



# WET-END APPLICATIONS OF NFC

Lutz Hamann, Papiertechnische Stiftung

SUNPAP Workshop 5.10.2011

## Content

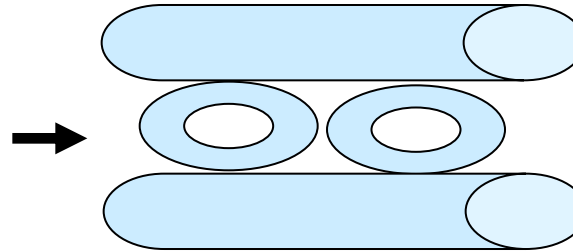
### Wet end applications of NFC

- Purpose
- Used samples and methods
- Preparation, dosage strategy, retention
- Influence to dewatering
- Improvement of paper properties
- Conclusion

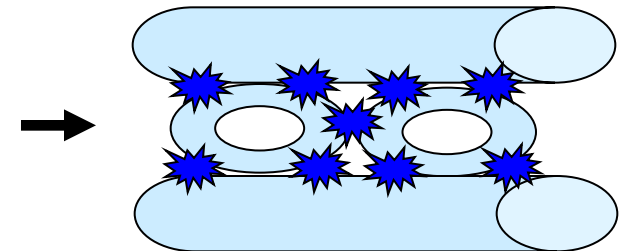
## Purpose of using NFC in bulk application



paper sheet photo, no NFC  
distribution of pulp fibers



paper sheet model,  
contact points of fibers

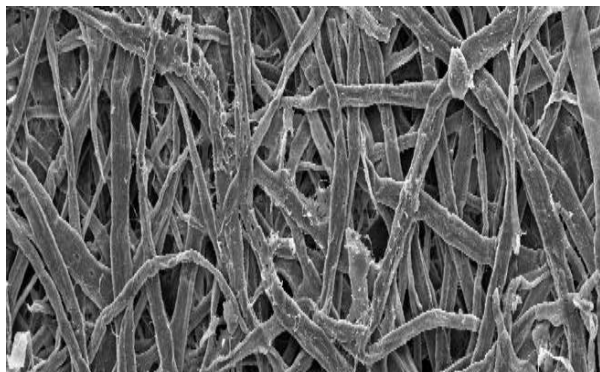



paper sheet model,  
improved fiber contact  
by NFC application in bulk

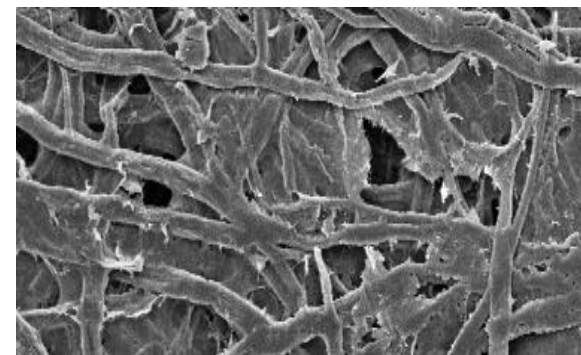
NFC bulk applications in wet-end are expected to positively impact

- the paper strength properties
- preserving the paper sheets density better than refining
- saving of wood fibers by a new way to reduce the paper grammage
- the efficiency of functional paper additive performance

## Possible applications of NFC in wet end



**NFC is bridging the**  
  
**distances between the fibers**  
**&**  
**close the pores in the network**



## Used samples and methods

### Materials

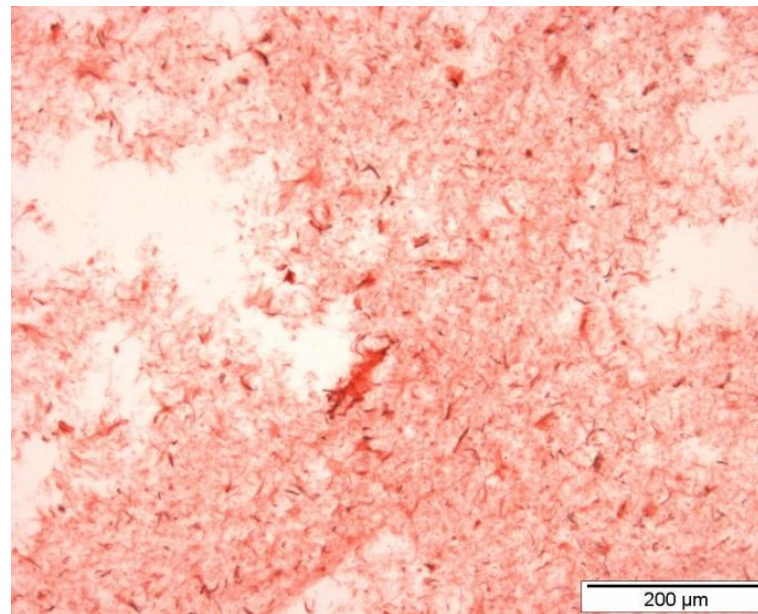
- Pulps:            hardwood (HW); SRE 0 / 40 / 80 kWh/t  
                      softwood (SW); SRE 0 / 70 / 140 kWh/t  
                      CTMP (board middle layer)
- NFC:             standard NFC sample NFC-CTP/VTT
- Retention aid: Polymin 1530 (C-PAM)
- Starch:            cationic potato starch, cooked together with NFC in micro wave

### Methods and analysis

- Retention :      gravimetric by weighting the sheets at medium NFC dosages
- Dewatering:    Schopper Riegler dewatering resistance
- Sheet forming: RAPID Köthen sheet former
- Paper testing: tensile index, E modulus, Scott Bond z-strength,...

