Decrease in strength along a process line for SC paper

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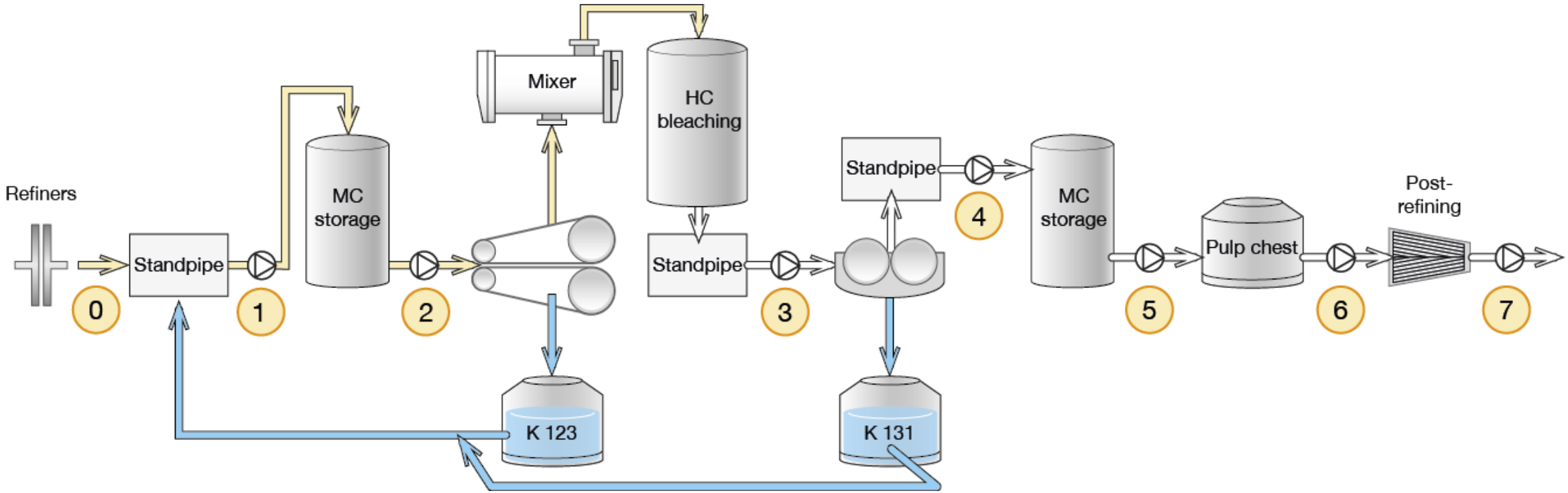
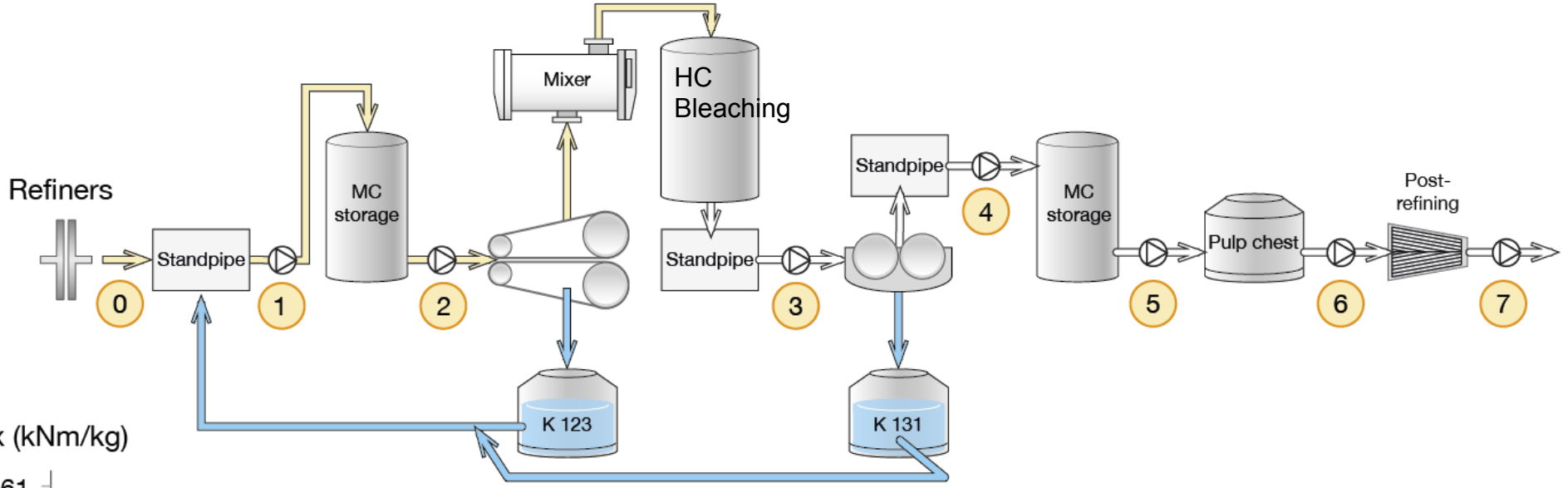

Refiners
Standpipe
MC storage
Mixer
HC bleaching
Standpipe
Standpipe
MC storage
Pulp chest
Post-refining
K 123
K 131
0
1
2
3
4
5
6
7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1
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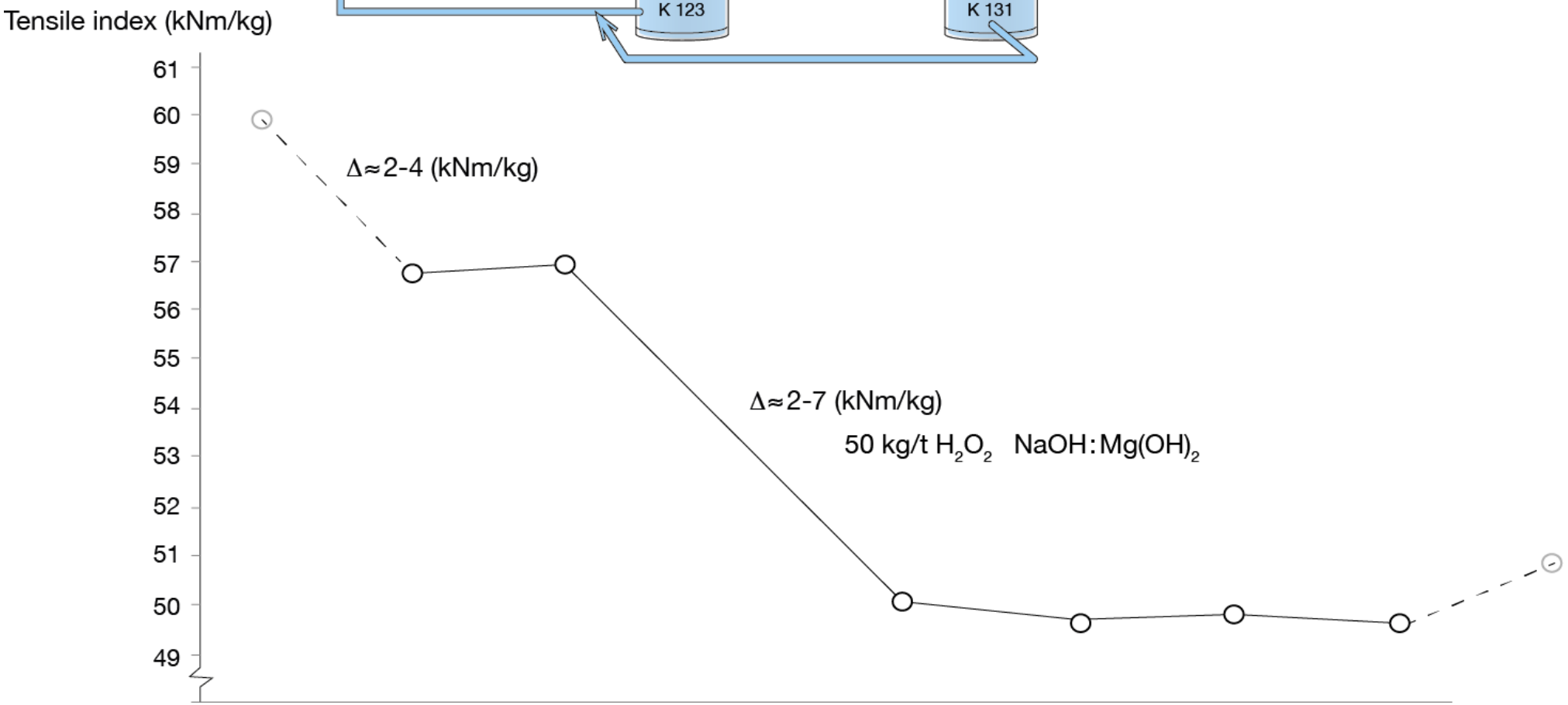
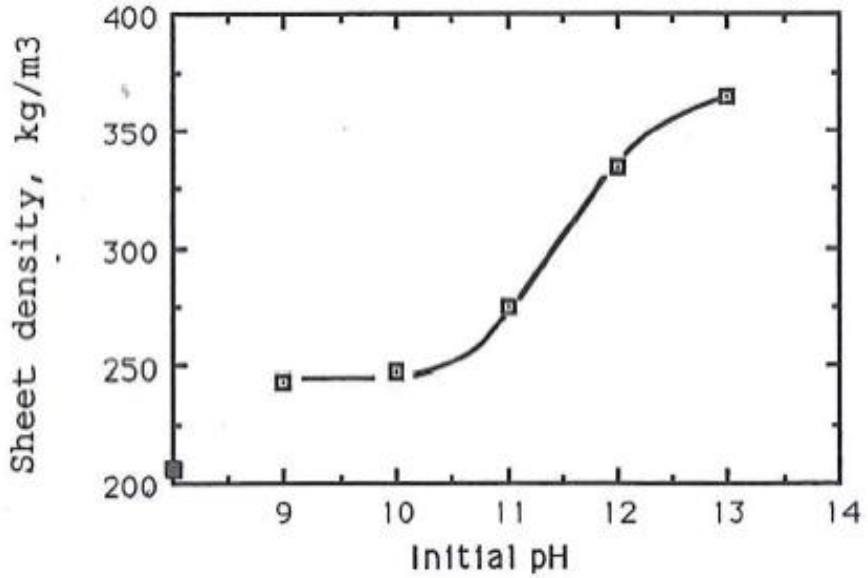
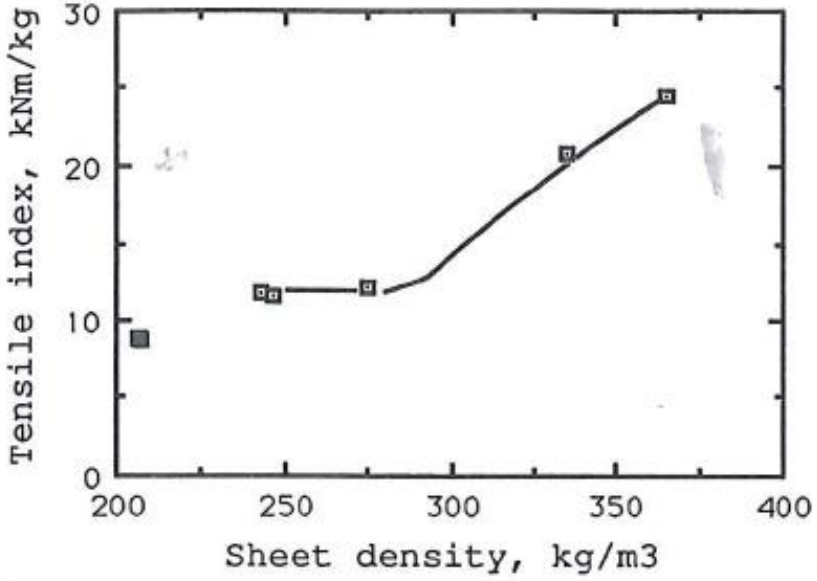
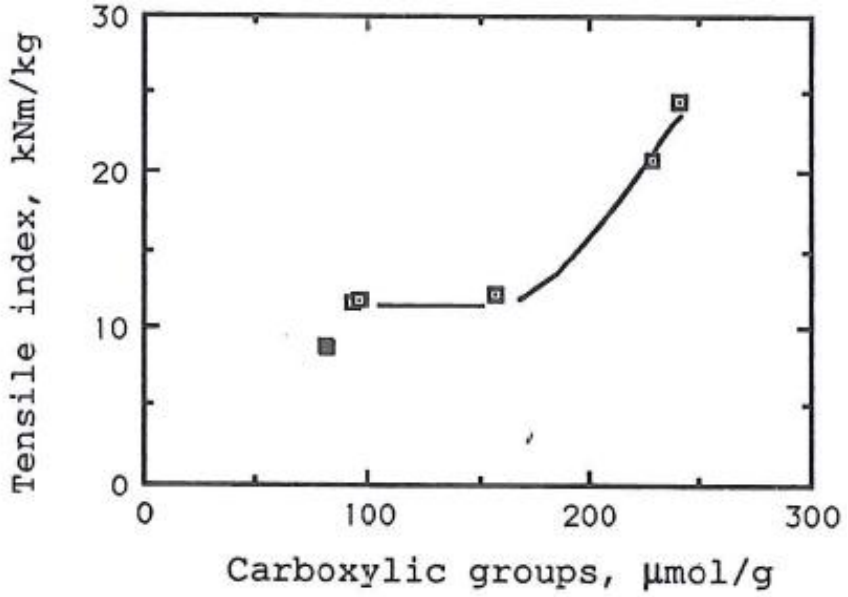
7

