# 4-acetamido-TEMPO-mediated oxidation of wood chips and thermomechanical pulp in large scale

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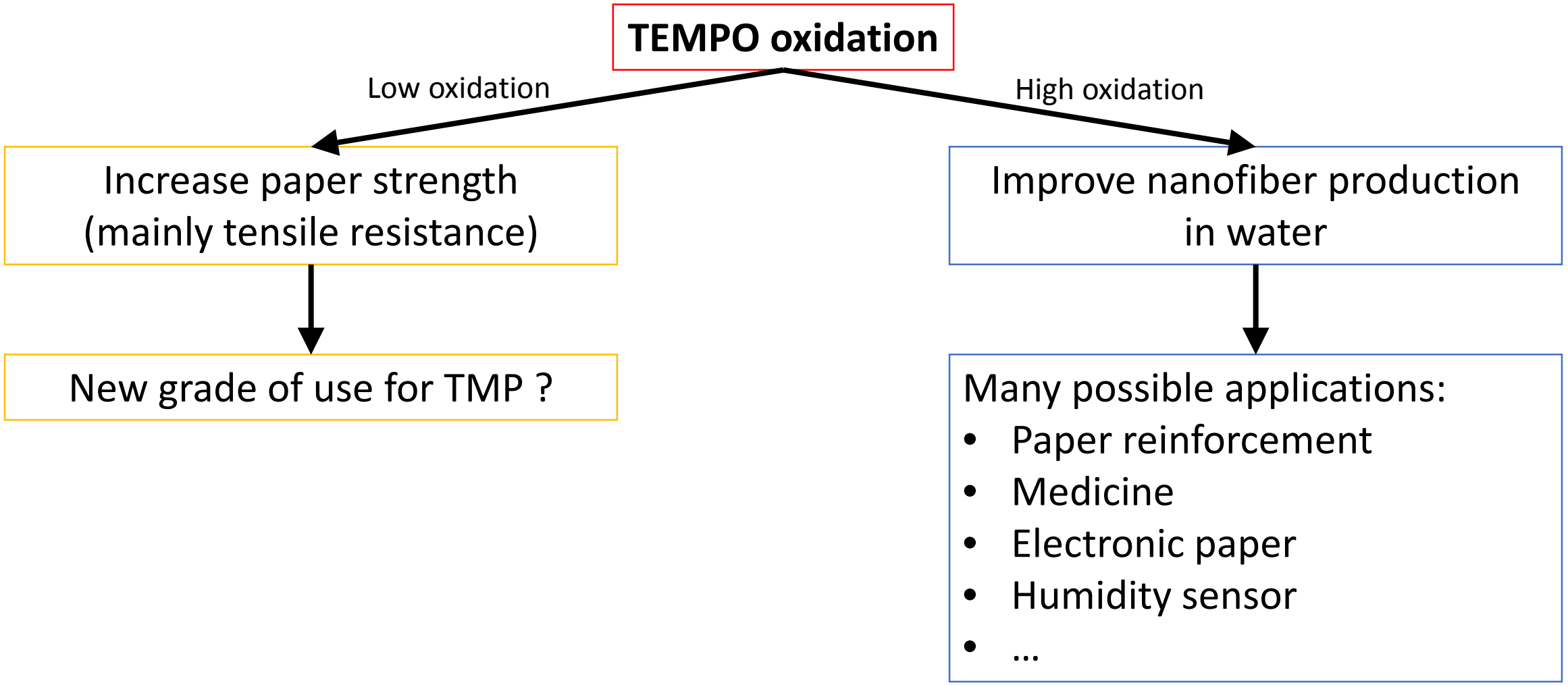
11th Fundamental Mechanical Pulp Research Seminar

April 3, 2019

INSTITUT d'INNOVATIONS
en écomatériaux, écoproduits
et écoénergies *à base de biomasse*
UQTR

# Why did we work with TEMPO ?



What's next ?

**Scale up**

How ?

**Implantation at different step in the TMP production process**

# Studied treaments

On softwood chips:

- Impregnation with TEMPO medium (TC)
- Large batch reactor oxidation (BTC)

Reference:

- Untreated chips (C)

Then:

- Primary and secondary refining
  - Disc gap from 0.15 to 1.00 mm

On softwood primary TMP:

- Replace water during the refining by TEMPO medium (TP)
- High consistency reactor treatment (HCTP)
- Large batch reactor oxidation (BTP)

Reference:

- Untreated primary pulp (P)