## NFC

- preparation before sheet forming
- dosage strategy
- retention



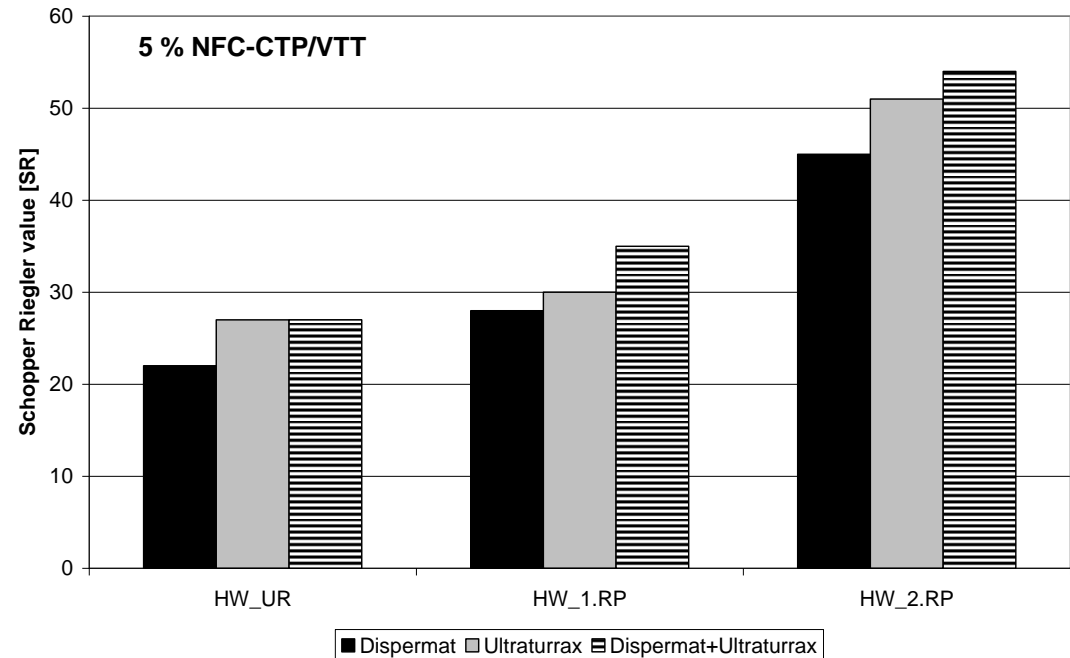
## Preparation of NFC before sheet forming



dispermat

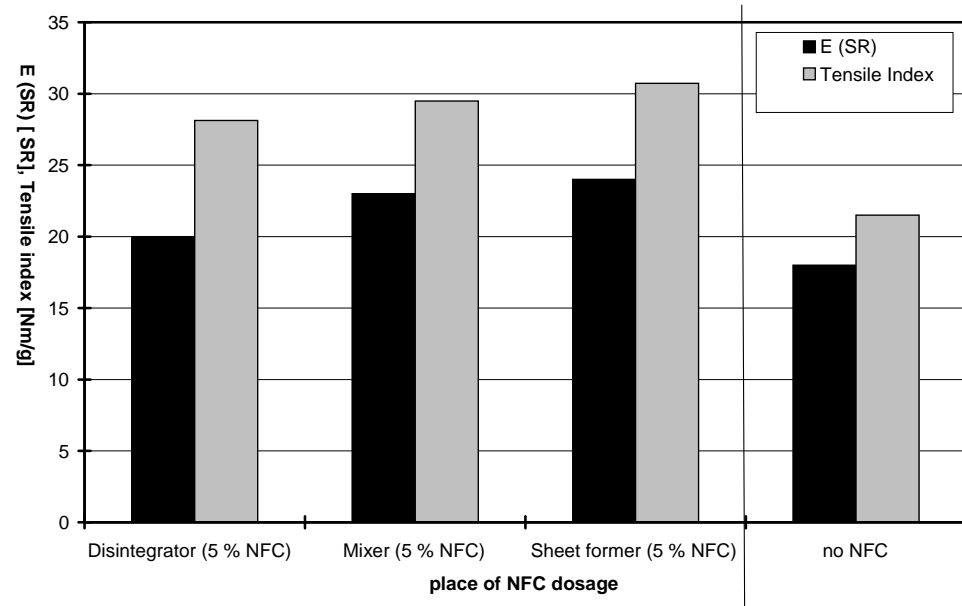
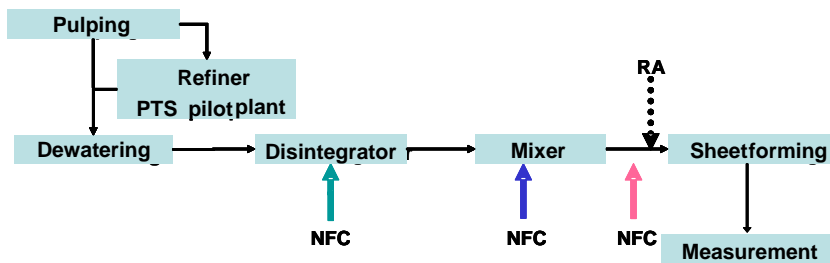


ultraturrax



- highest dewatering resistance indicates best NFC dispersion
- better results when using also ultraturrax
- standard procedure in all trials (NFC concentration 2 g/l):  
dispermat 10 min / 1,400 rpm + ultraturrax 4.5 min / 7,500 rpm