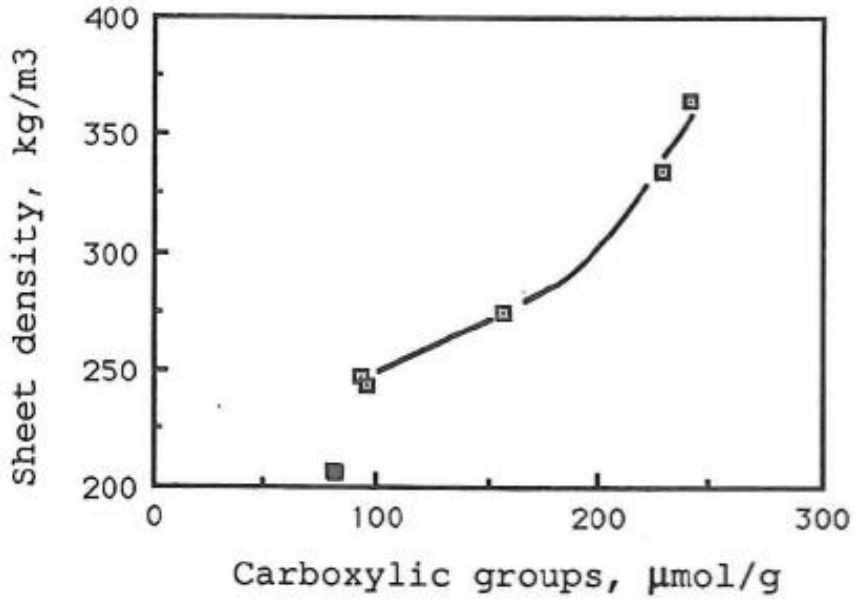

Tensile index (kNm/kg)
61
60
59
58
57
56
55
54
53
52
51
50
49
Δ≈2-4 (kNm/kg)
Δ≈2-7 (kNm/kg)
50 kg/t H_2O_2 NaOH:$Mg(OH)_2$





This is true in a clean system (lab).
Na base and thus high initial pH





Engstrand et al.
The Significance of carboxylic groups for the physical properties of mechanical pulps
6th Int. Symp. Wood Pulp. Chem. Melbourne, Australia, April 29 - May 3, 1991, vol. 1., 75

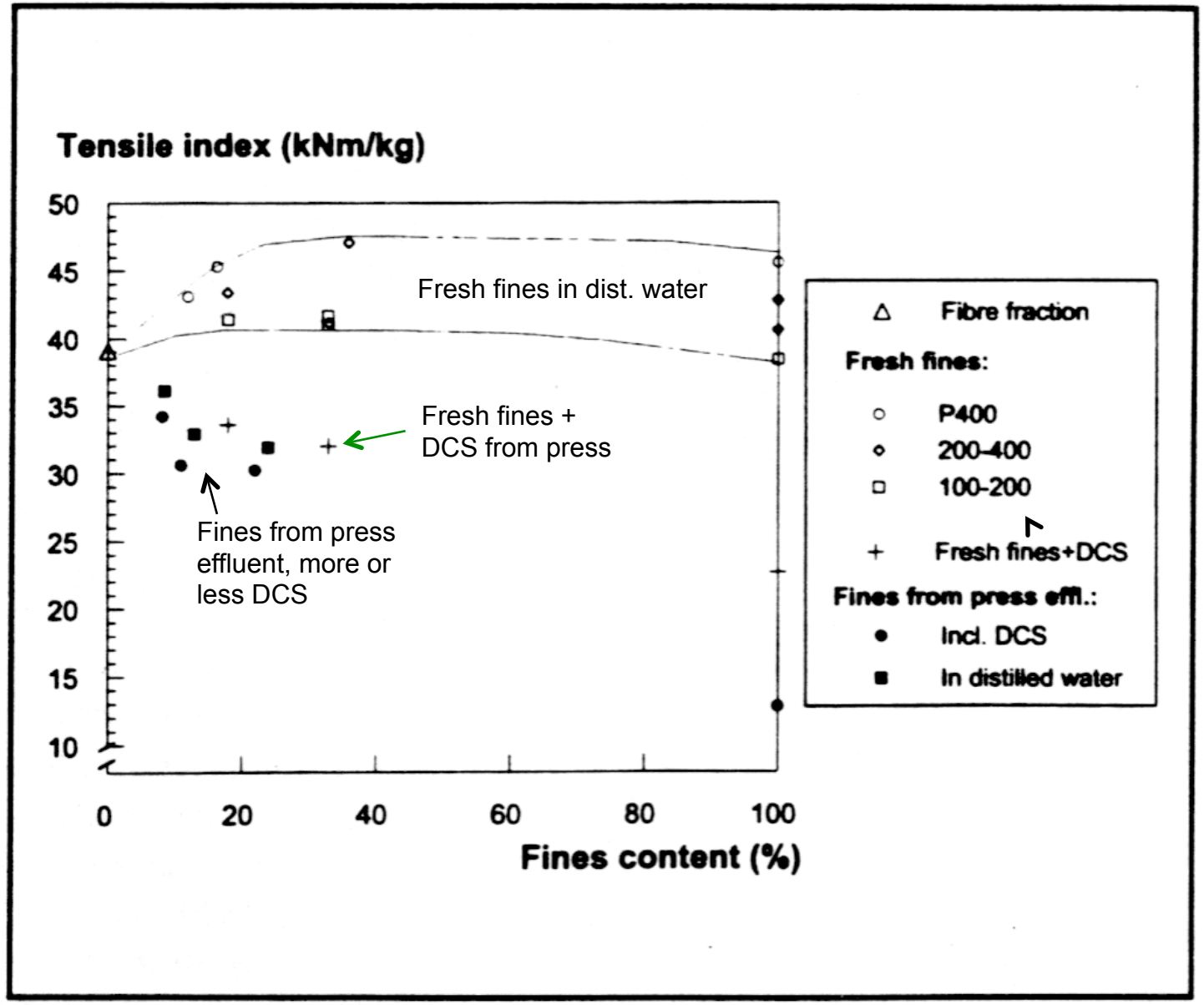


Fig. 9. Effect of the amount of DCS in the water phase during sheet making on the tensile index of handsheets containing bleached fines.