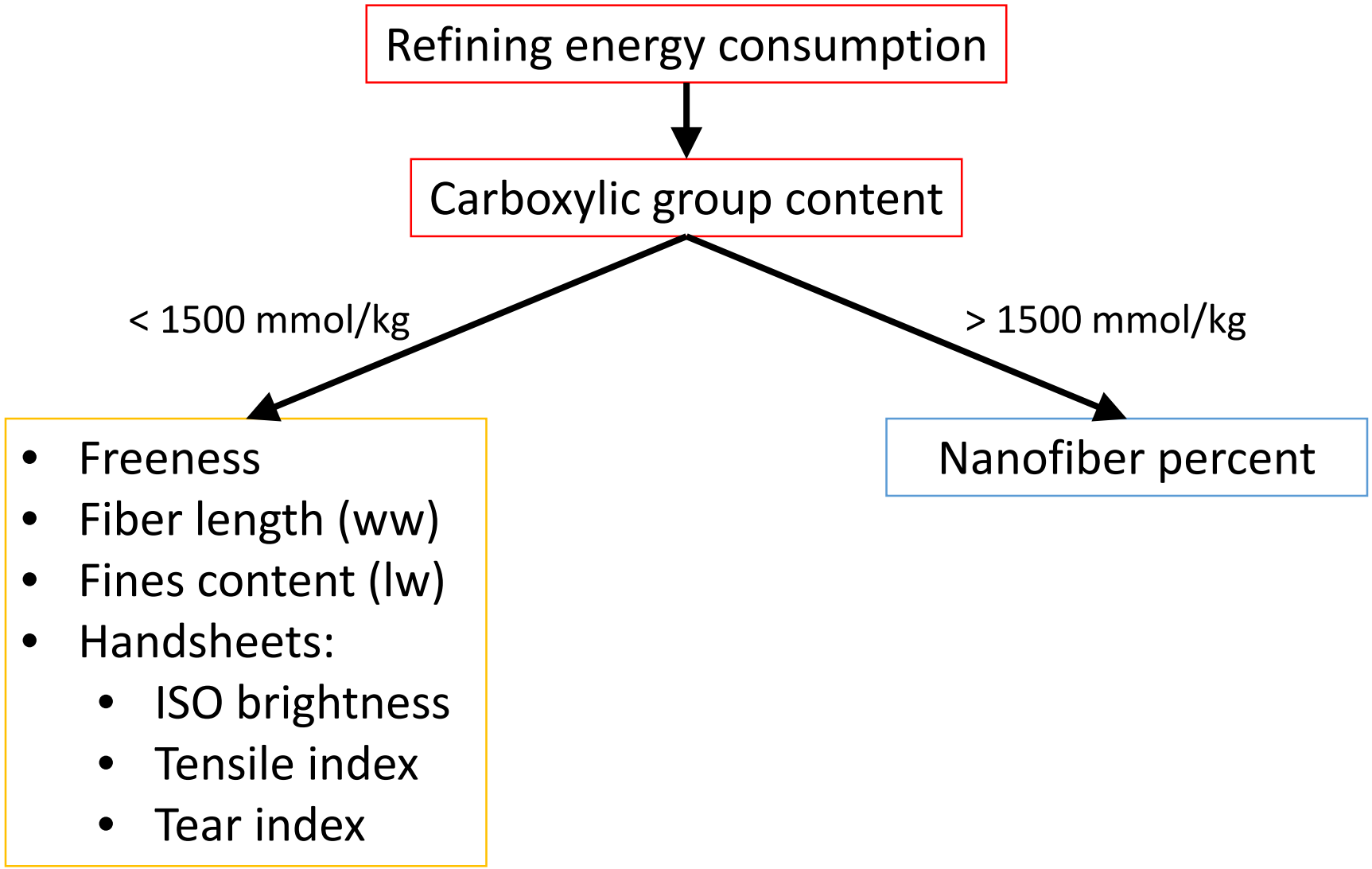
Then:

- Secondary refining
  - Disc gap from 0.15 to 1.00 mm

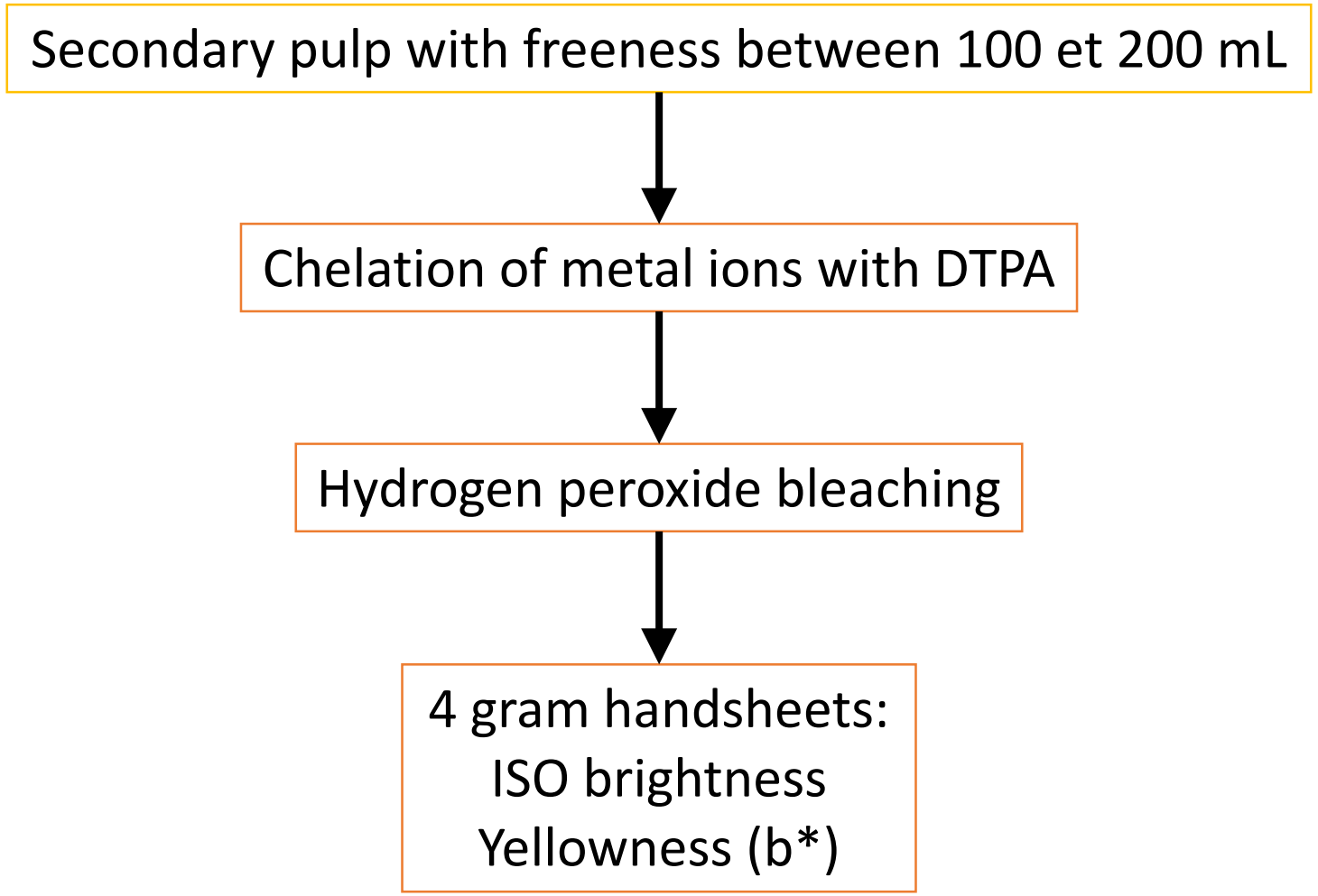
# Analysis on primary pulp from softwood chips