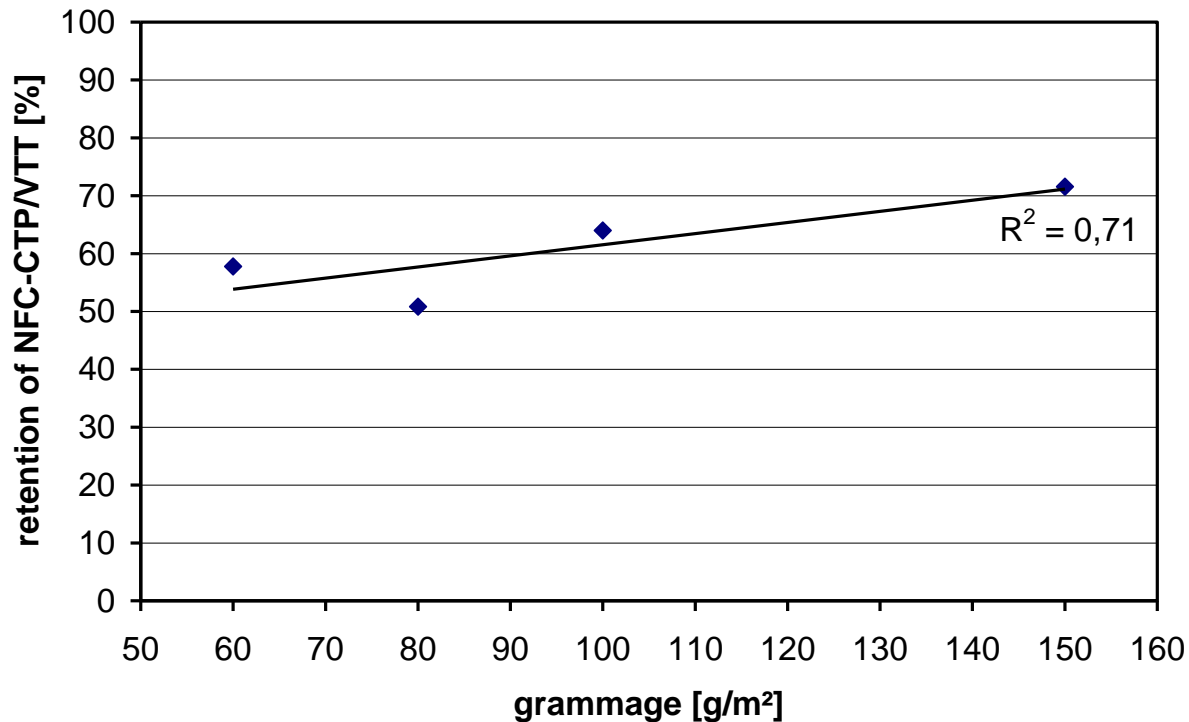
## NFC in wet end: dosage strategy



- In order to avoid unwanted NFC agglomeration the reaction time of NFC and pulp should be minimized
- Used standard in all further trials:  
NFC dosage sheet wise directly before sheet forming



## Retention of NFC in lab sheets

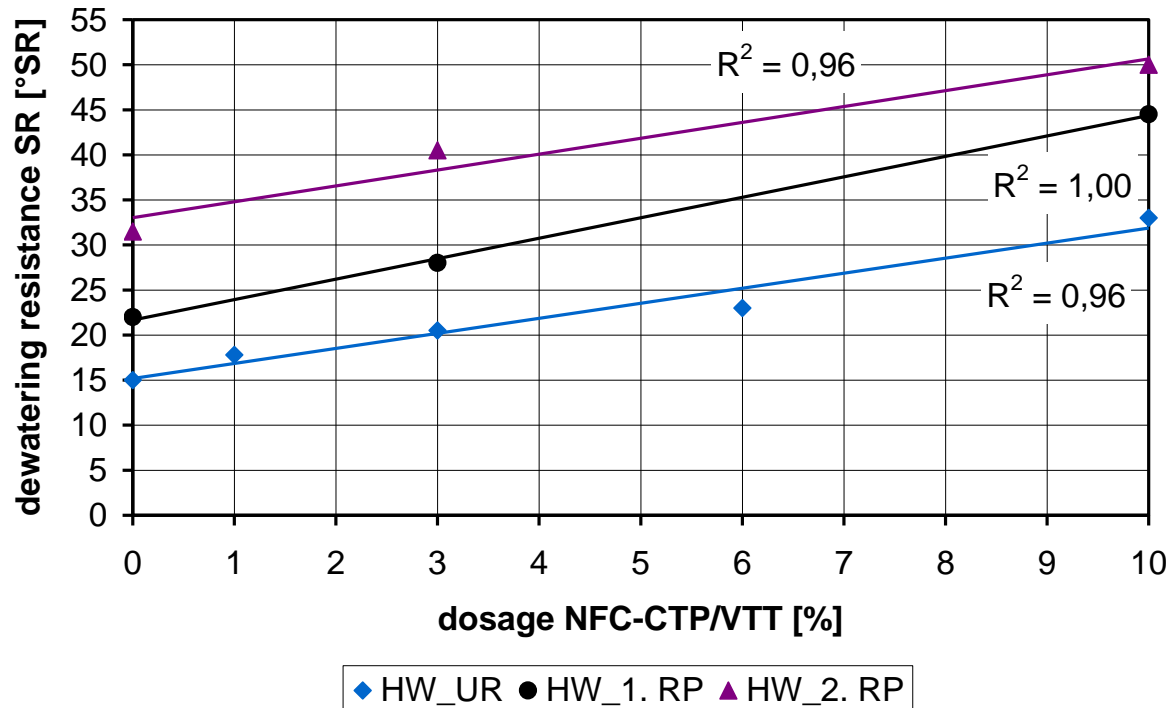


- 10 % NFC-CTP/VT was used
- roughly 50 % NFC retention in unrefined hardwood pulp standard sheets
- increased NFC retention at higher grammage

