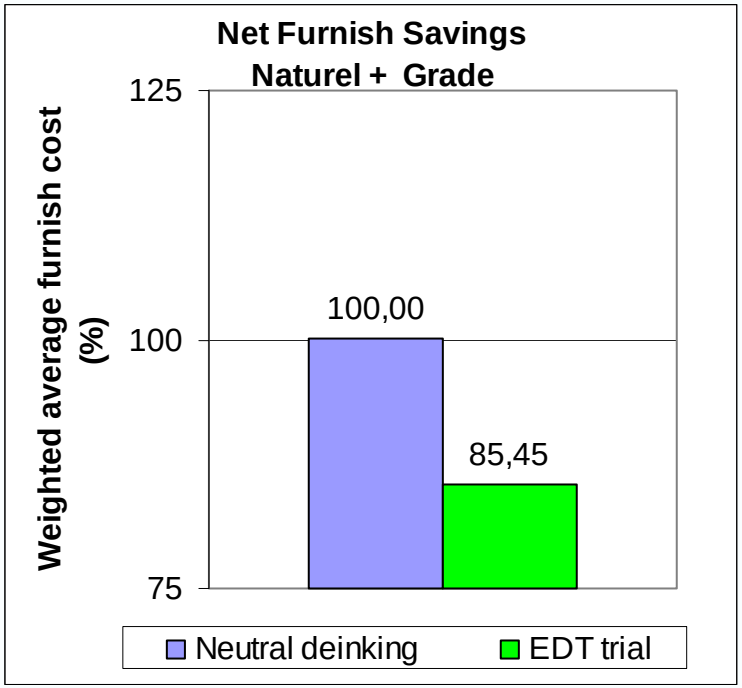
	Naturel	Naturel +	RC	LC	RC+
Target Brightness ISO	50	61	67	71	77
MOW	100%	~~34%~~ 80%	25%	20%	
Light coloured ledgers		~~66%~~ 20%	75%	80%	~~33%~~ 50%
Extra light coloured ledgers					~~17%~~ 17%
Wood Free White Letters					~~17%~~ 17%
Sulphate board					~~33%~~ 16%

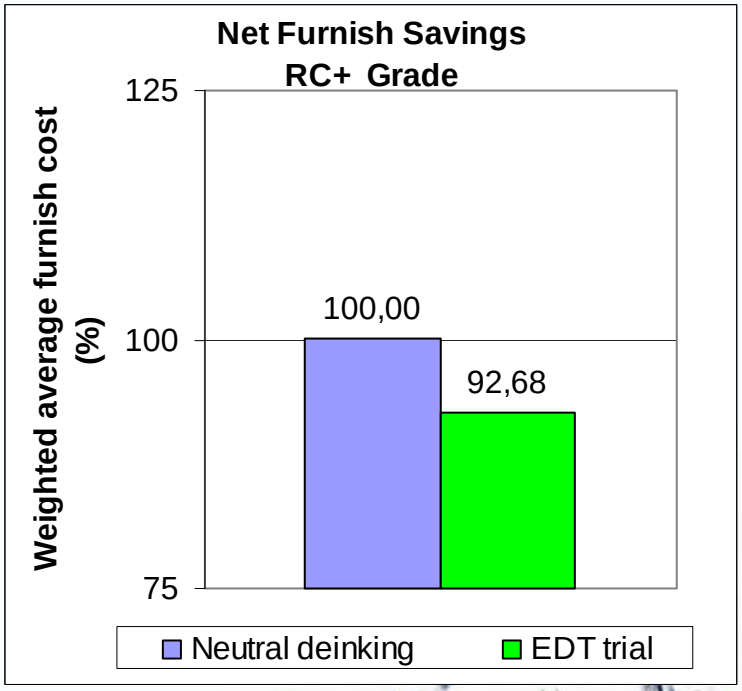
Phase 2: Short trial (results)

- Brightness development in stock preparation
  (Neutral deinking agent vs enzymes)
  - Furnish mix started 1,8 points lower brightness
  - Final product was 0,9 points brighter
  - Brightness gain across mill increased 2,7 points

Phase 2: Short trial (results)