- Refining energy consumption
- Freeness
- Fiber length (ww)
- Fine content (lw)
- Shive content
- Carboxylic group content of:
  - Pulp
  - Shives
  - Fibers

# Analysis on secondary pulp



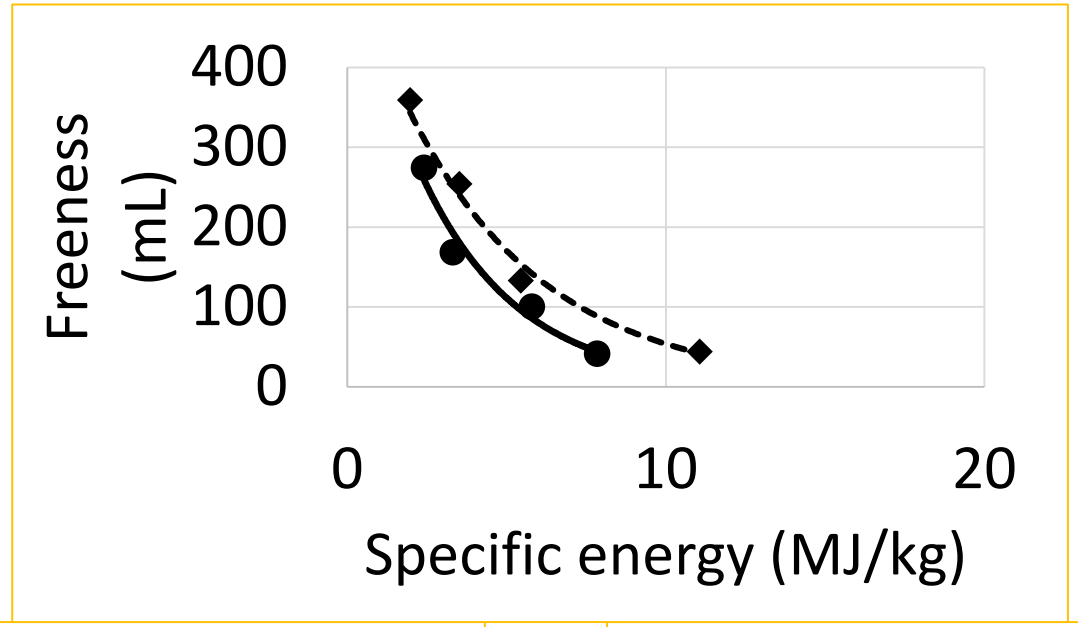
# Pulp bleaching

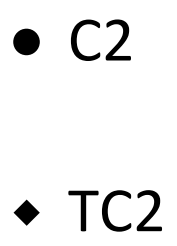


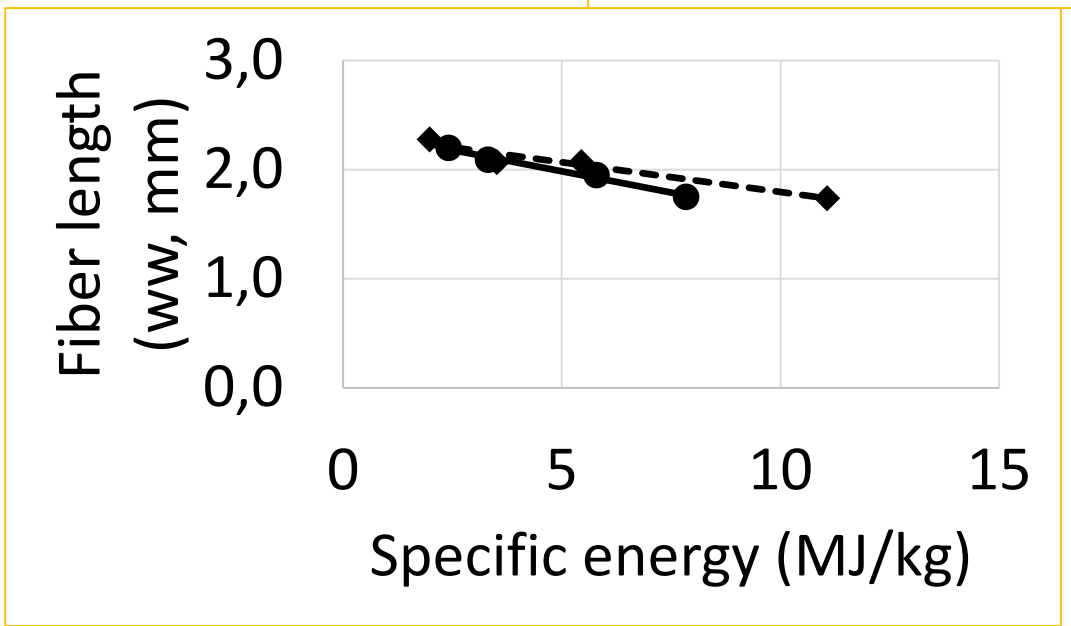
# Observations on primary pulp from chips