NFC

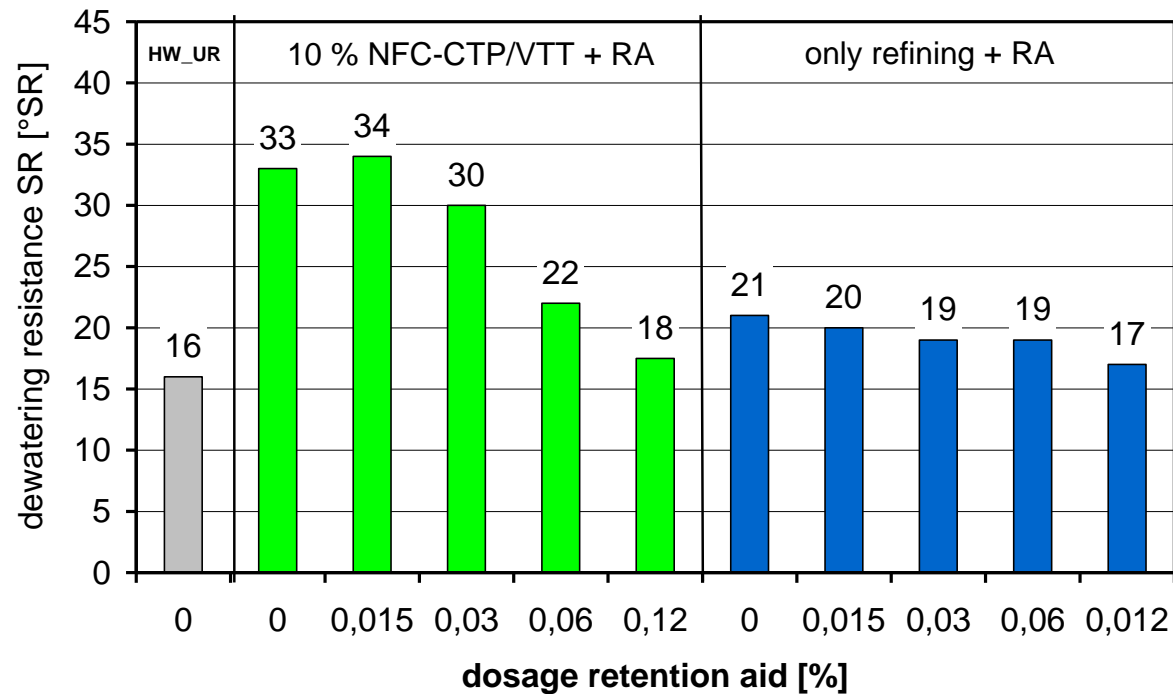
influence to dewatering

## Influence of NFC to dewatering resistance (hardwood)



- significant increase in dewatering resistance by NFC
- 10 % (5 % retained) NFC in HW\_UR meets the SR level of 2. RP
- approx. increase of 2 SR for 1 % dosage of NFC-CTP/VTT
- effect is not so dominant by adding NFC to CTMP or softwood

## Options for reducing dewatering resistance - comparison of NFC effect and refining -

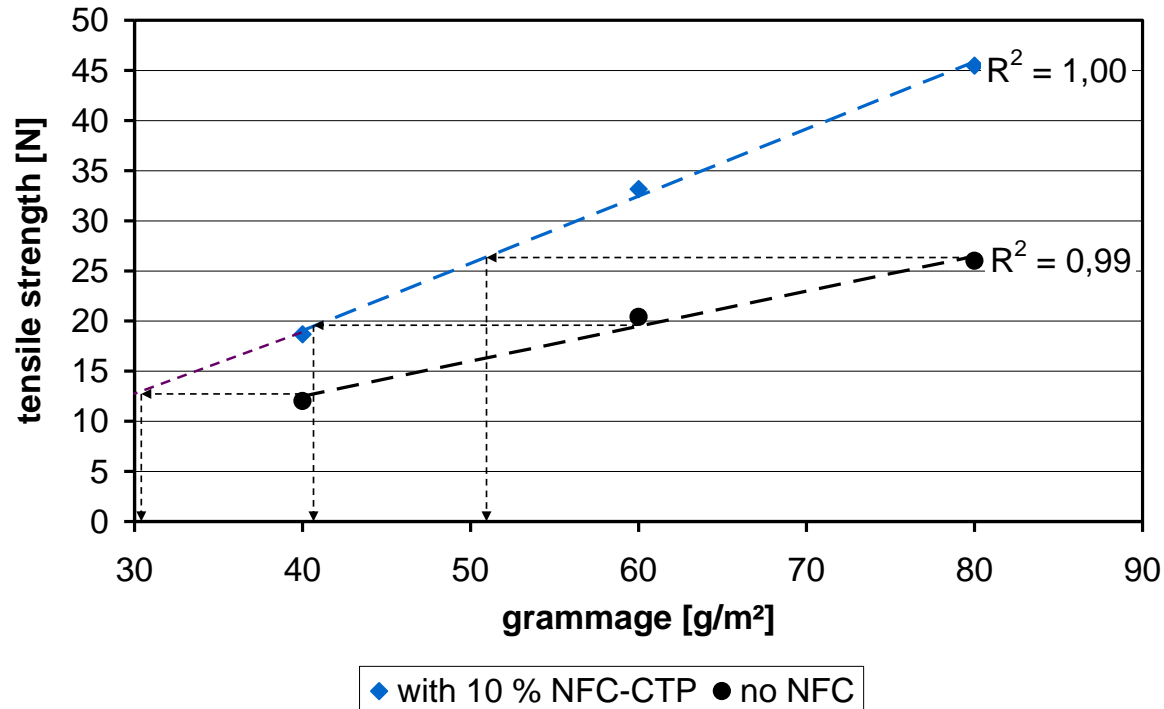


- retention aid reduced the unwanted effect of increase in SR
- both samples (10 % NFC & refined stock without NFC) nearly reached basic SR level at 16