Rundlöf M., Htun M., Höglund H., Wågberg, L.
1995 IMPC, Ottawa
2000 JPPS 26 (9) p314

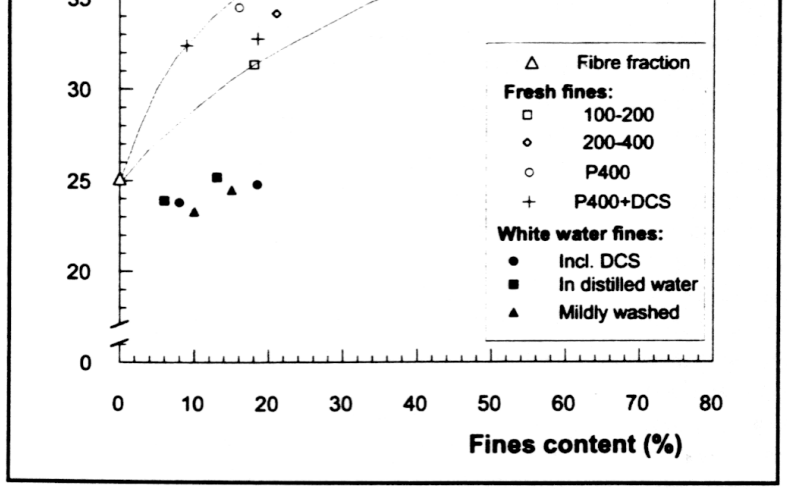


Fig. 8. Effect of different treatments of unbleached white-water fines and fresh fines on the tensile index of handsheets as a function of fines content. The different types of fines were added to the same fibre fresh fraction.

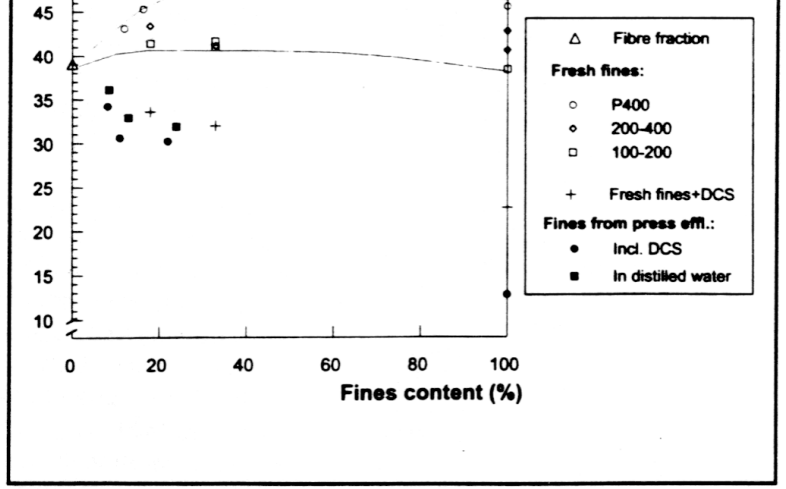


Fig. 9. Effect of the amount of DCS in the water phase during sheet making on the tensile index of handsheets containing bleached fines.

water fines, which suggests that the low tensile index was related to the fines themselves rather than to the presence of DCS in the water phase during the sheet making. An attempt was made to induce the observed poor bonding ability by suspending a fresh fines fraction (P400) in the DCS-containing water taken from the white-water sample. This treatment did not affect the tensile index of the handsheets, referred to as "fresh fines +DCS" in Fig. 8. This experiment has been carried out with contact times of up to 14 h at 60°C (not shown) without any decrease in the tensile index of the handsheets. This result implies that the assumed adsorption of extractives did not occur spontaneously from the slightly acidic water onto these unbleached fines.

The *s* value was not significantly affected by the different treatments. No significant effect on the *k* value of the removal of DCS could be seen at these low fines contents, but the addition of DCS to the fresh fines increased the light absorption of the handsheets somewhat. This indicates that

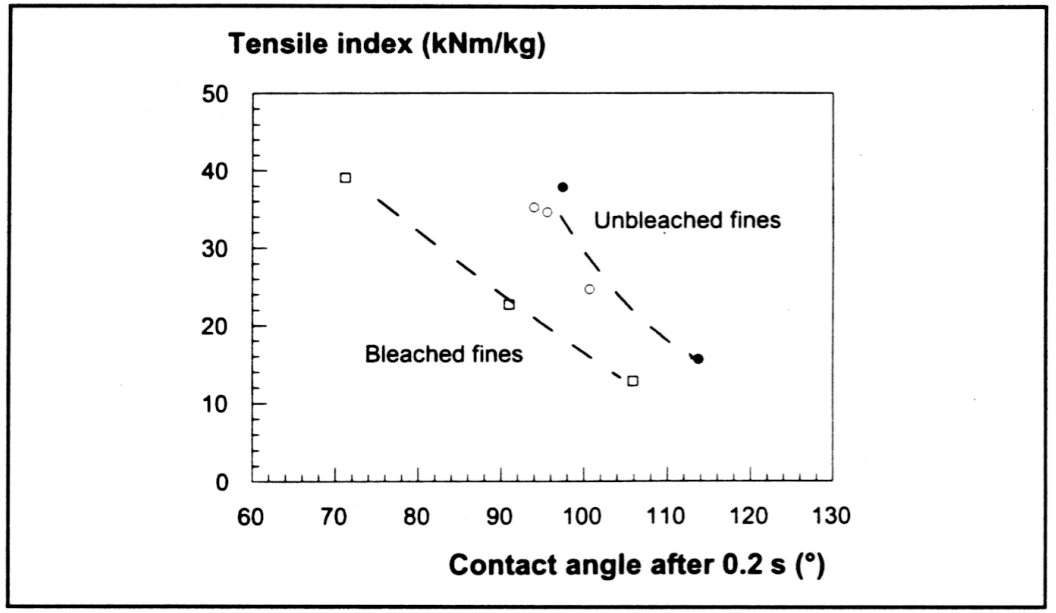
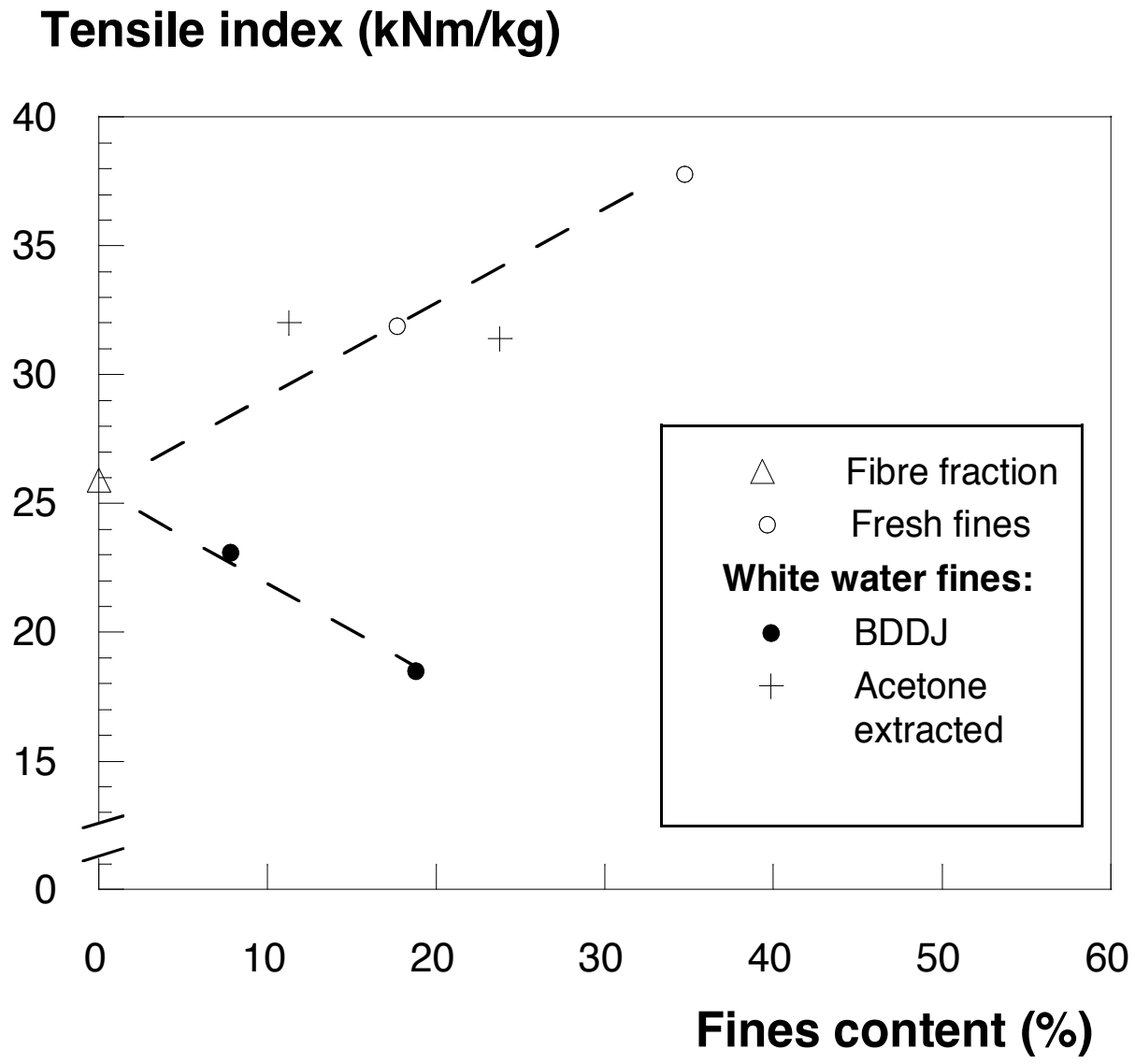


Fig. 10. The tensile index of sheets made solely of fines, unbleached and bleached, plotted against the contact angle of water on the surface.

by a slight increase in the Light-scattering coefficient, possibly due to a decrease in