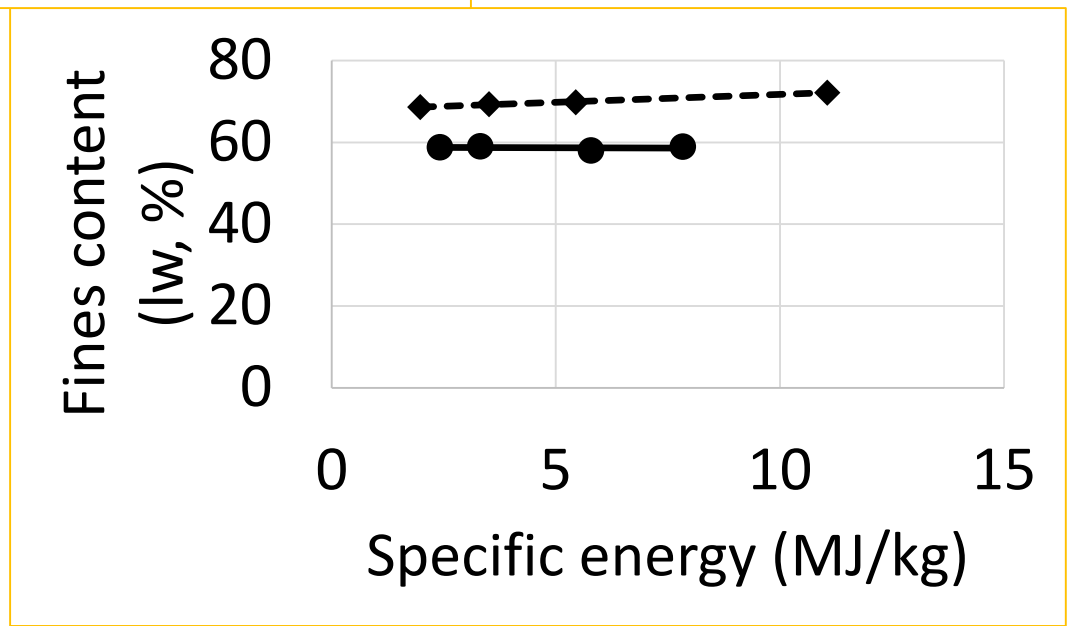
| Pulp | Disc gap | Specific energy | Freeness | Fiber Length (ww) | Fines content (lw) | Shives content | Carboxylic group content | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Pulp | Shive | Fiber |
| | mm | MJ/kg | mL | mm | % | % | mmol/kg | | |
| **C1** | 1.00 | 2.27 | 715 | 2.21 | 61.0 | 24.1 | 120 | 41 | 145 |
| **TC1** | 1.00 | 2.43 | 702 | 2.25 | 61.8 | 27.1 | 220 | 45 | 285 |
| **BTC-1** | 1.00 | 1.13 | 425 | 1.11 | 69.5 | 47.5 | 545 | 89 | 958 |
| **BTC-2** | 0.70 | 2.19 | 297 | 1.21 | 71.0 | 40.9 | 605 | 69 | 977 |
| **BTC-3** | 0.15 | 4.27 | 217 | 1.62 | 64.3 | 21.2 | 675 | 58 | 841 |