NFC

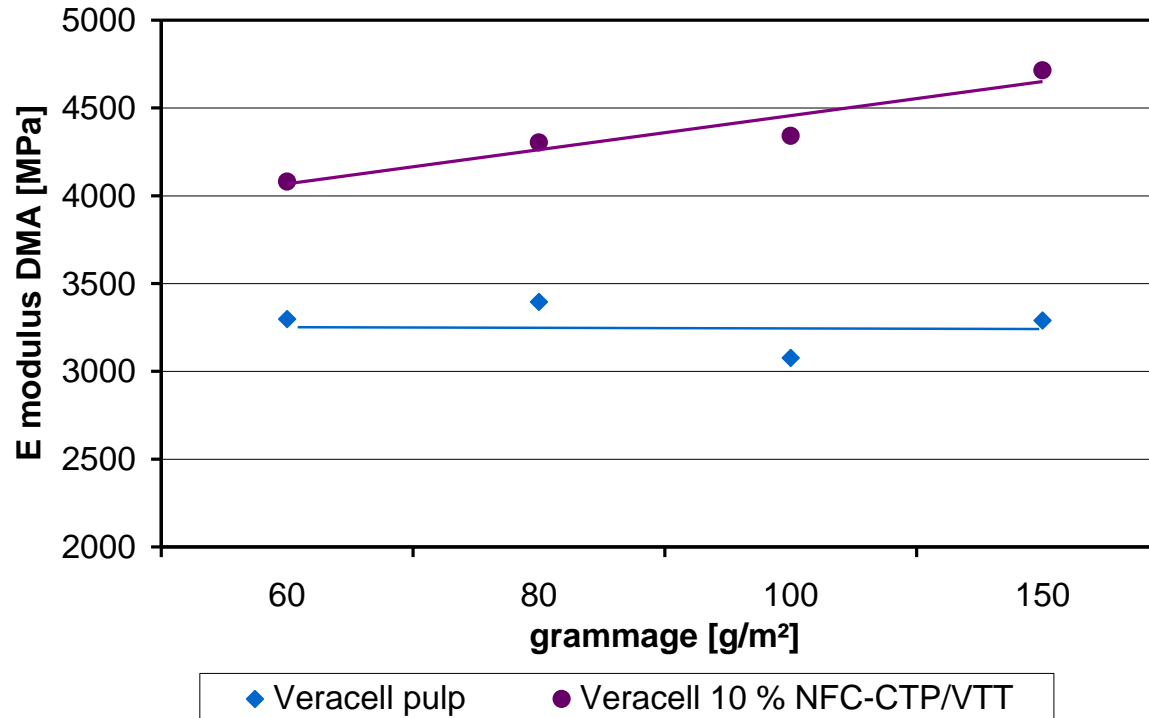
improvement of paper properties

## Effect of grammage reduction



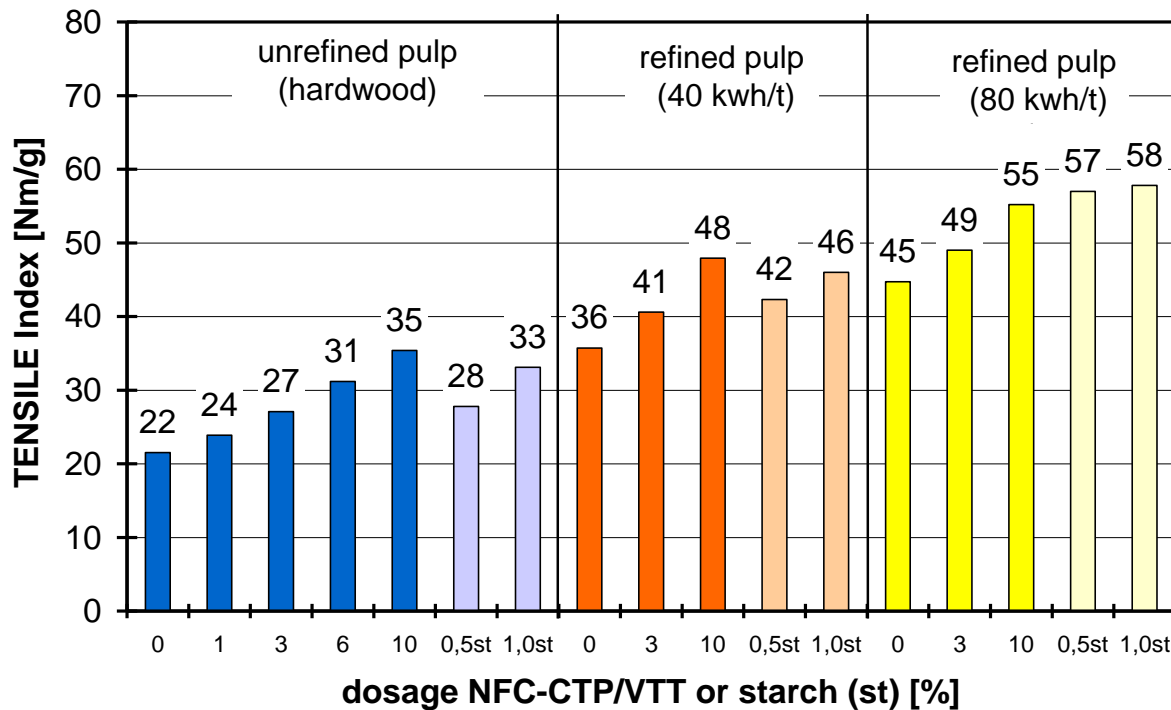
- 3 sheet grammages tested 80, 60, 40 g/m<sup>2</sup>
- significant grammage reduction by NFC possible (concerning to tensile)
- example: 60 g/m<sup>2</sup> without NFC gave same tensile like 41 g/m<sup>2</sup> with NFC

