Final web conference: "Holistic approaches for water and resources efficiency in process industry"

New strategies for effluent reuse in packaging paper industry

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SpotView

Horizon 2020 European Union Funding for Research & Innovation

SPIRE PROJECT

Effluent reuse for fresh water reduction

SpotView

Horizon 2020 European Union Funding for Research & Innovation

SPIRE PROJECT

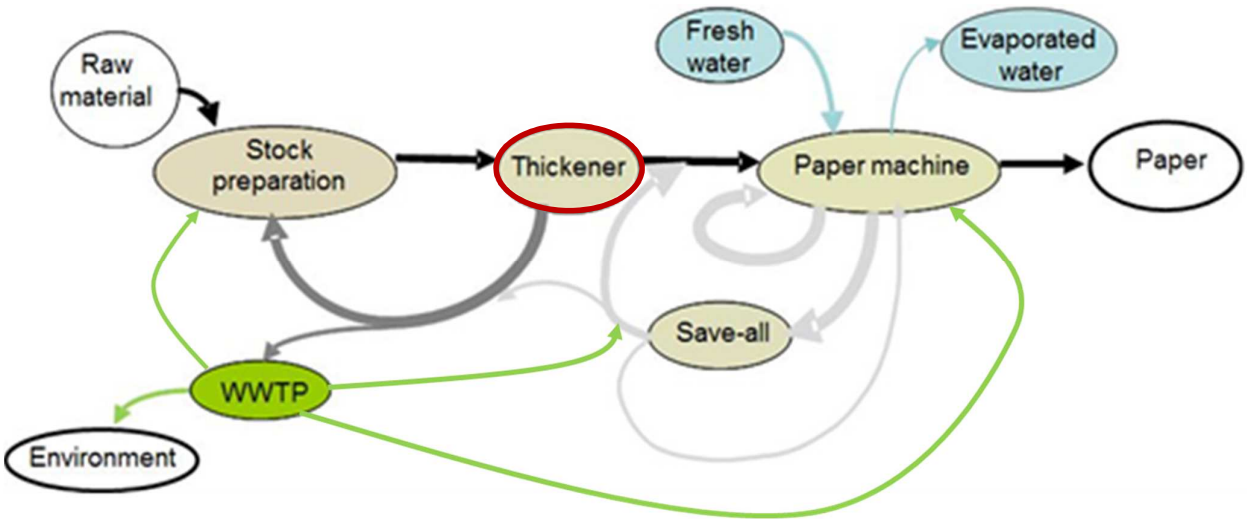
- Water circuits closure is still a hot topic due to
  - environmental and regulatory constraints and
  - simultaneously Industry self commitment to further progress in sustainable papermaking processes
- Reducing fresh water volume has environmental and techno-economical advantages:
  - Reduction of natural resources needs, energy consumption, effluent flow,
  - Fresh water and effluent treatment cost reduction,
- But…

Fresh water reduction consequences

- **Process water load increases**:
  - Suspended fine solids not retained in paper web,
  - Organic and colloidal substances (released by raw material or produced by bacterial activity)
  - Salts build up (from raw material, chemicals, fresh water)
- Decrease in fiber bonding ability (zeta potential is crushed)
- **Temperature** increase – up a point this is beneficial
- **Oxygen** content decrease,
- **Volatile fatty acids increase and H_2 builds up** due to bacteria fermentation (anaerobic conditions) ⇨
  - pH ⇘
  - flammable explosive biogas ⇗

Water management

- Strategies to control COD build-up
  - ⇨ Water loop separation principle combined to counter-current circulation of process waters: BAT
  - ⇨Effluent reuse after biological treatment: Kidney



Water management

- Thanks to efficient water management (BAT) , detrimental effects due to organic matters can be well controlled nowadays but **mineral salts still build up**.
- Consequences of salinity increase:
  - Additives become ineffective (retention agents, wet-ends additives, flocculants)
  - Weak fibre bonding
  - Scaling, deposits, corrosion
- What is the main source of conductivity?
  - Raw material ?
  - Fresh water ?
  - Additives?
  - Effluent reuse?