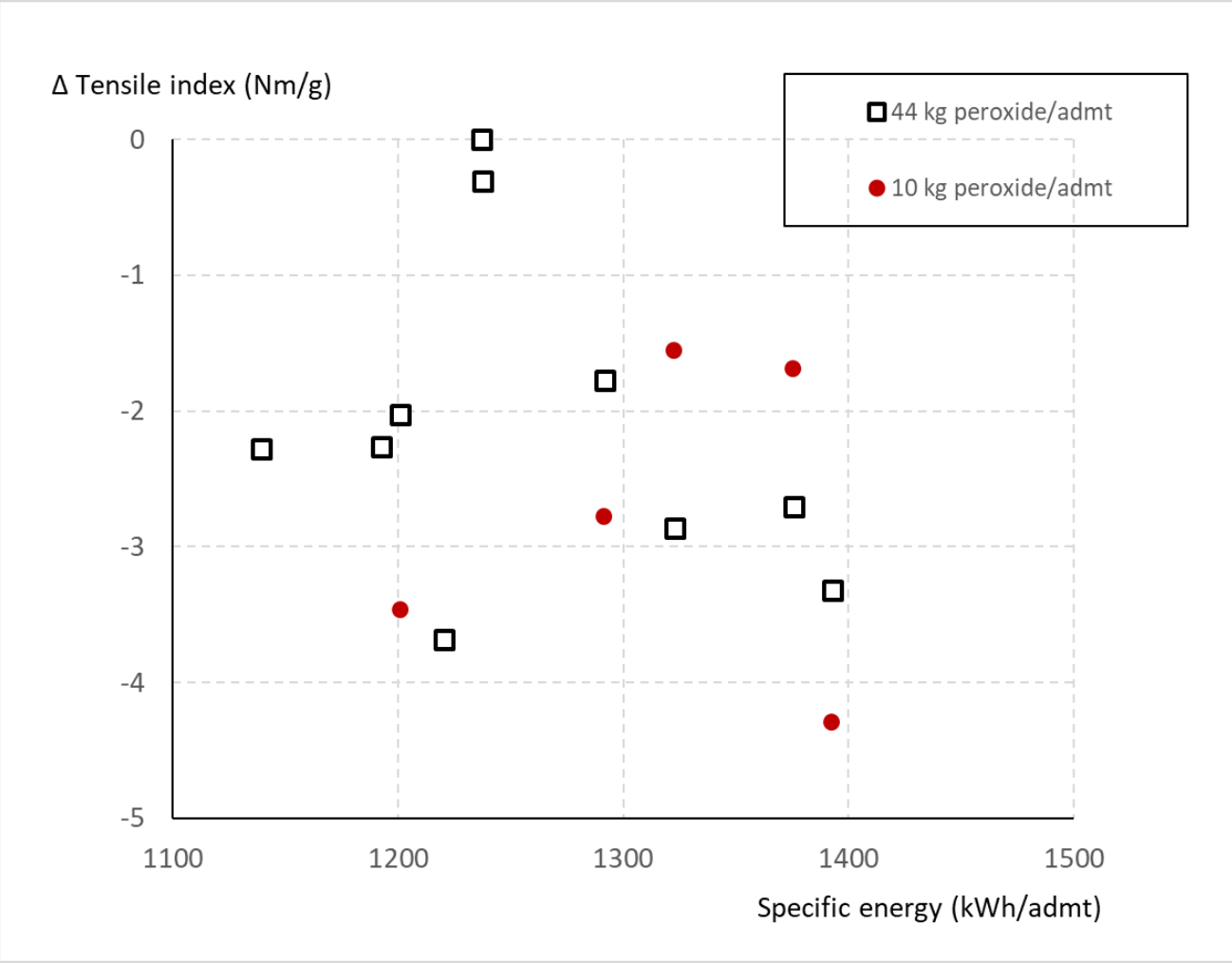
tact angle of the same order of magnitude as the sheet containing fresh fines, indicating a

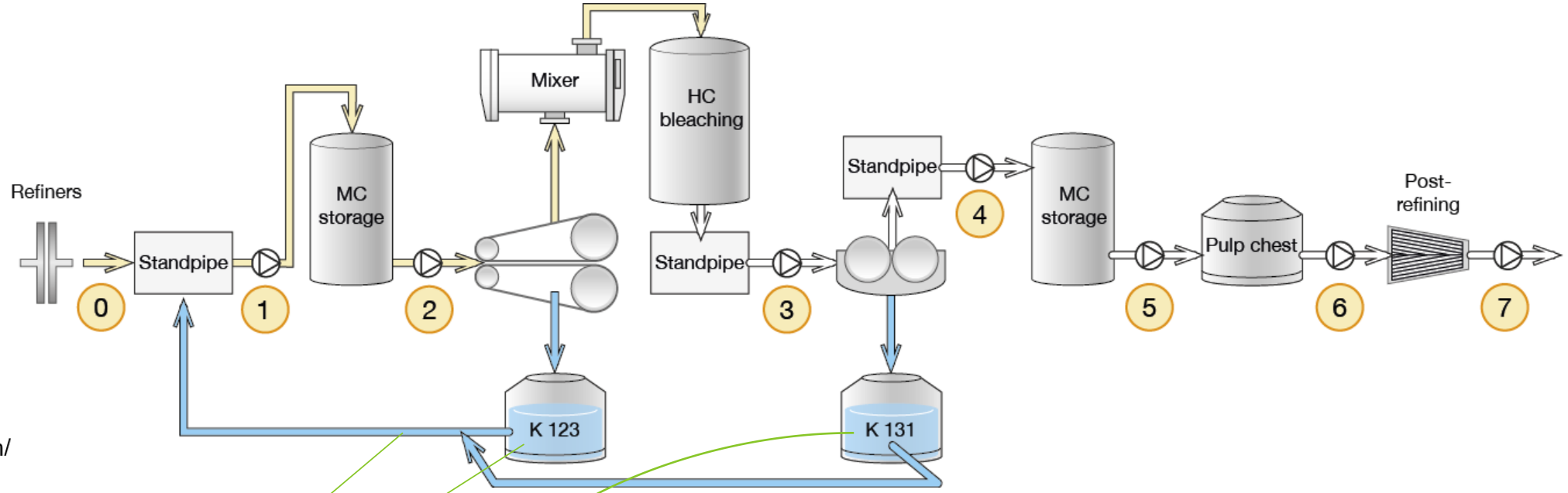
Clearly, surface properties were affected

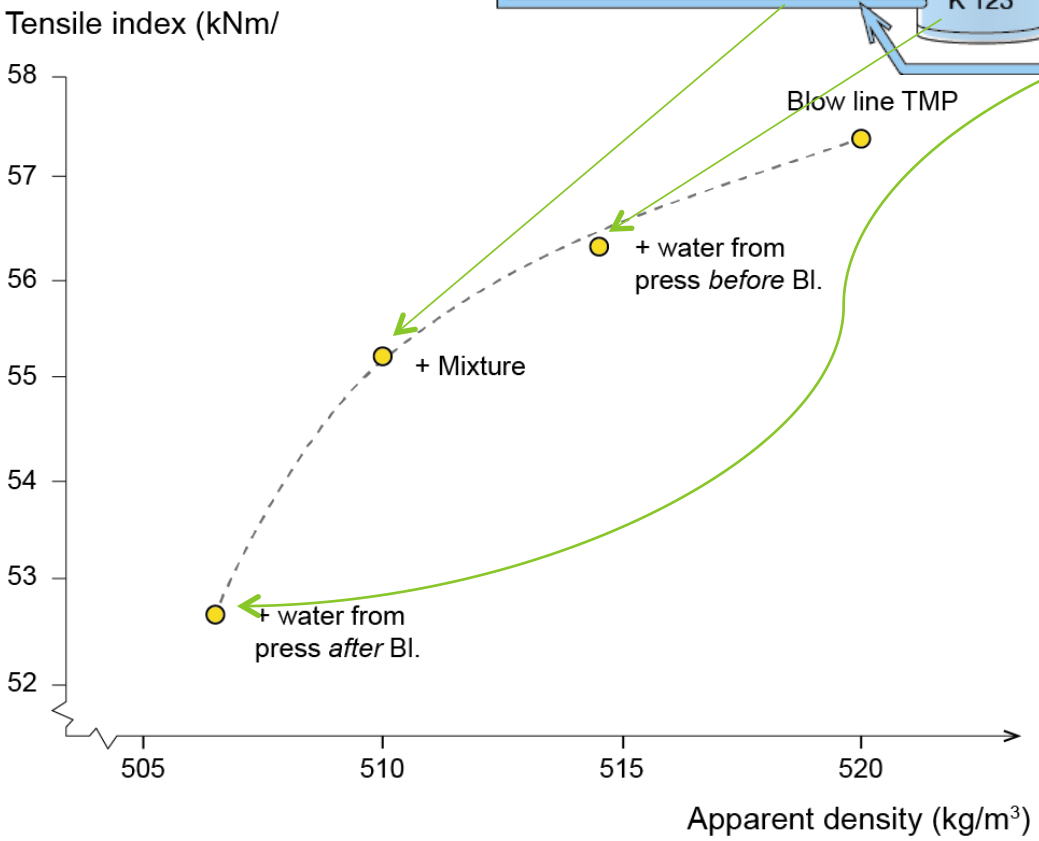


Rundlöf M., Htun M., Höglund H., Wågberg, L.
1995 IMPC, Ottawa
2000 JPPS 26 (9)

The decrease in tensile index at the first dilution after refining shows no clear relation to specific energy or if high or low bleaching was run at the time.