## Effect of NFC retention to strength properties



- E modulus is a material constant
- so E modulus without NFC is nearly independent from grammage
- increased E modulus at increased NFC retention

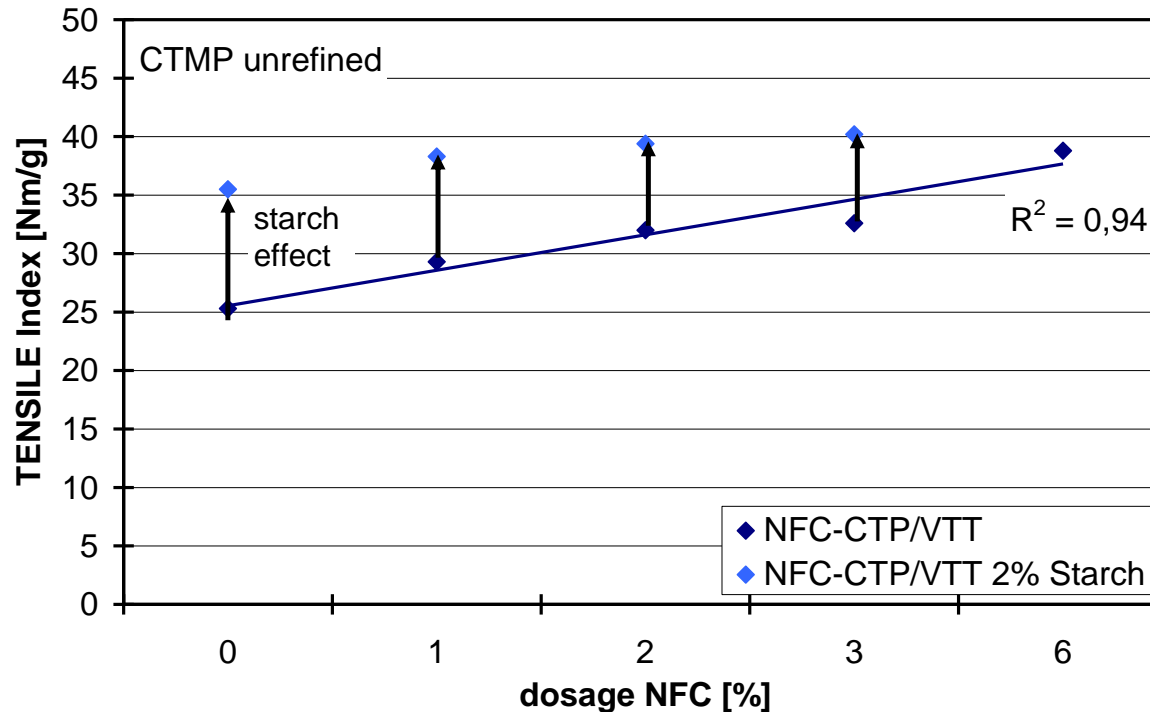
## Tensile index - hardwood chemical pulp comparision of NFC, refining and starch effect



- increase of 60 % in tensile strength at 10 % NFC (5 % NFC retained)
- nearly the same effect of 3% NFC as with 0,5% starch
- please remember: NFC retention is 50 % of the dosage
- (complete starch retention & effect only in very clean water systems)