# Observations on secondary pulp from chips



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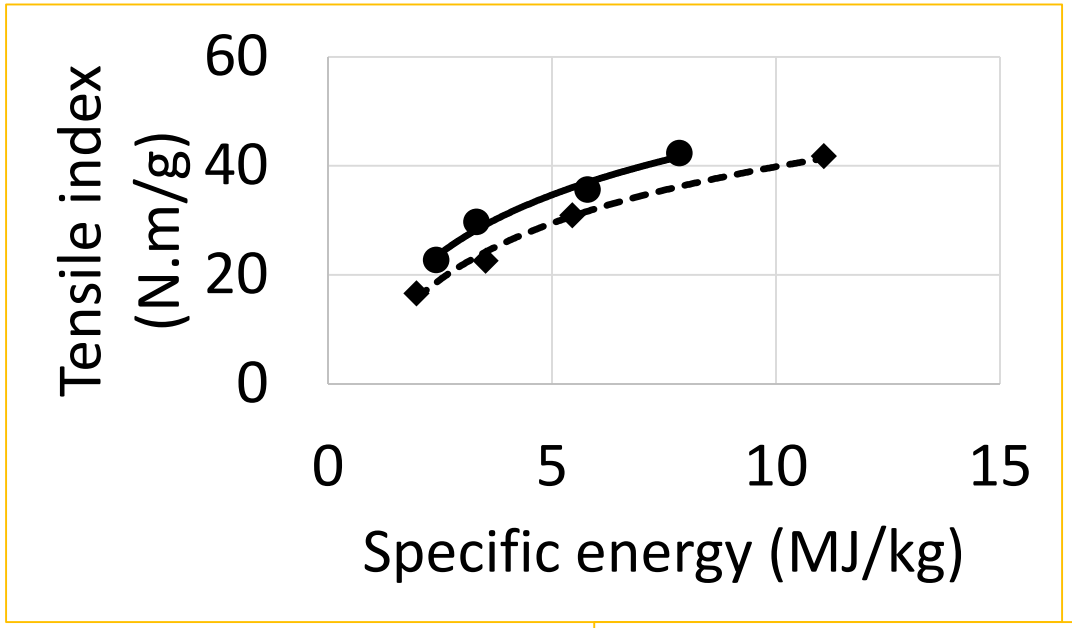
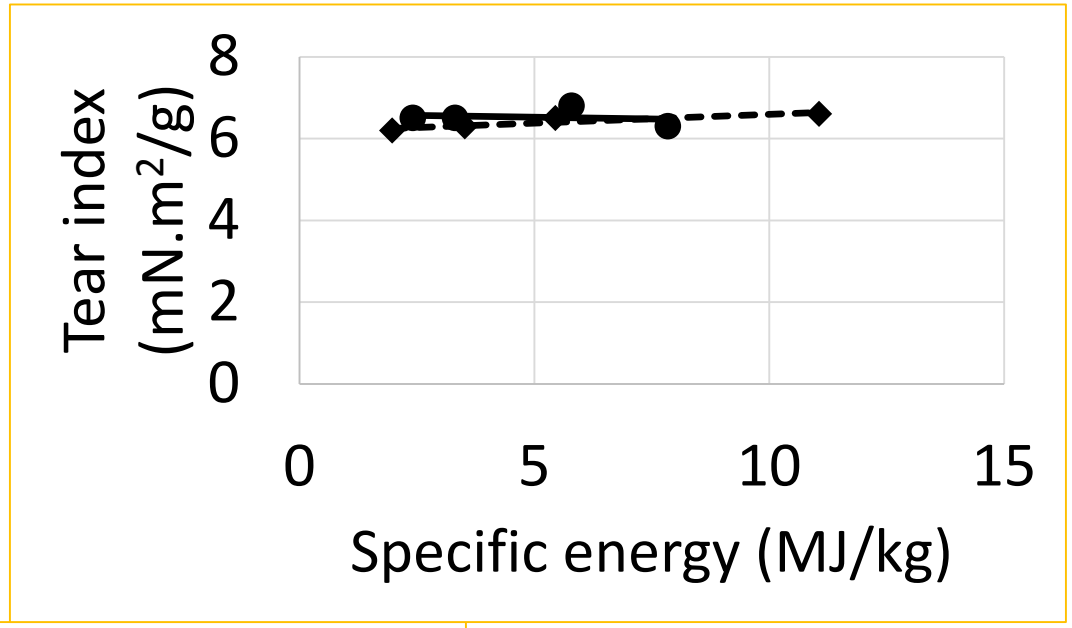
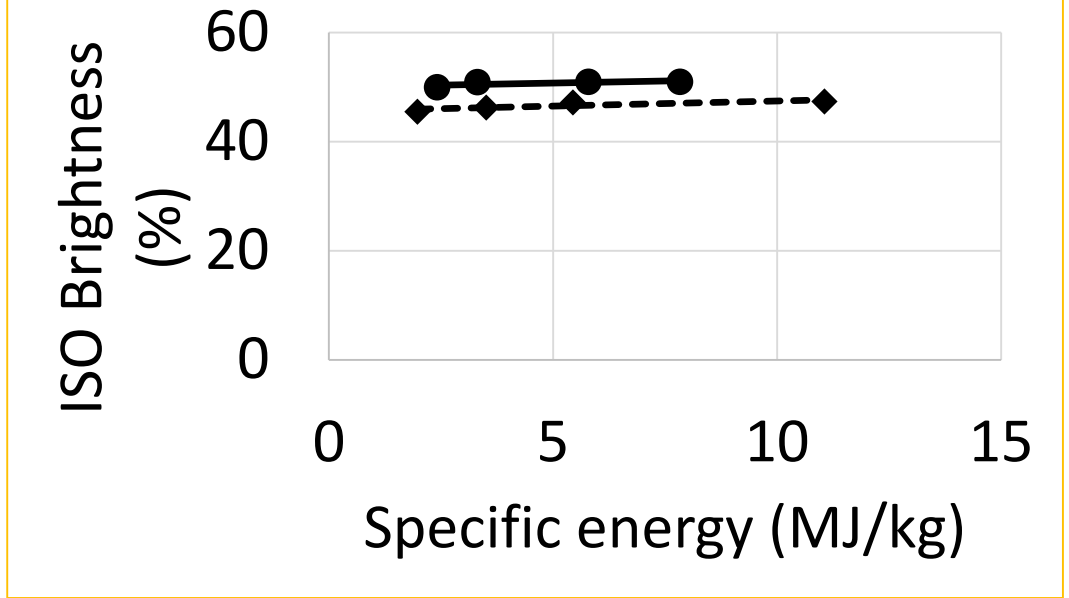
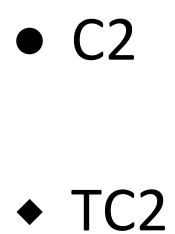