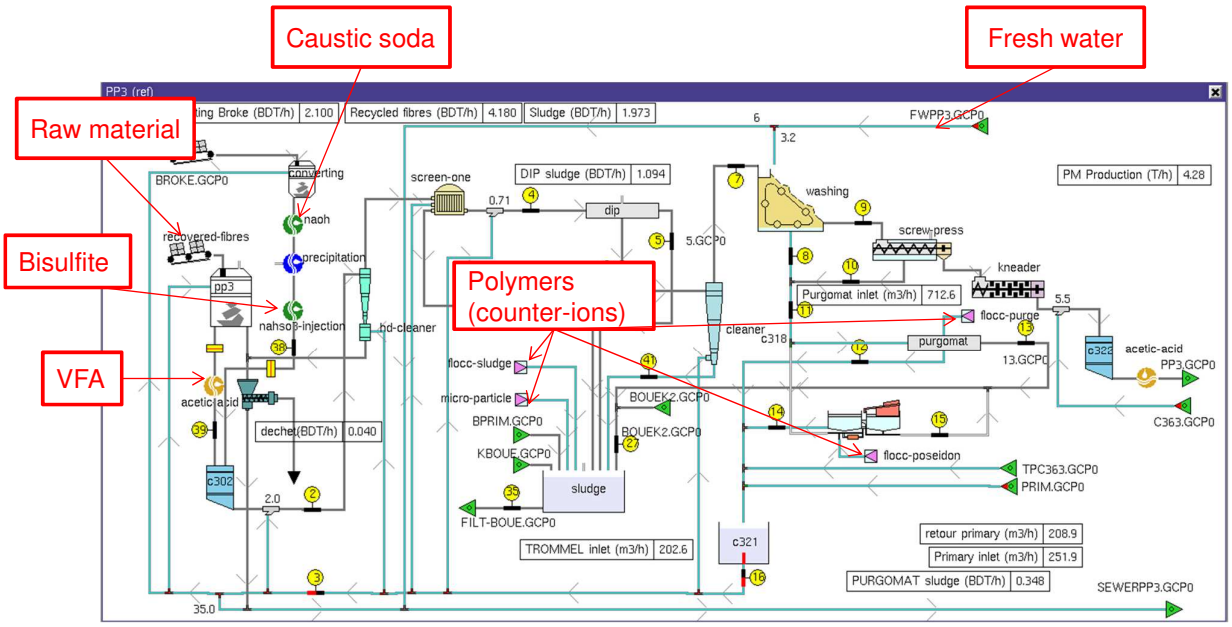
Use of modelling

Method

- Digital model of process circuit design
  - Design of flowcharts with all process equipment, inputs, outputs and the different connections between them.
  - Data collection during on-site campaigns through:
    - Data collection from DCS control system
    - On site flow measurements
    - Physico-chemical analyses on pulp and process waters
  - Design of digital model of the process circuit with CTP simulation tool (PS2000).

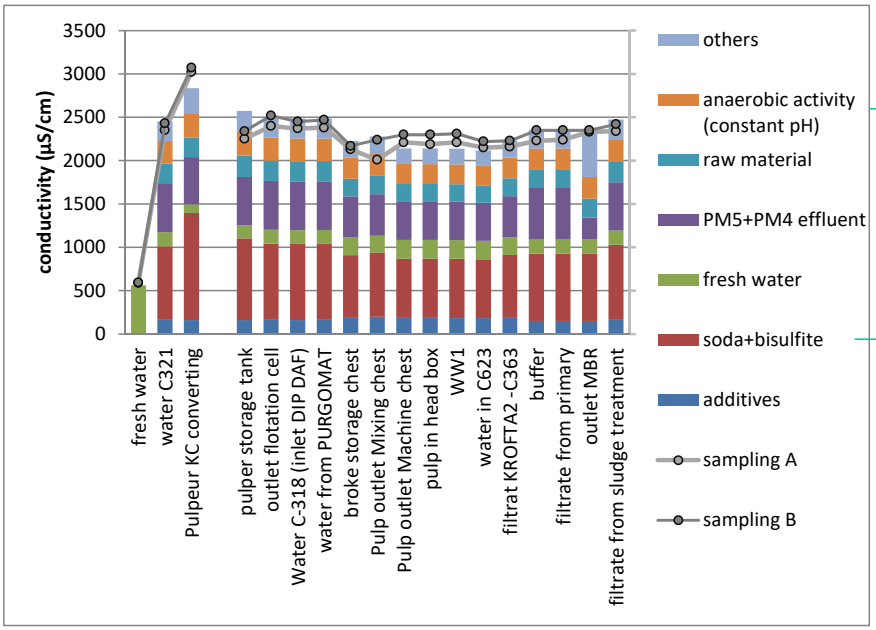
Method

- Build mass and hydraulic balances simulation of the mill (PS2000) and implement ionic sources (PhreeQC)