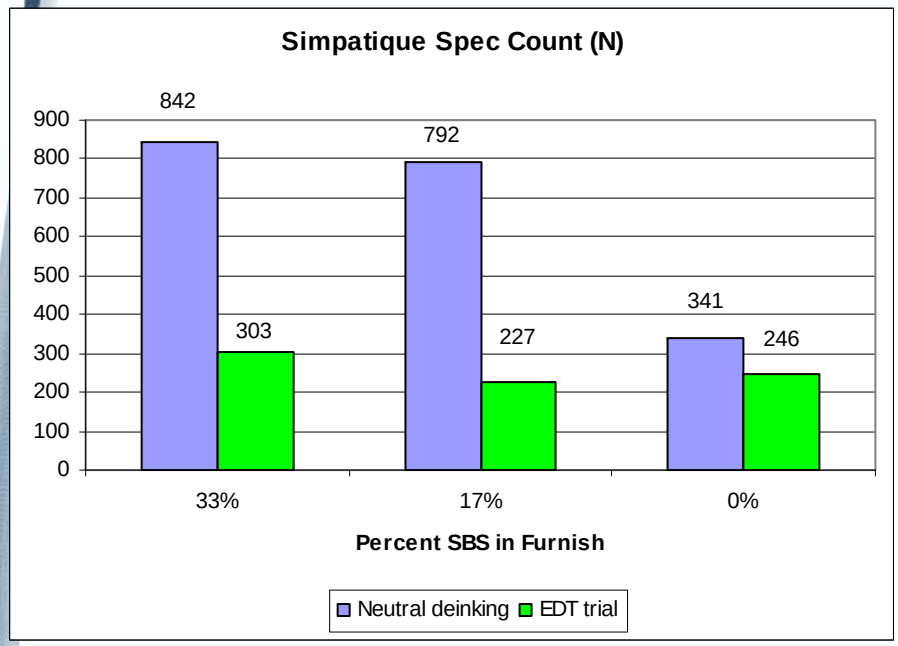
- Furnish savings with enzymes
  (neutral deinking = 100% index)

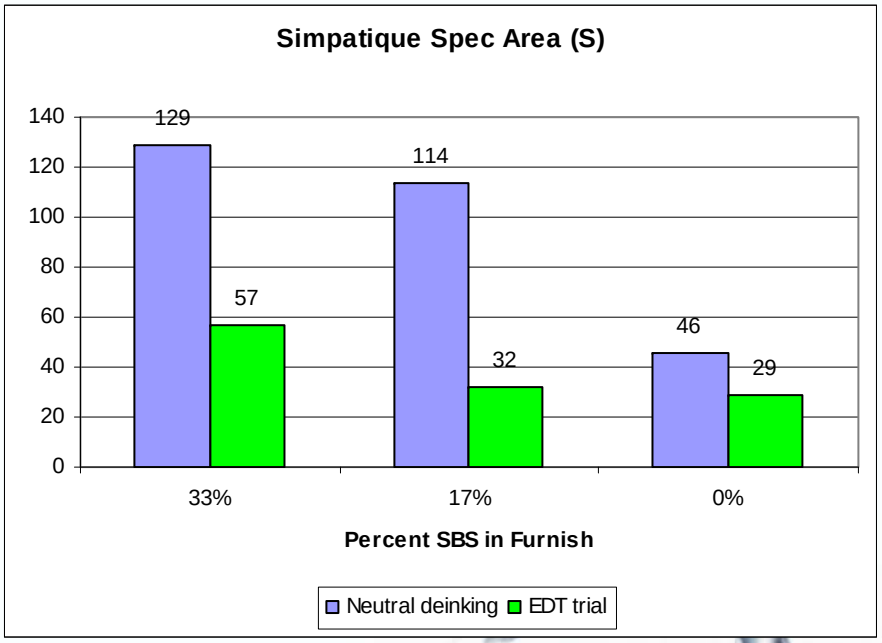




Phase 2: Short trial (results)

- Dirt removal measured by inline dot counter





Phase 3: Long trial

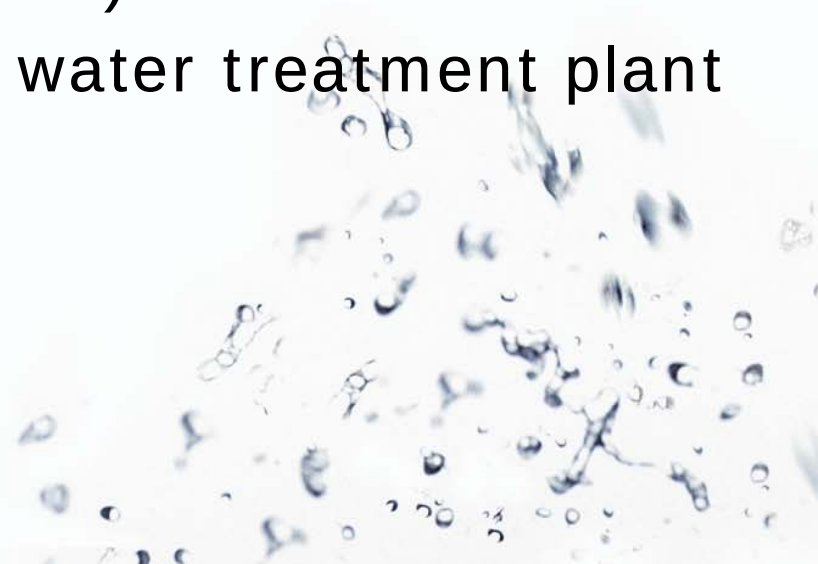
- Further optimisation furnish (for all grades)
  - Decrease enzyme dosage
  - Changes in proces stock preparation