# Bleaching effect on untreated and impregnated with TEMPO medium chips

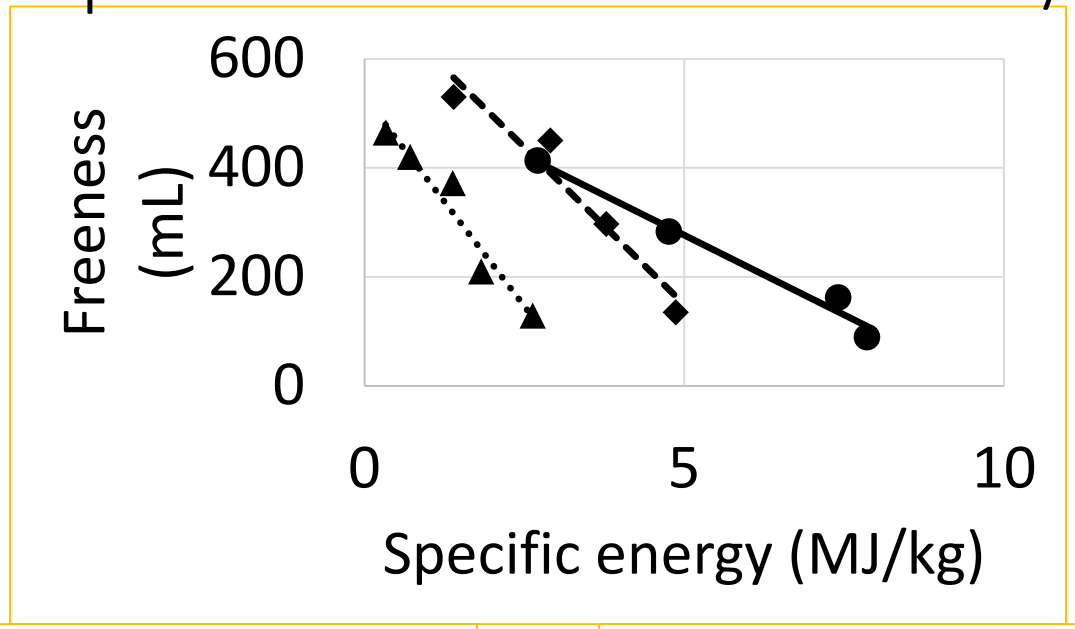
| Pulp | Before hydrogen peroxide bleaching | | After hydrogen peroxide bleaching | |
|---|---|---|---|---|
| | ISO Brightness (%) | Yellowness (b*) | ISO Brightness (%) | Yellowness (b*) |
| **C2-2** | 51.8 | 13.3 | 72.2 | 11.3 |
| **TC2-3** | 47.2 | 14.2 | 61.8 | 14.7 |