Conductivity sources

- Conductivity « balance »

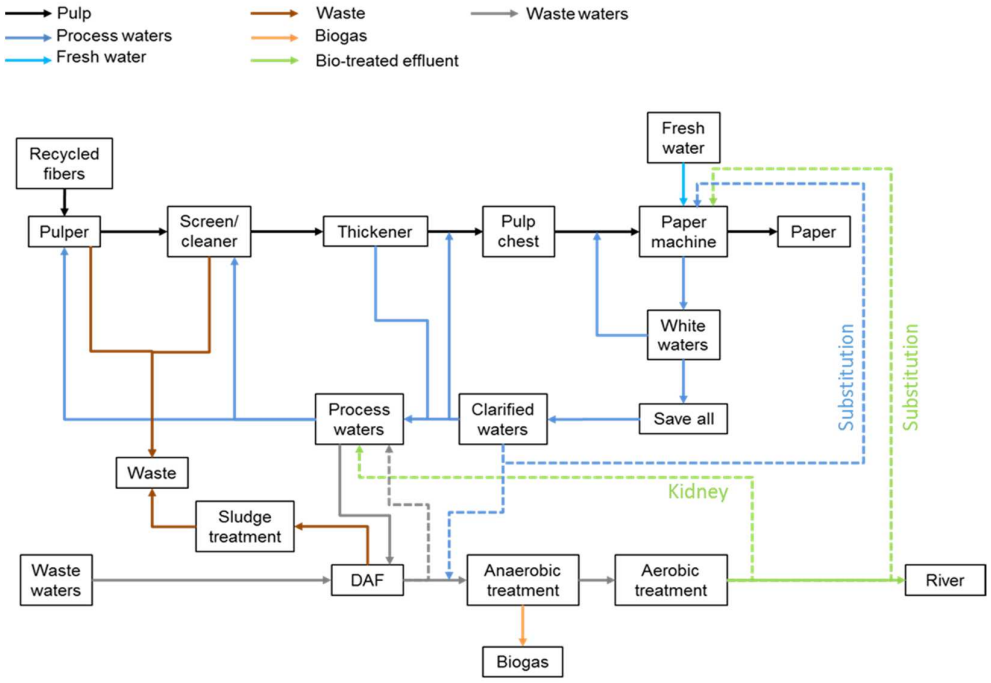


(contribution without considering reduced soda + bisulfite)