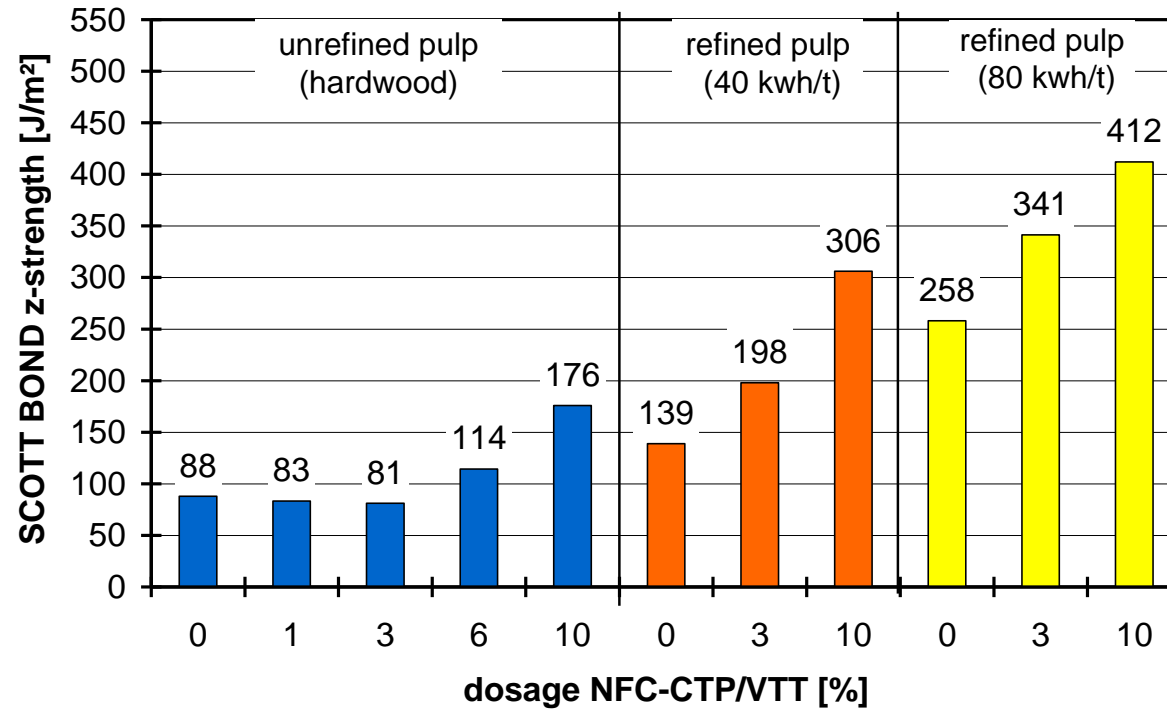


## Tensile index - CTMP mechanical pulp



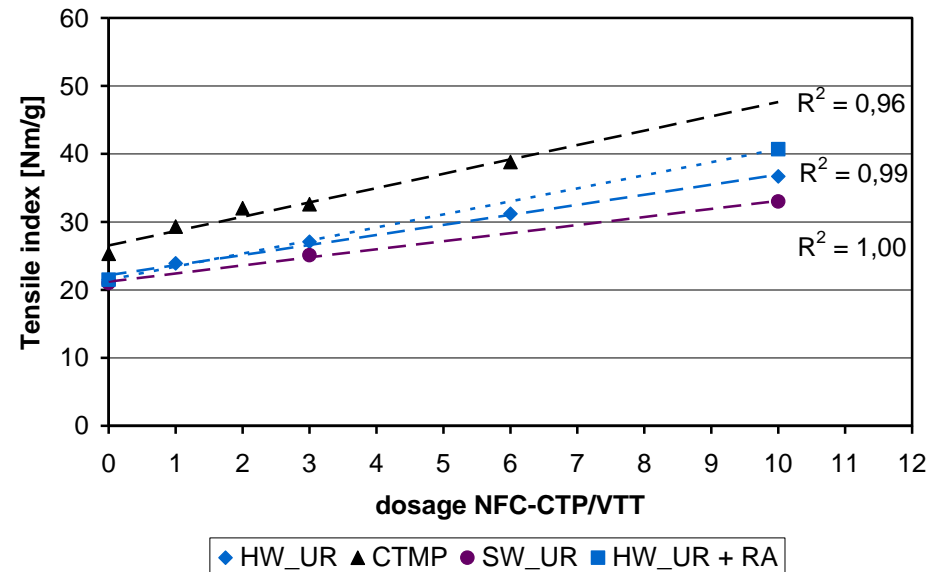
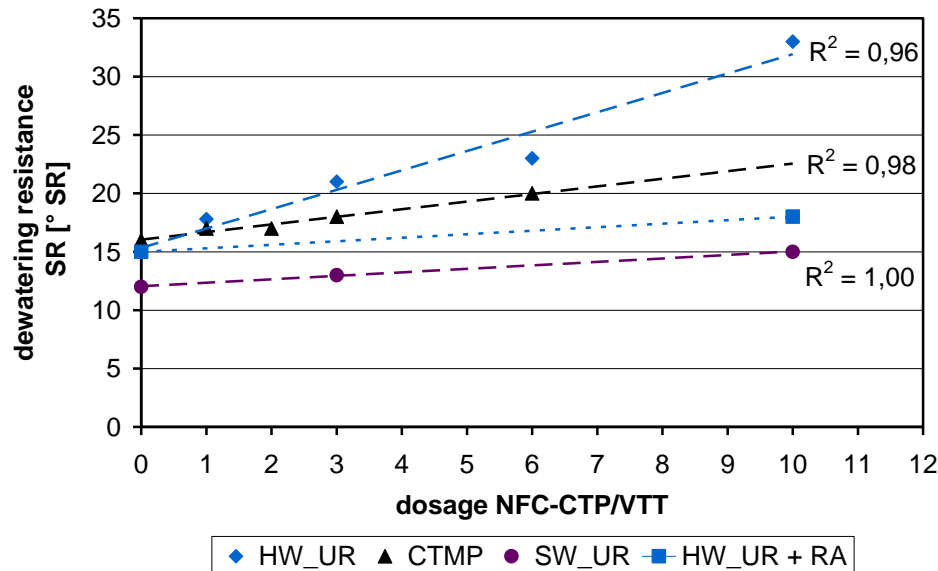
- **unrefined CTMP**: very strong increase (56 %) of tensile by 6 (3) % NFC
- tensile increase was higher in comparison to hardwood pulp
- NFC and starch action to tensile was effective together

## Scott Bond – hardwood chemical pulp



- generally significant increase in Scott Bond z-strength by NFC-CTP/VTT

## Comparison of the pulp samples



- lowest dewatering resistance increase at softwood pulp
- highest tensile increase at CTMP pulp
- How to compare the samples in a best suitable way?

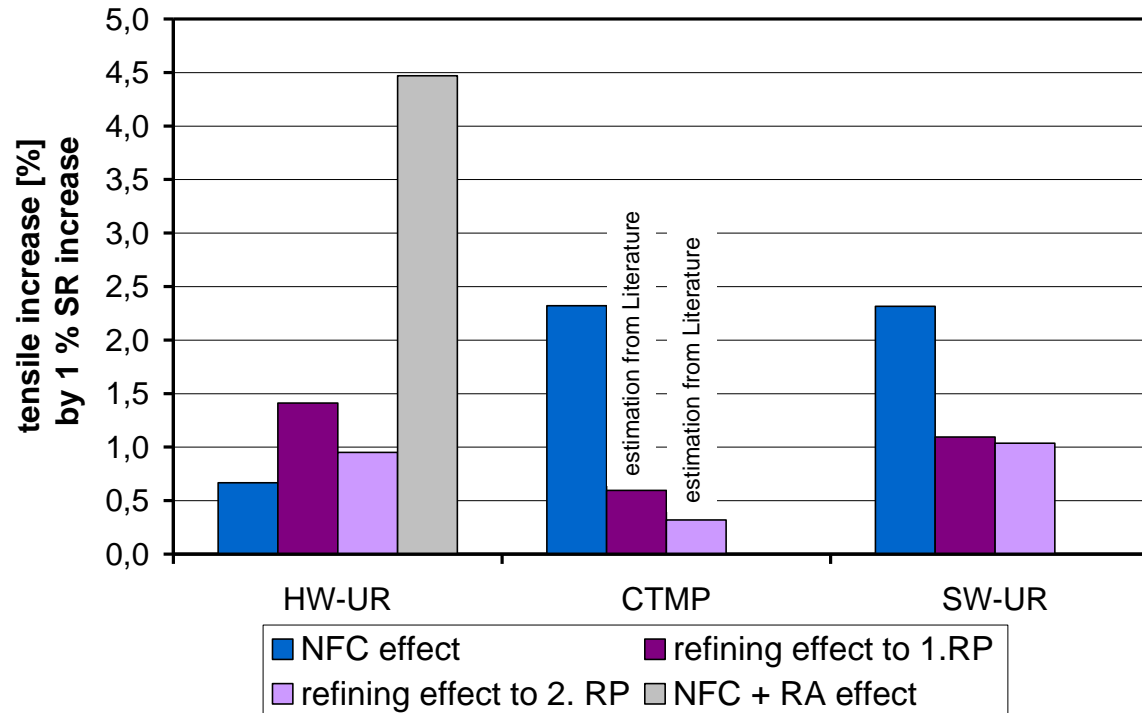
## Comparison of the pulp samples NFC, refining and retention aid effects to tensile