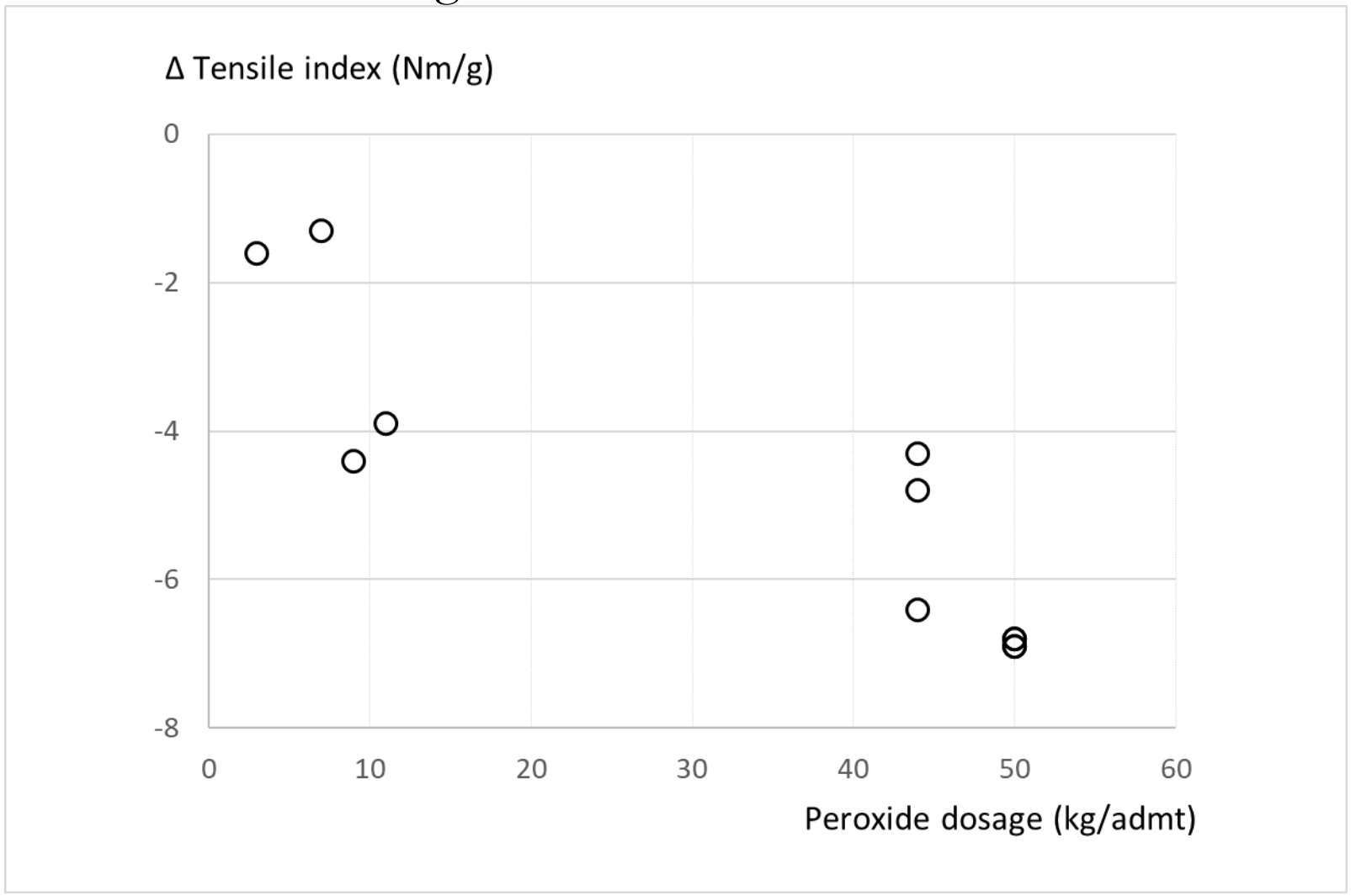




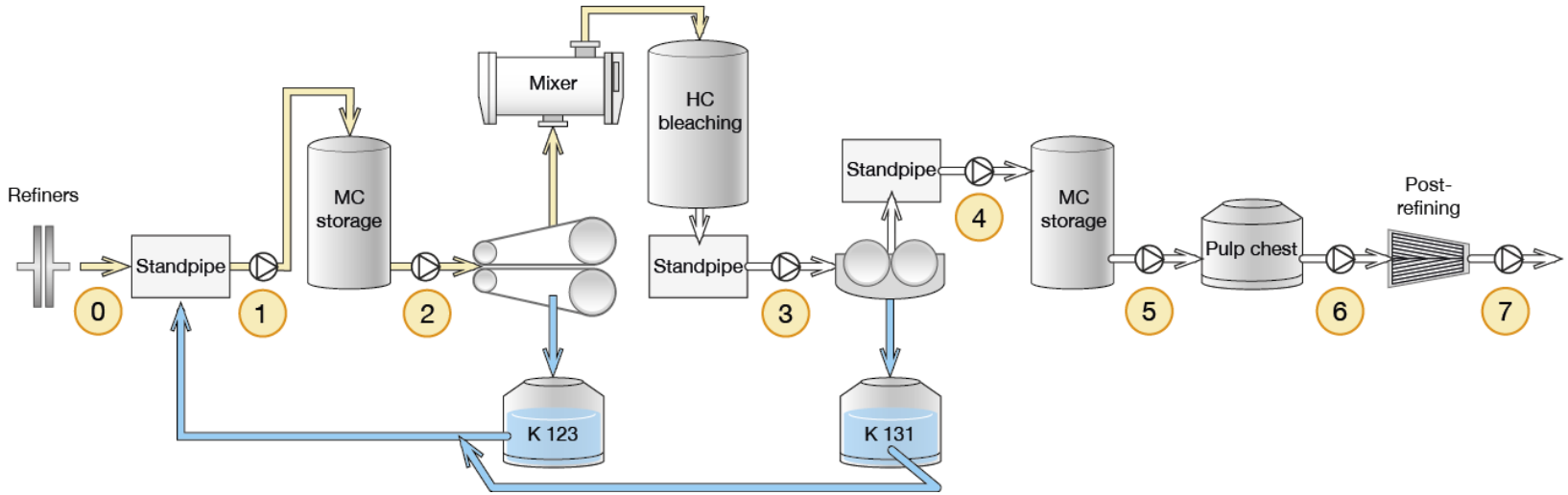


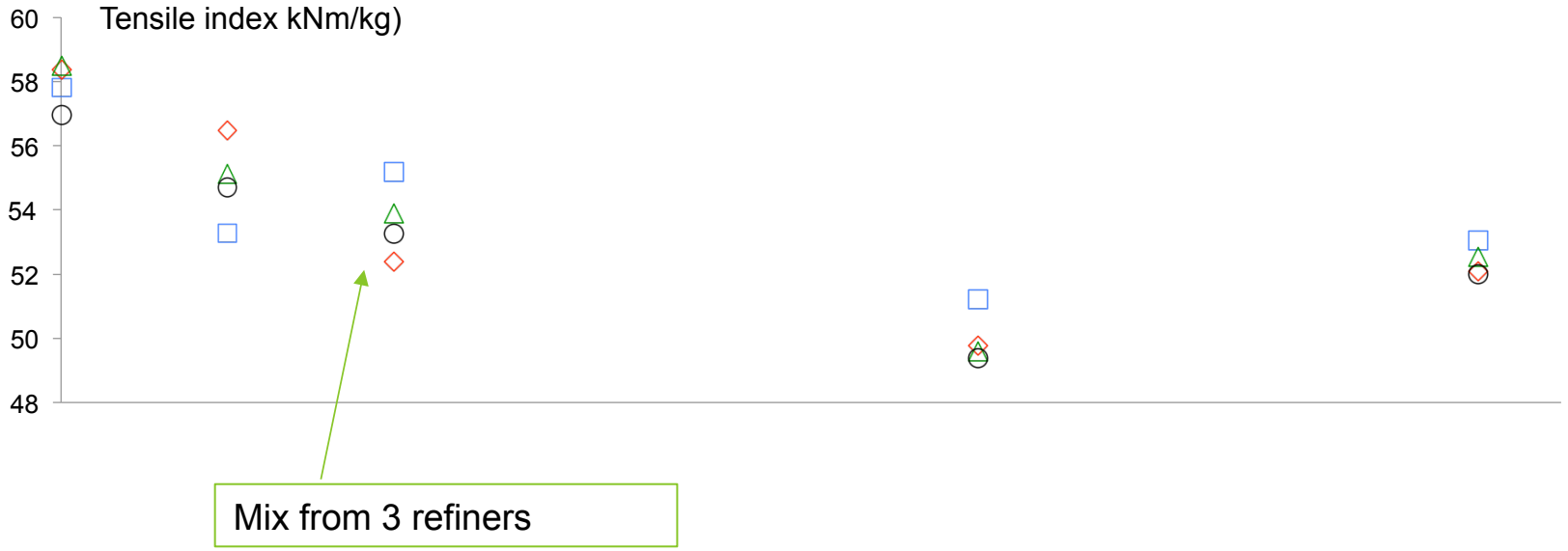
Effect of first dilution simulated in the lab.