Major impact of broke repulping chemicals

Case study: Containerboard mill

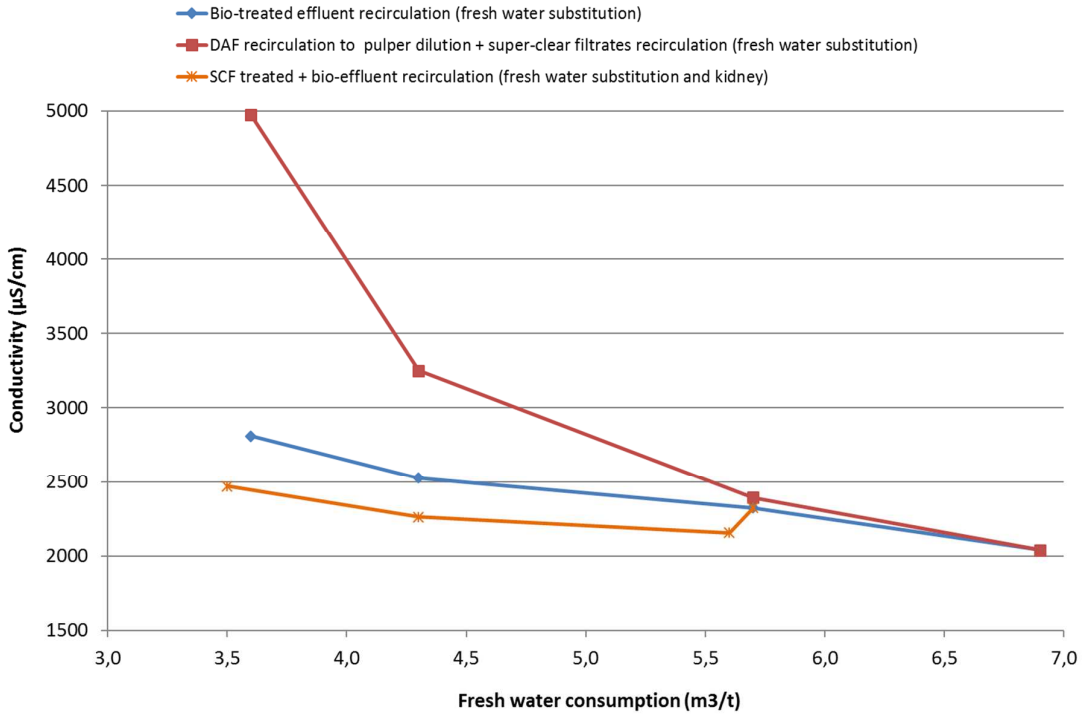
- Proposed scenarios for clarified effluent reuse



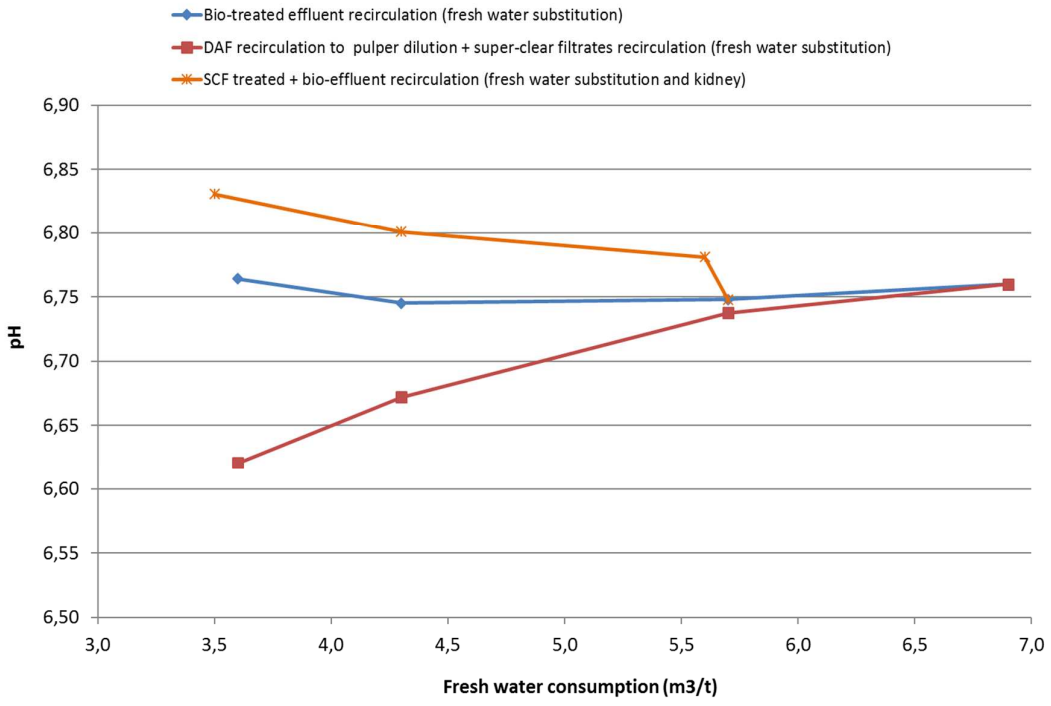
Case study: Containerboard mill

- Options for process water and effluent reuse
  - DAF effluents reuse as dilution water for stock preparation + substitution of fresh water by super-clear filtrates on some low pressure PM showers (sheet forming section)
  - Bio-treated effluent reuse as substitution of fresh water on low pressure PM showers (forming section)
  - Bio-treated effluents reuse as kidney loop in stock preparation facility + substitution of fresh water on low pressure PM showers.
    - This scenario requires to flush part of the super-clear filtrates out of the process, into the WWTP, in order to be able to increase the recirculated bio-treated flow