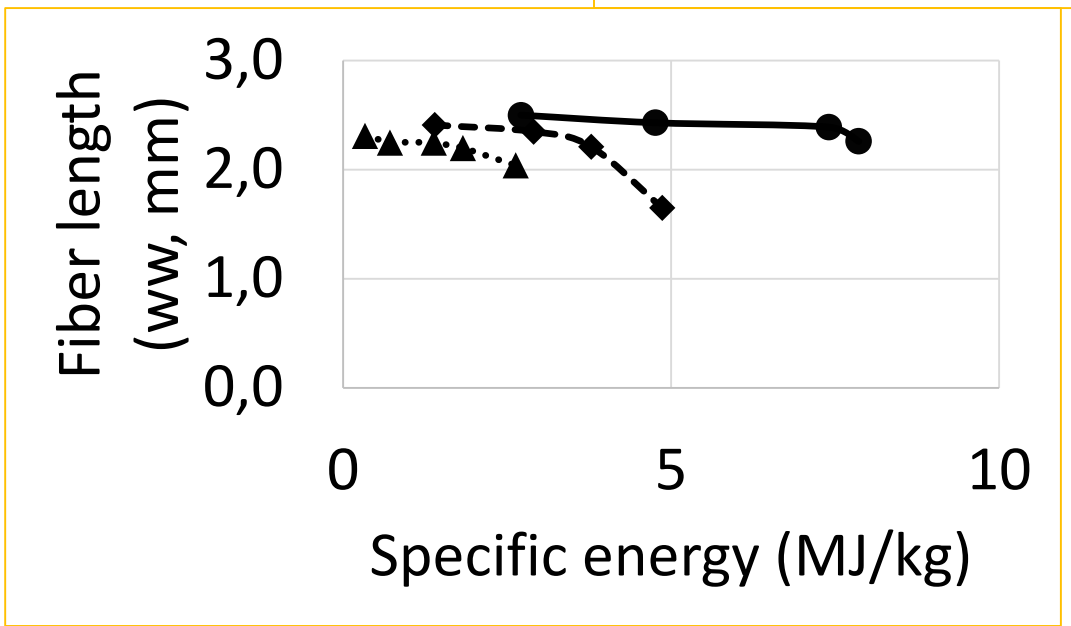
# Conclusions on chips treatments

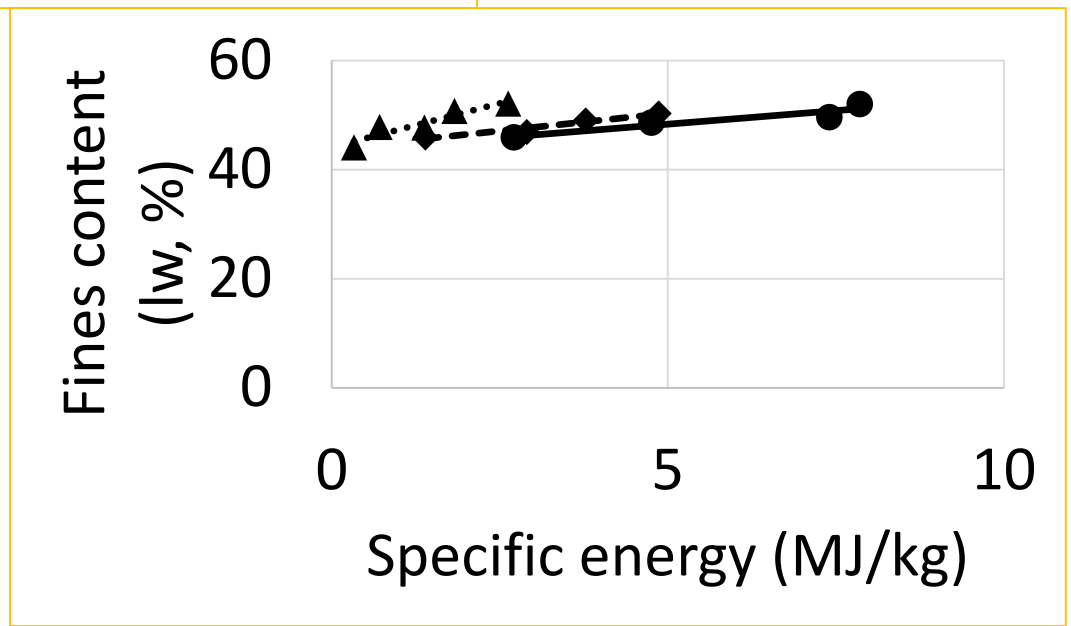
- Harmfull effect of chips impregnation with TEMPO mixture
  → Not recommanded

- Chips batch oxidation effective and change refining effects
  → Further investigation needed

# Observations on secondary pulp from primary TMP with a carboxylic group content under 1500 mmol/kg



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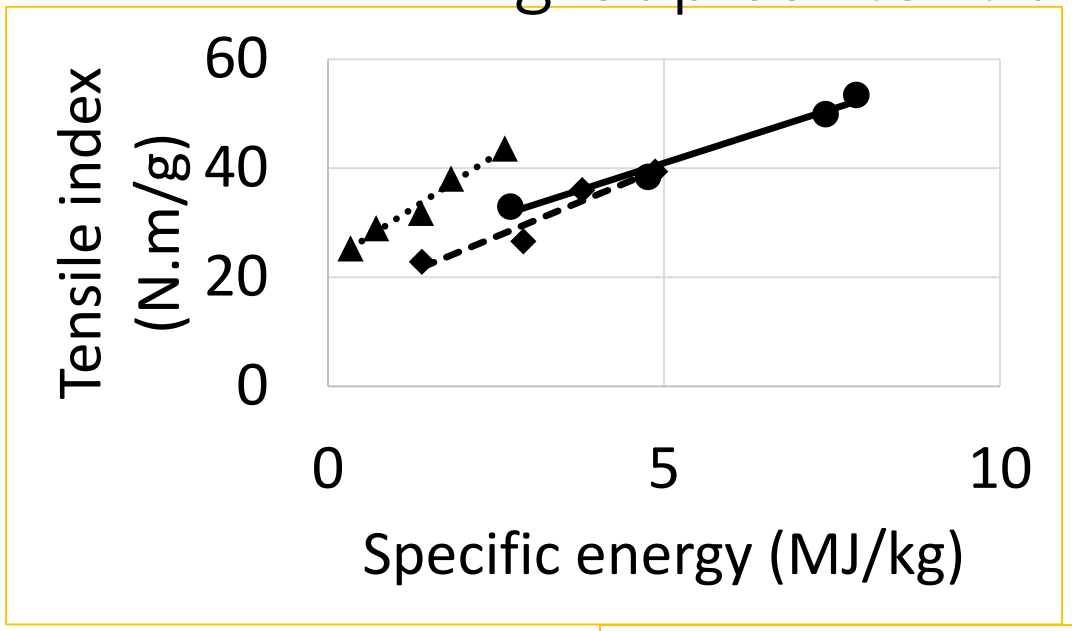