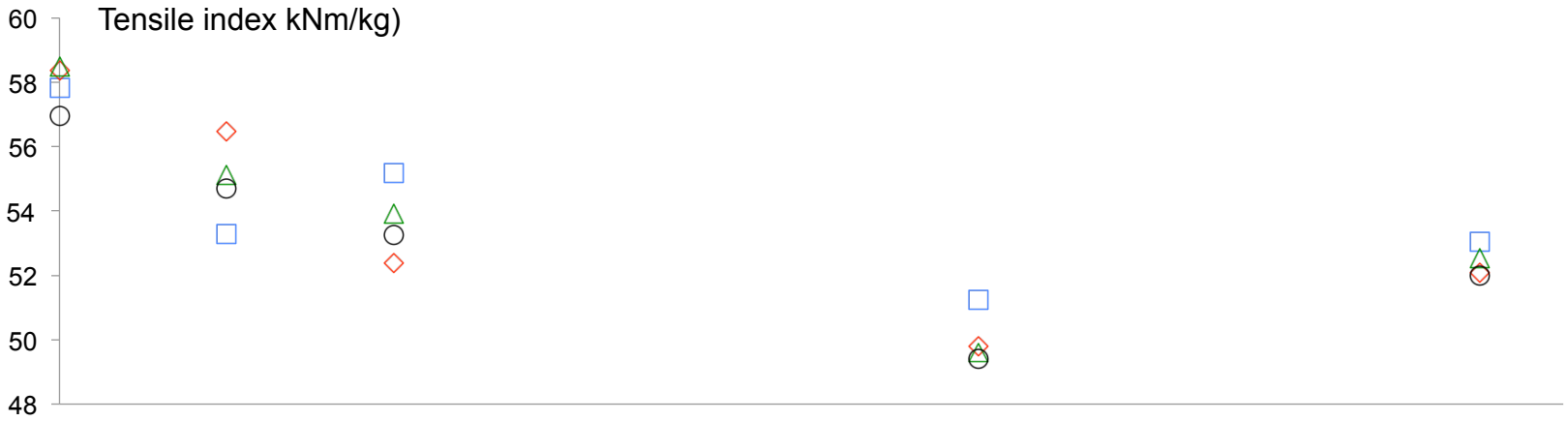
Strength decrease over bleach tower

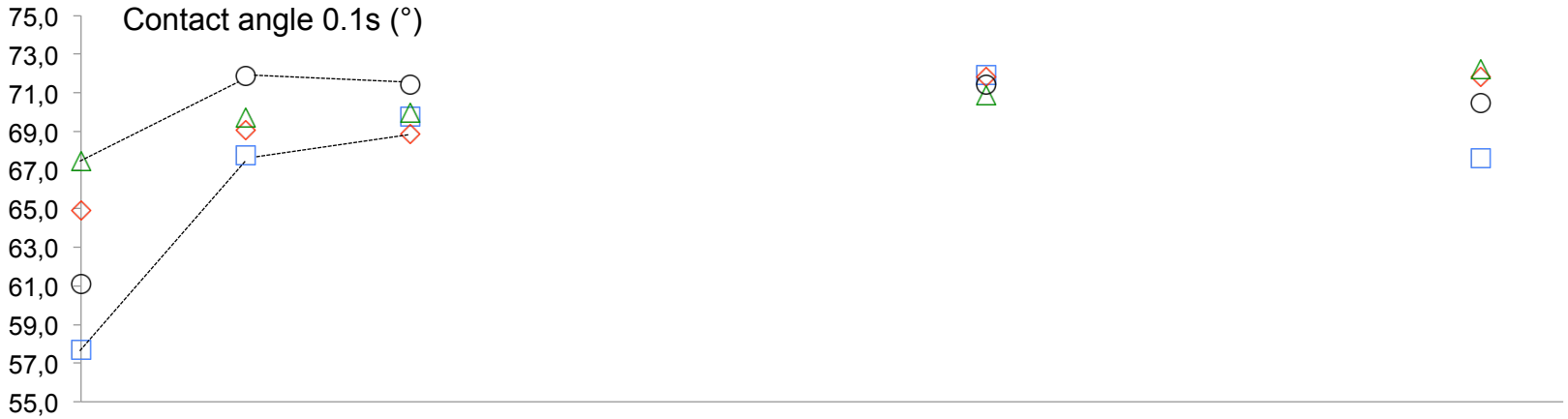


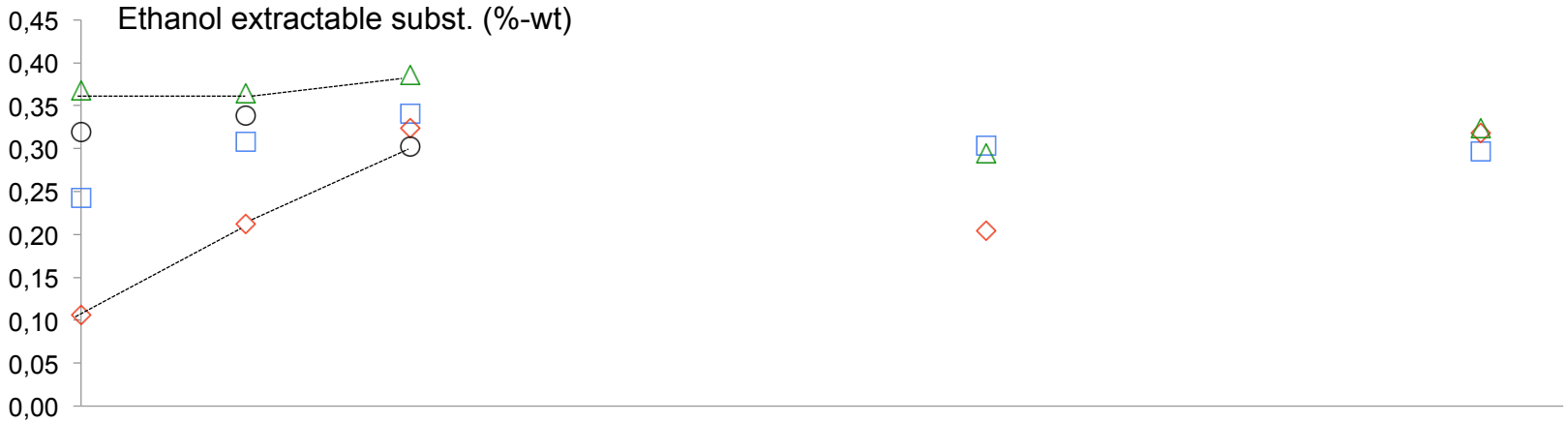
5 samples x 4 during 24hrs:

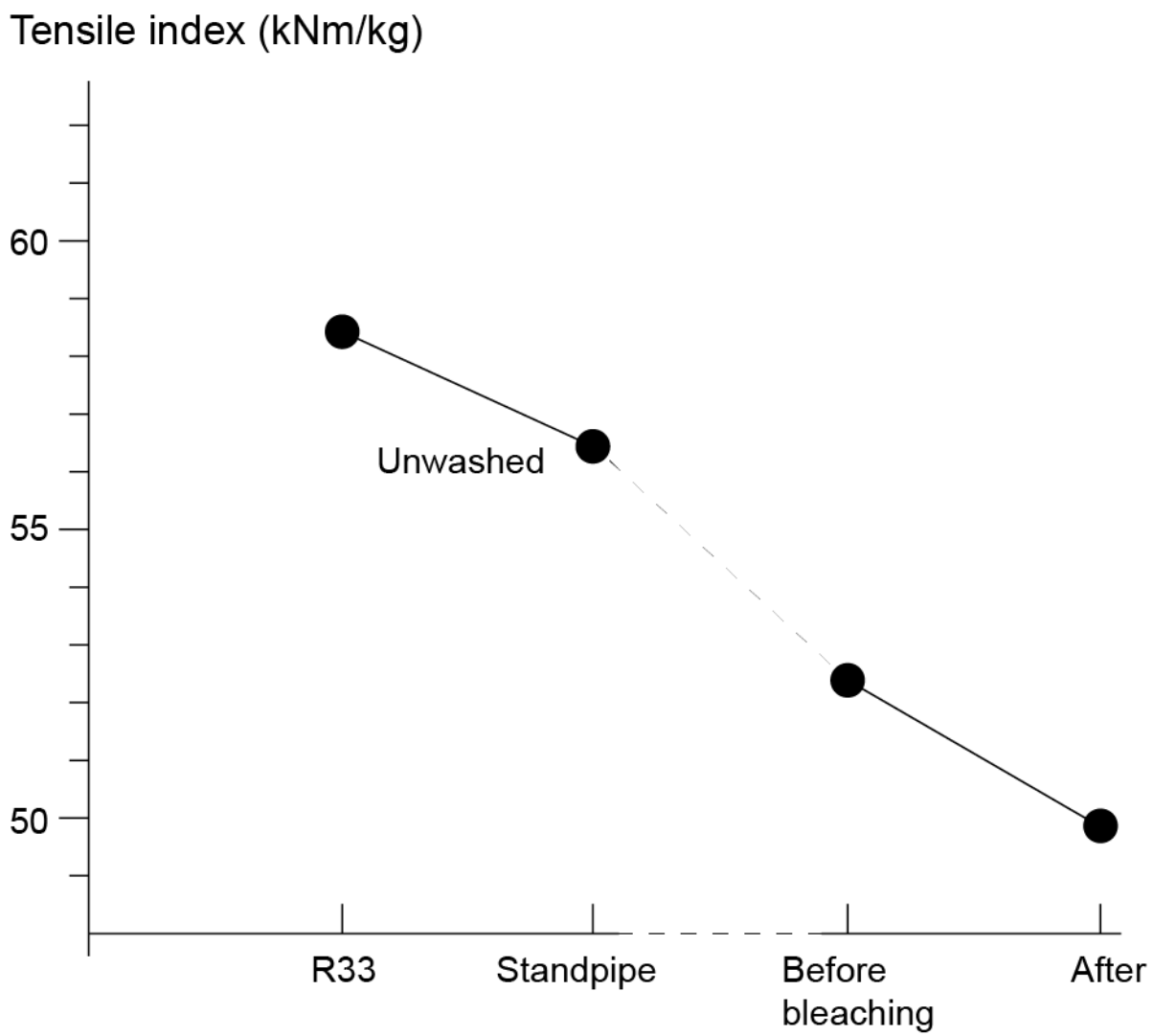


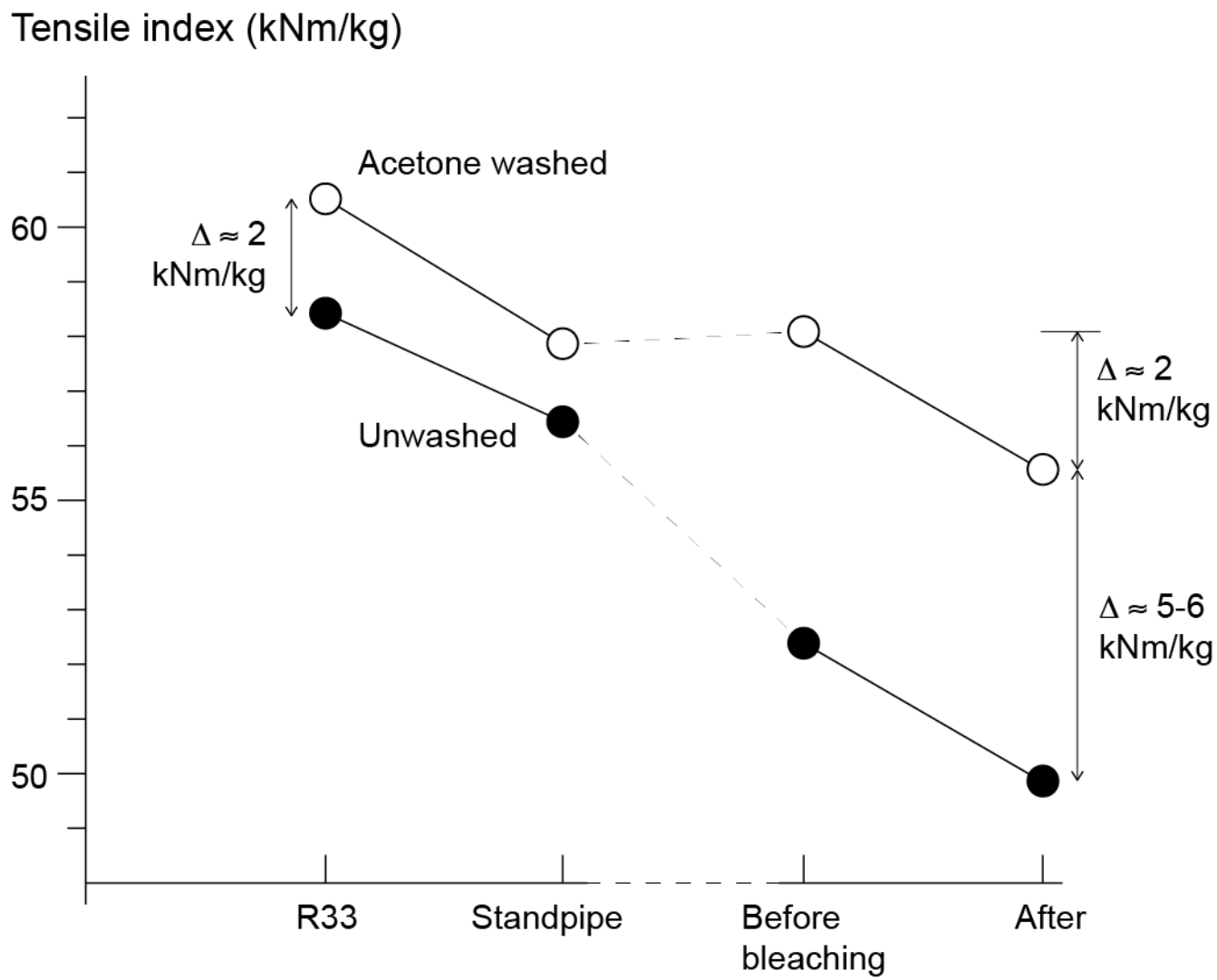


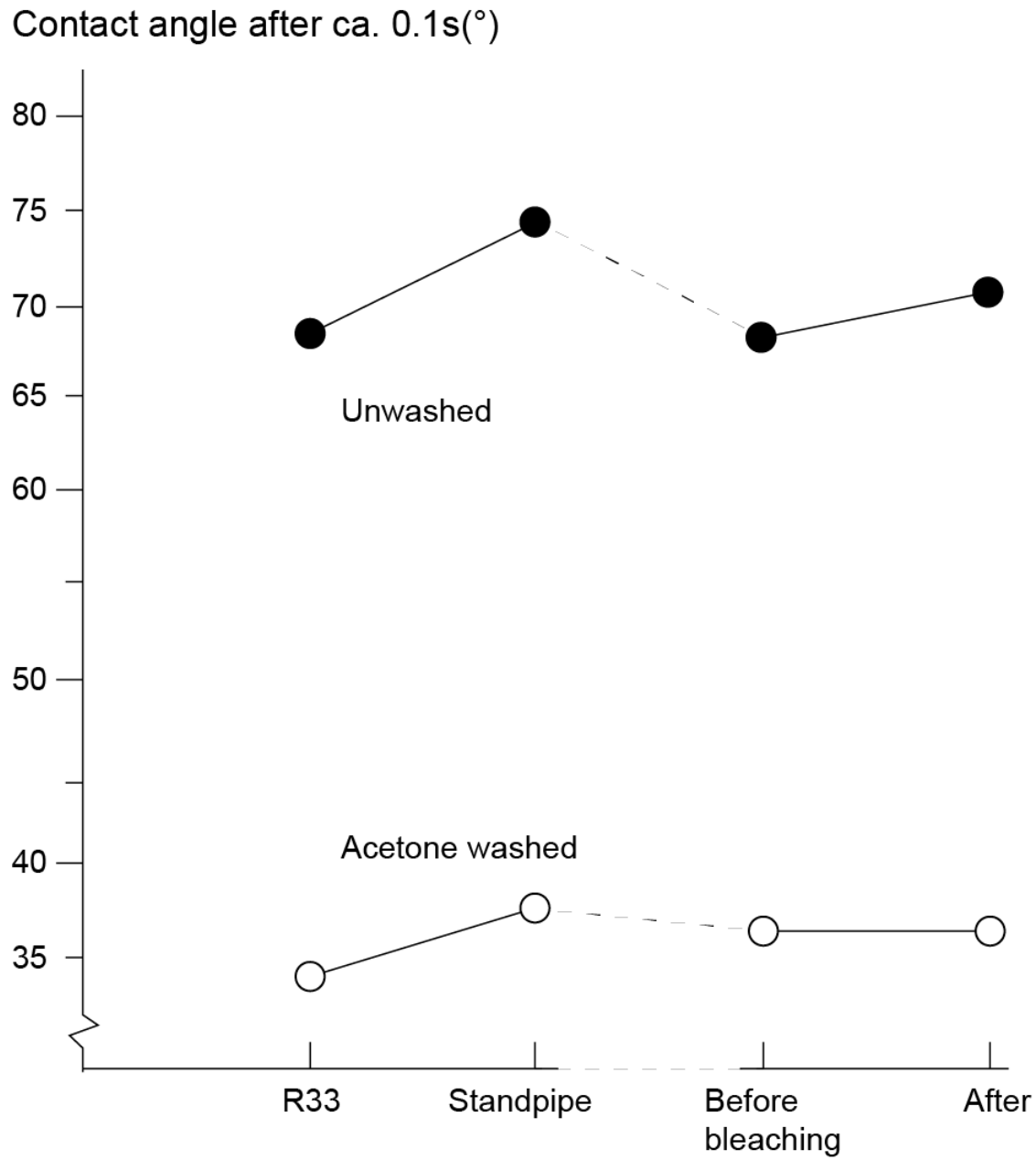

Tensile index kNm/kg)
60
58
56
54
52
50
48


Contact angle 0.1s (°)
75,0
73,0
71,0
69,0
67,0
65,0
63,0
61,0
59,0
57,0
55,0


Ethanol extractable subst. (%-wt)
0,45
0,40
0,35
0,30
0,25
0,20
0,15
0,10
0,05
0,00


Tensile index (kNm/kg)
60
55
50
Unwashed
R33
Standpipe
Before bleaching
After

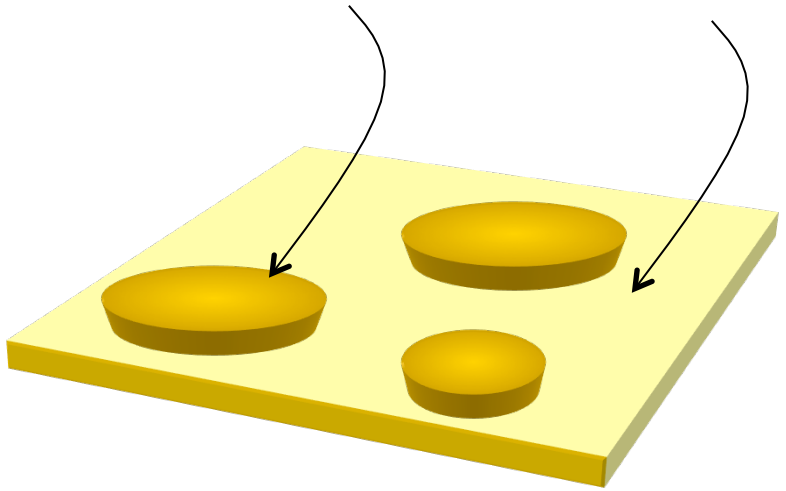

Tensile index (kNm/kg)
60
55
50
Acetone washed
Δ ≈ 2
kNm/kg
Unwashed
Δ ≈ 2
kNm/kg
Δ ≈ 5-6
kNm/kg
R33
Standpipe
Before
bleaching
After


Contact angle after ca. 0.1s(°)
80
75
70
65
60
50
40
35
Unwashed
Acetone washed
R33
Standpipe
Before bleaching
After

Surface composition, atom-%
ESCA – Electron Spectroscopy Chemical Analysis (XPS – X-ray --), max depth 100Å

Estimated surface coverage of extractives:

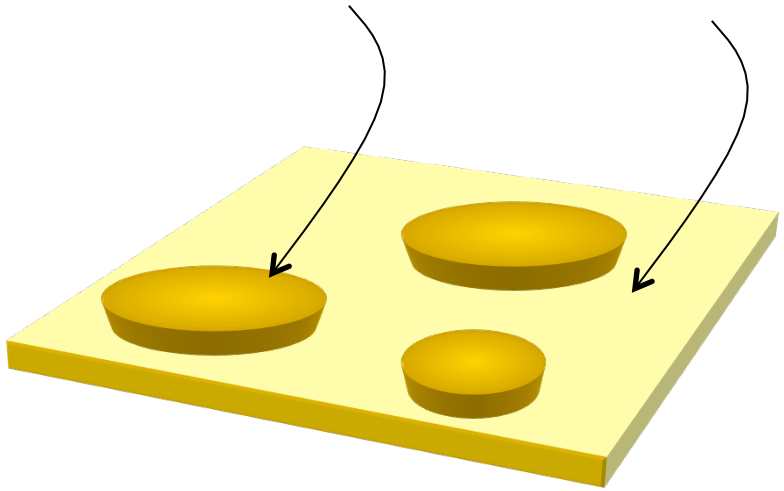
$$\left[\frac{O}{C}\right]_{Sample} = \phi\left[\frac{O}{C}\right]_{"Dirt"} + (1-\phi)\left[\frac{O}{C}\right]_{Extracted}$$