Case study: Containerboard mill



Case study: Containerboard mill



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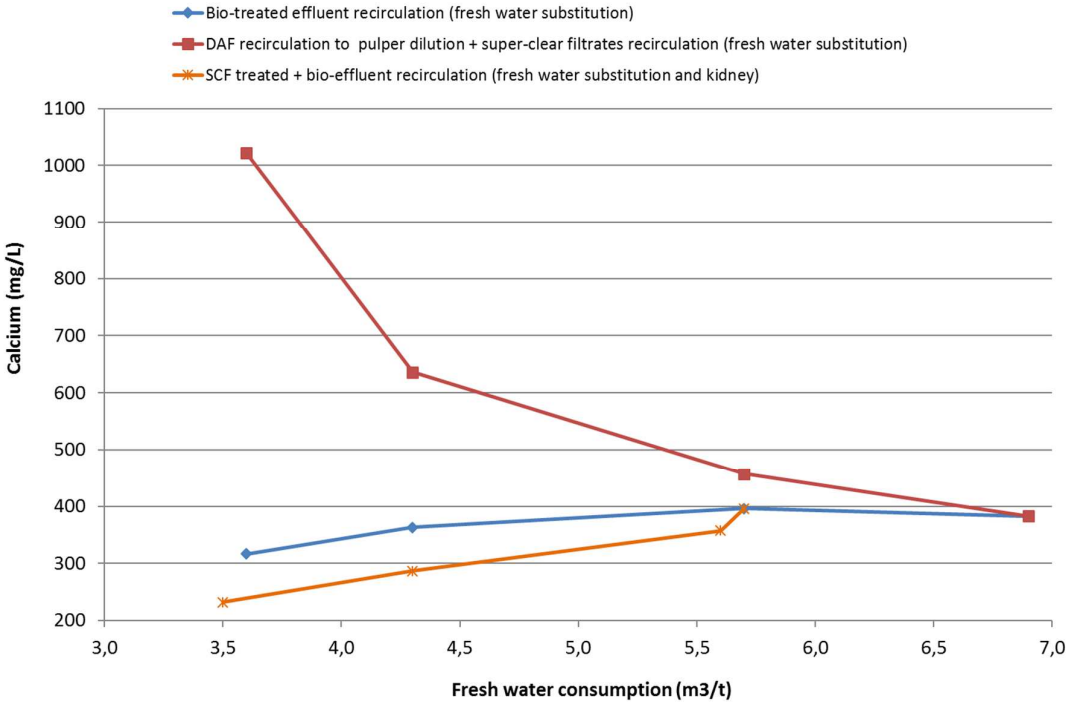
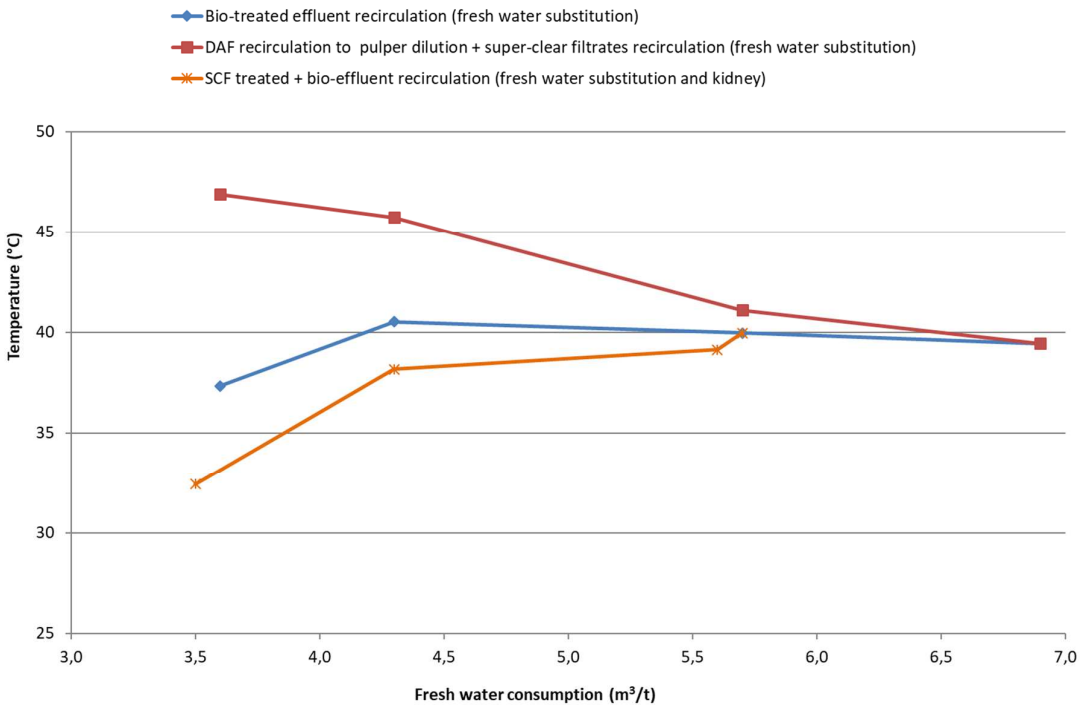