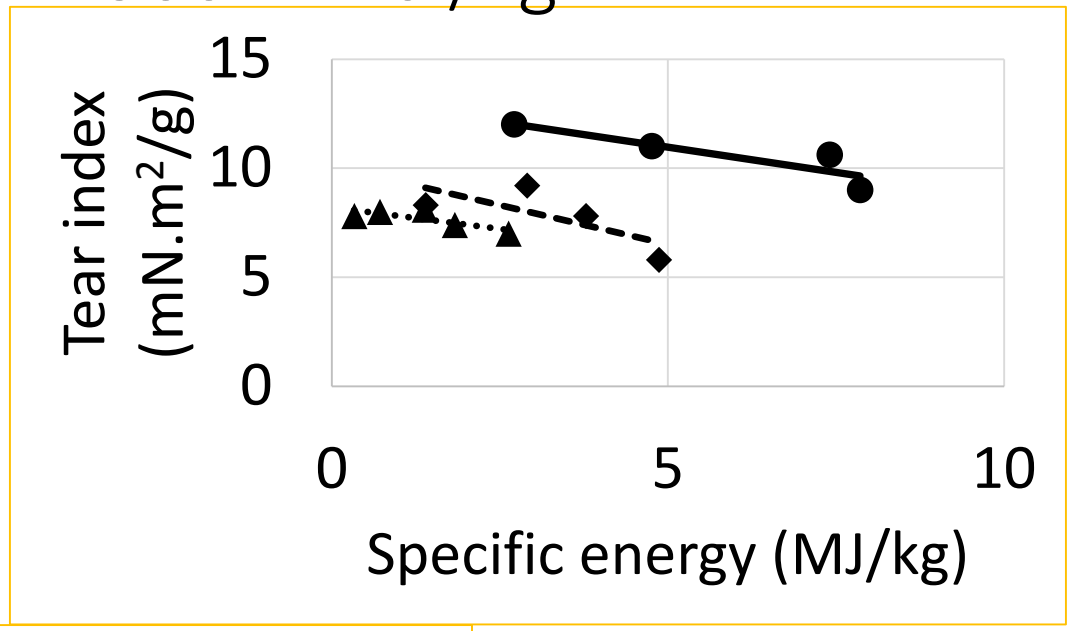


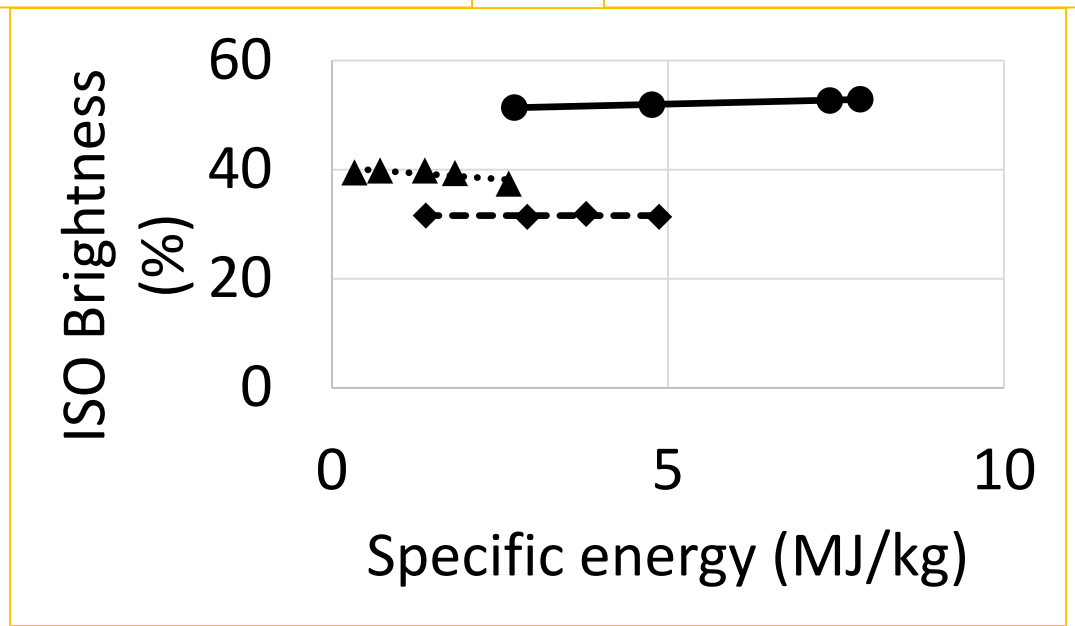

# Bleaching effect on untreated, refined with TEMPO medium and oxidized in high consistency reactor primary TMP

| Pulp | Before hydrogen peroxide bleaching | | After hydrogen peroxide bleaching | |
|---|---|---|---|---|
| | ISO Brightness (%) | Yellowness (b*) | ISO Brightness (%) | Yellowness (b*) |
| **P-3** | 55.3 | 13.0 | 75.2 | 11.0 |
| **TP-4** | 30.8 | 21.4 | 43.8 | 24.9 |
| **HCTP-5** | 38.1 | 17.3 | 52.1 | 19.8 |

# Observations on secondary pulp from primary TMP with a carboxylic group content higher than 1500 mmol/kg

| Pulp | Disc gap | Specific energy | Pulp carboxylic group content | Nanofiber percent |
|---|---|---|---|---|
| | mm | MJ/kg | mmol/kg | % |
| **BTP-1** | 1.00 | 0.63 | 1840 | 12.3 |
| **BTP-2** | 0.50 | 3.21 | 2005 | 23.8 |
| **BTP-3** | 0.15 | 4.80 | 2095 | 27.2 |
| **BTP-IKA** | / | 57.11 | 1975 | 19.9 |

# Conclusions on primary pulp treatments

- High consistency treatment is better than to replace water in the refiner but harshly affect the paper optical properties
  → Further investigation needed (Better control of the pH?)

- High efficiency dispersion when refining highly oxidized pulp
  → Recommended to be used as disperser

# Global conclusions

- Highly oxidized pulp obtained only with batch treatment of primary TMP
- Batch treatment of chips should be further investigate
- Difficulties to control oxidation conditions during impregnation, inside refiner or high consistency reactor treatments decrease their efficiency
- Refiner is clearly viable for large scale nanofiber producer

# Thank you

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