How to evaluate the effects observed on different pulps and the influence on paper making?

- Significant increase in strength properties, but at the same time unwanted loss in dewatering speed should be reached.
- Balancing of the positive strength effect and negative dewatering loss

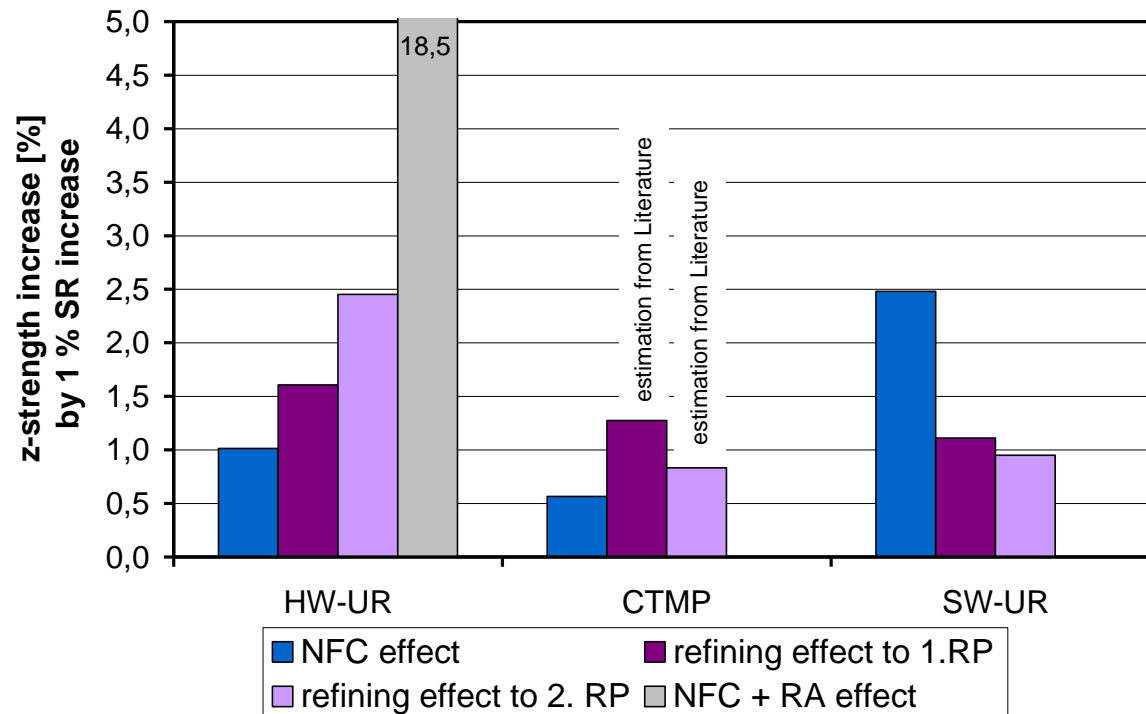
$$\frac{\Delta \text{ tensile index [\%]}}{\Delta \text{ SR [\%]}}$$

## Comparison of the pulp samples NFC, refining and retention aid effects to tensile



- hardwood: refining better than NFC
- softwood and CTMP: NFC significantly better than refining

## Comparison of the pulp samples NFC, refining and retention aid effects to z-strength



- hardwood and CTMP: refining better than NFC
- softwood: NFC significantly better than refining

## Conclusion

### **Use of NFC in bulk application**

- before use NFC should be well dispersed
- the NFC retention in standard lab sheets is approx. 50 -70% (depending on the grammage)

### **Dewatering behaviour**

- NFC increased the dewatering resistance significantly
- dewatering speed loss depends from the used pulp
- there are successful options to restore dewatering speed

### **Paper properties**

- generally very strong improvement in tensile- and z-strength by NFC
- tensile hardwood: 5 % NFC-VTT comparable to refining with 40 kWh/t
- also significant increase of air flow resistance (stronger than refining)
- best results on unrefined softwood and CTMP pulp

## Acknowledgment

The research leading to these results received funding from the European Community's Seventh Framework Programme under Grant Agreement No 228802.

Contact:

Lutz Hamann

Tel: +49 3529 551 657

Fax: +49 3529 551 899

[Lutz.Hamann@ptspaper.de](mailto:Lutz.Hamann@ptspaper.de)

Papiertechnische Stiftung (PTS)

Pirnaer Str. 37

01809 Heidenau

Homepage: [www.ptspaper.de](http://www.ptspaper.de)