Case study: Containerboard mill



Case study: Containerboard mill

- Synthesis

	DAF recirculation to pulper dilution + SCF* recirculation (FW substitution)	Bio-effluent recirculation (FW substitution)	SCF* bio-treated + bio-effluent recirculation (FW substitution + kidney)
COD	-	+	+++
Conductivity	- - -	-	+
T°	- - -	-	- - -
pH	- -	+	++
Calcium	- - -	+	++

- Fresh water reduction from 7.0 to 3.5 m^3/t
- Temperature decrease ⇨ heat pumps implementation

Conclusion

- **To go further on fresh water reduction:**
  - Need case by case of a specific local study taking into account
    - Pulp and water process circuits, existing and retrofit program
    - Water management rules
  - Identification of chemicals sources
    - Raw materials, fresh water, chemicals
  - Modeling of the mill
    - Mass and hydraulic balances
    - Chemical equilibrium
  - Simulation of bio-effluent reuse according to different scenarios to predict COD, conductivity and pH outcomes

Exploitation's outlook in an OCC mill

- During Spotview, many scenarios concerning the reuse of water and recovery of heat have been investigated.
- From this we forecast extensive stepwise reuse of bio-treated effluent
  1. **as a kidney** to limit contaminant build-up in circuit water
  2. **as fresh water substitution**

  – Preliminary reduce pulp and water retention times in circuits to limit starch release and hydrolysis:
    - Limit tanks volumes, piping routes, storage levels…

  – Complete the water circuits rearrangement with specific additional satellite processes to overcoming rising bottlenecks:
    - Heat exchangers/pumps,
    - Sand/membrane filters
    - Deionization units,
    - Antimicrobial treatments…

Extensive reuse of clarified effluents

- Implement effluent reuse as **kidney**
  – Additional loop with high circulating flows
  – Operates specifically in the pulp preparation area.
  – Solubilised species are washed out, including starch, VFAs, COD and free calcium.
    - Washed out starch is converted into usefull biogas in WWTP
    - Free calcium settles in form of precipitated lime and is disposed of
  – Depending on circuit closure rate, this can be based on
    - current WWTP
    - or an new extra short loop with small bioreactor next to the pulp building, completed by a lime trap (to avoid calcium building up)

- Constraints
  – Significant impact on process temperature. Heat recovery is recommanded
  – Small specific bioreactor would be less impacting with regard to temperature loss

Outlook – Reuse of clarified effluents

- **Substitue Fresh water**
  - Possibly wide use in many applications with low quality requirements
    - Dilution of chemical additives and cooked starch,
    - Washing hoses around PM (house keeping),
    - Wet end showers…To be investigated case by case

- Constraints
  - Out of scope applications due to mild effluent temperature and unsecured cleanliness
    - Cooling water for air compressors or hydraulic power units (several x10 m3/h).
    - Few high demanding technical applications like HP showers on felts
  - Costs of water circuits rearrangements may increase fast.
    - Concept is easier and cheaper to implement in a mill under construction
  - Preliminary antimicrobial treatment needed

Aknowledgement

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