	Naturel	Naturel +	RC	LC	RC+
Target Brightness ISO	50	61	67	71	77

MOW	100%	~~34%~~	85%	~~25%~~	50%	~~20%~~	34%			
Light coloured ledgers		~~66%~~	15%	~~75%~~	50%	~~80%~~	66%	~~33%~~	50%	
Extra light coloured ledgers								~~17%~~	33%	
Wood Free White Letters								~~17%~~	9%	
Sulphate board								~~33%~~	8%	

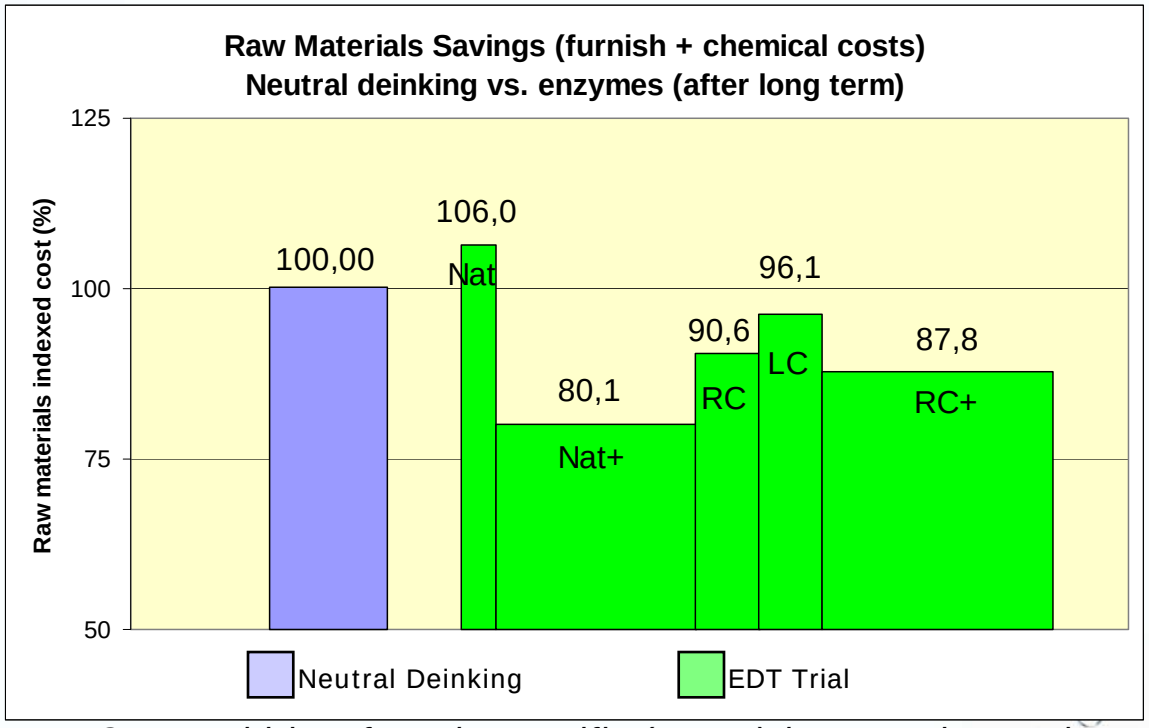
Phase 3: Long trial

- Side effects
  - Stickie outbreak (cleaning out system)
  - More heavy dirt removal and brightness gain, because changes in furnish (more MOW).
  - Other behaviour stickies (more stickies furnish, treatment impact)
  - Increase COD towards water treatment plant



PM4 Conclusions

- Economics: furnish savings



NOTE: Widths of grade-specific (green) bars are in rough proportion to relative production volumes.

- Economics: reject cost increase 1% due to ash/fines/contaminants removal
- Economics: mill yield decreased 1%, however, at least 90% of this was due to higher non-fiber contaminants in lower grade furnish mix

Trial PM3

- Trial PM3 (Fourdrinier machine):

Reason: less broke by grade changes, higher brightness

Two paper grades:

ECO → furnish MOW (without deinking) ISO-brightness <46

Naturel → furnish MOW (with deinking) ISO-brightness 46-52

Deinking:

Fatty acid + caustic soda (without peroxid bleaching)

→ enzymes

Results: no broke & ISO-brightness 50

(no yellowing, less dirt)

Final Conclusions

- Enzymatic deinking can be a powerful tool to improve bottom-line mill performance
- Necessary to customize treatment to mill situation
- Value optimisation requires managing beyond just chemical use (e.g., furnish mix, product mix, process conditions)