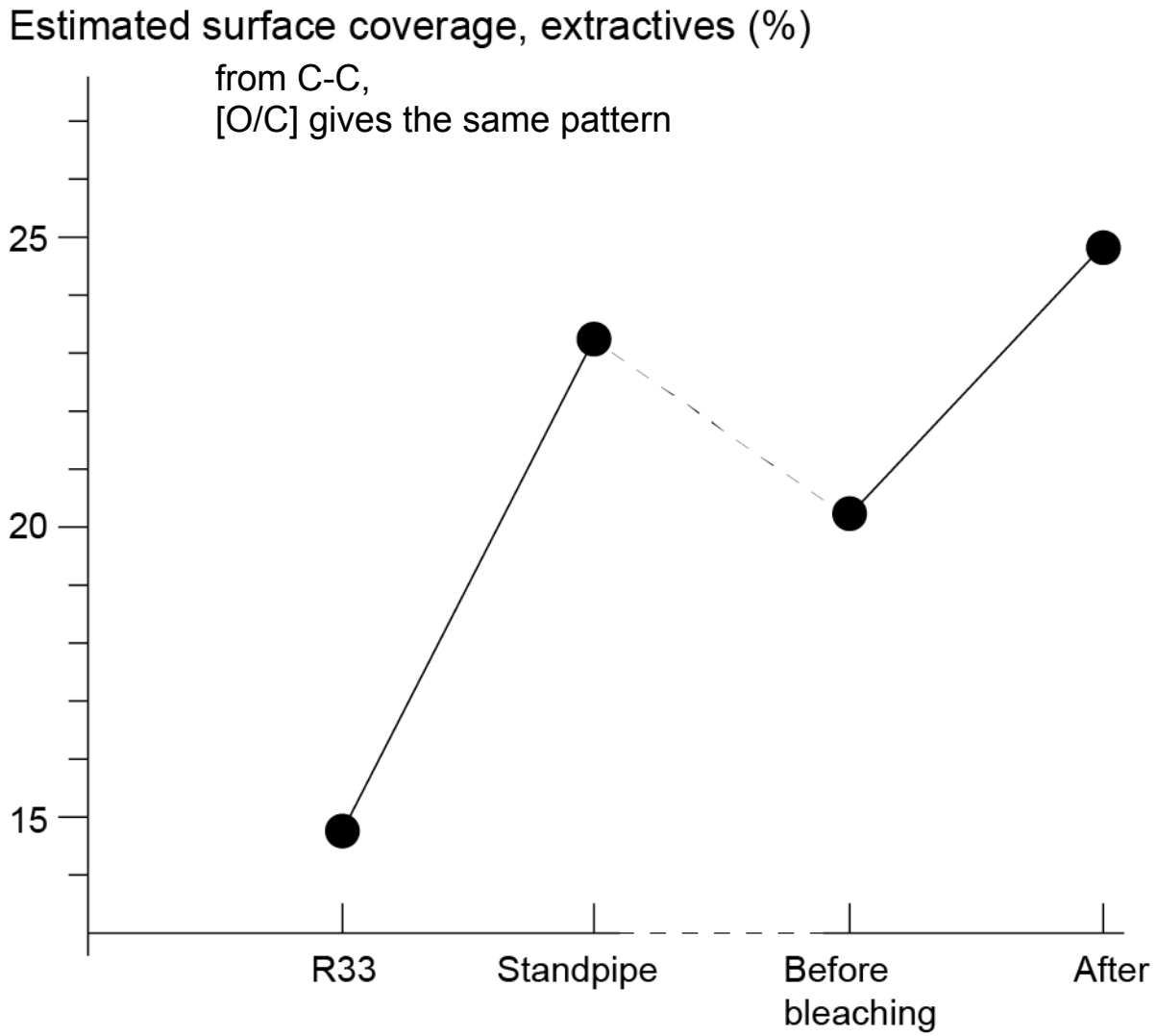


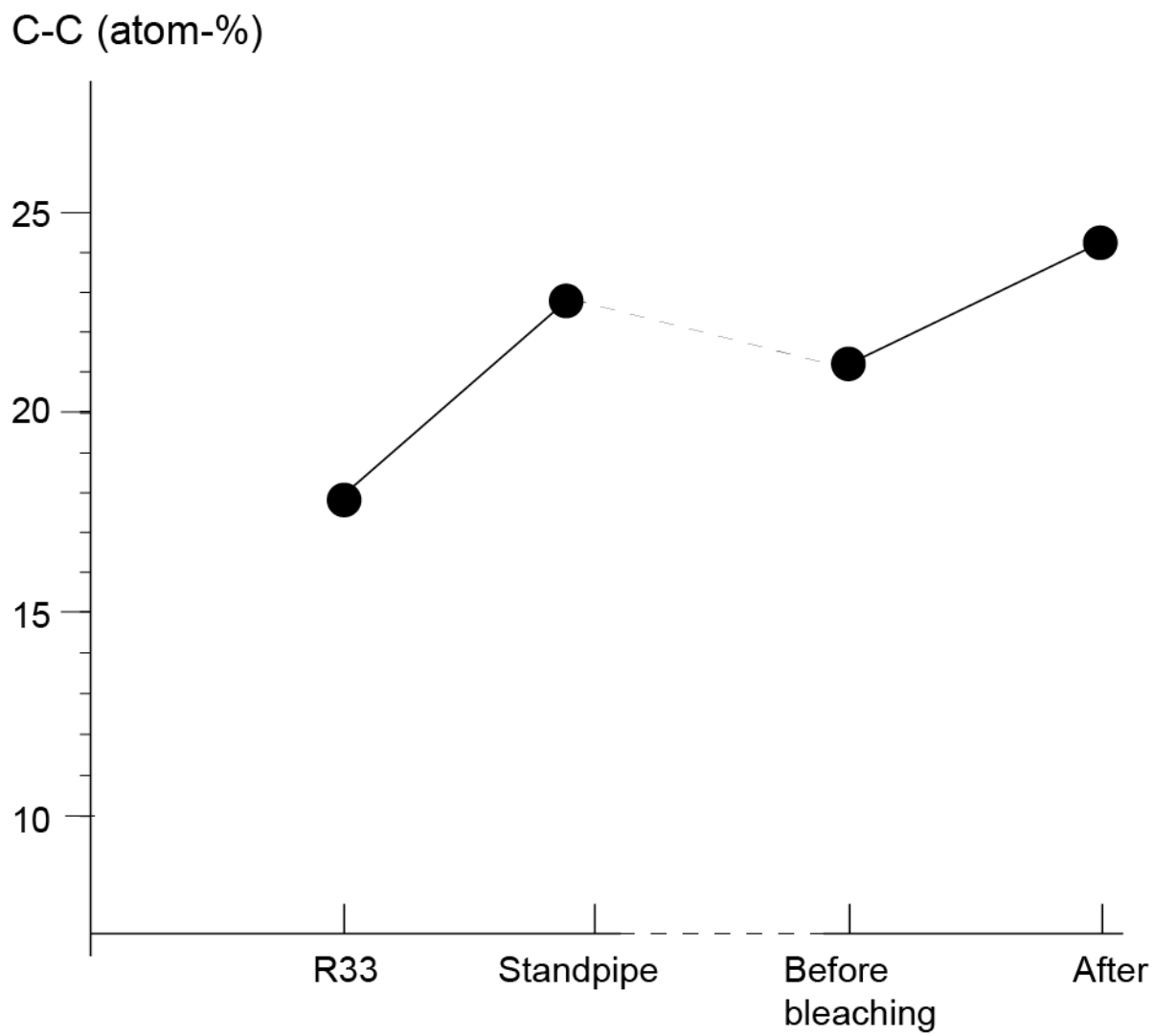
Surface composition, atom-%
ESCA (XPS), max depth 100Å

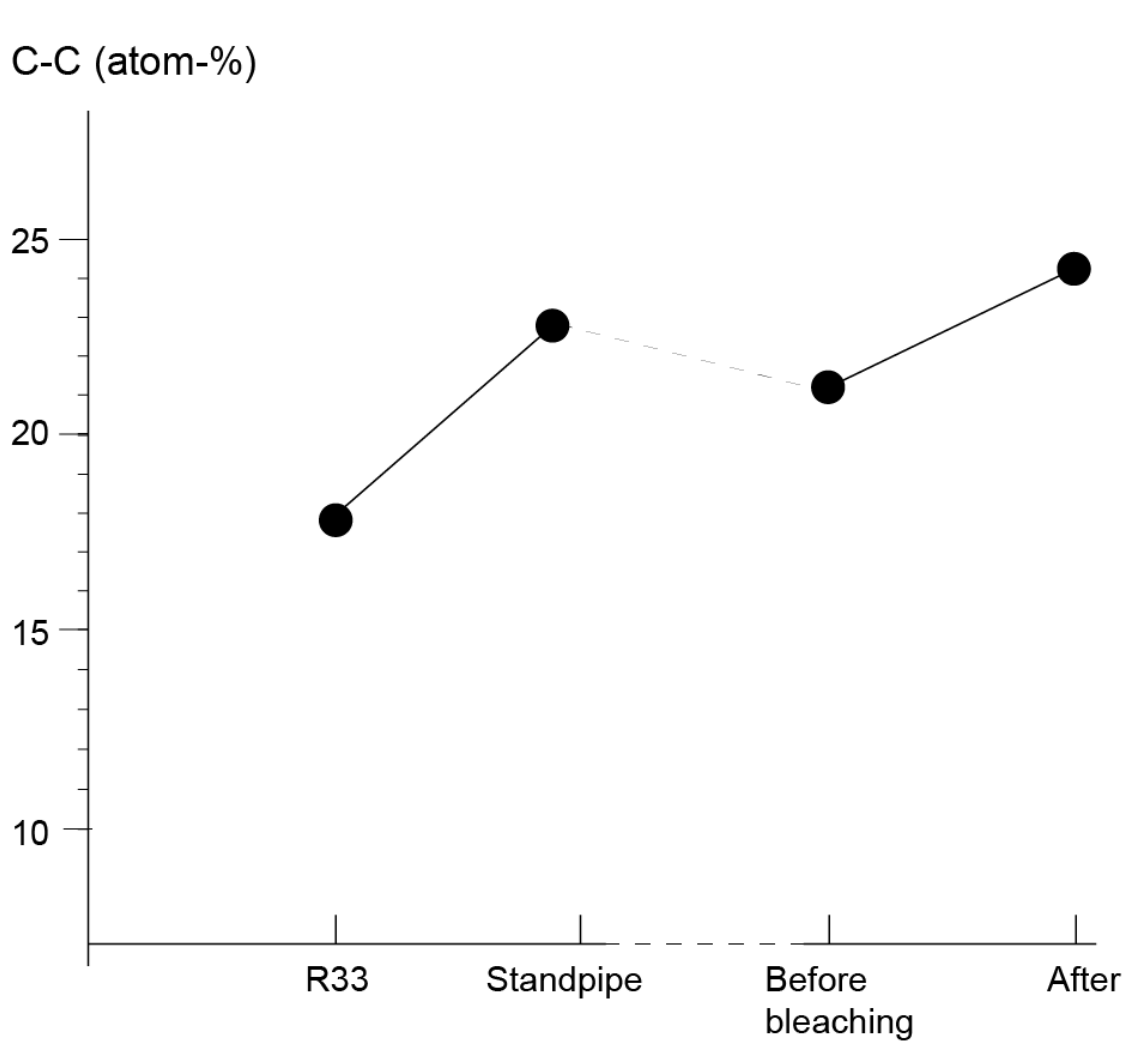
Estimated surface coverage of extractives:

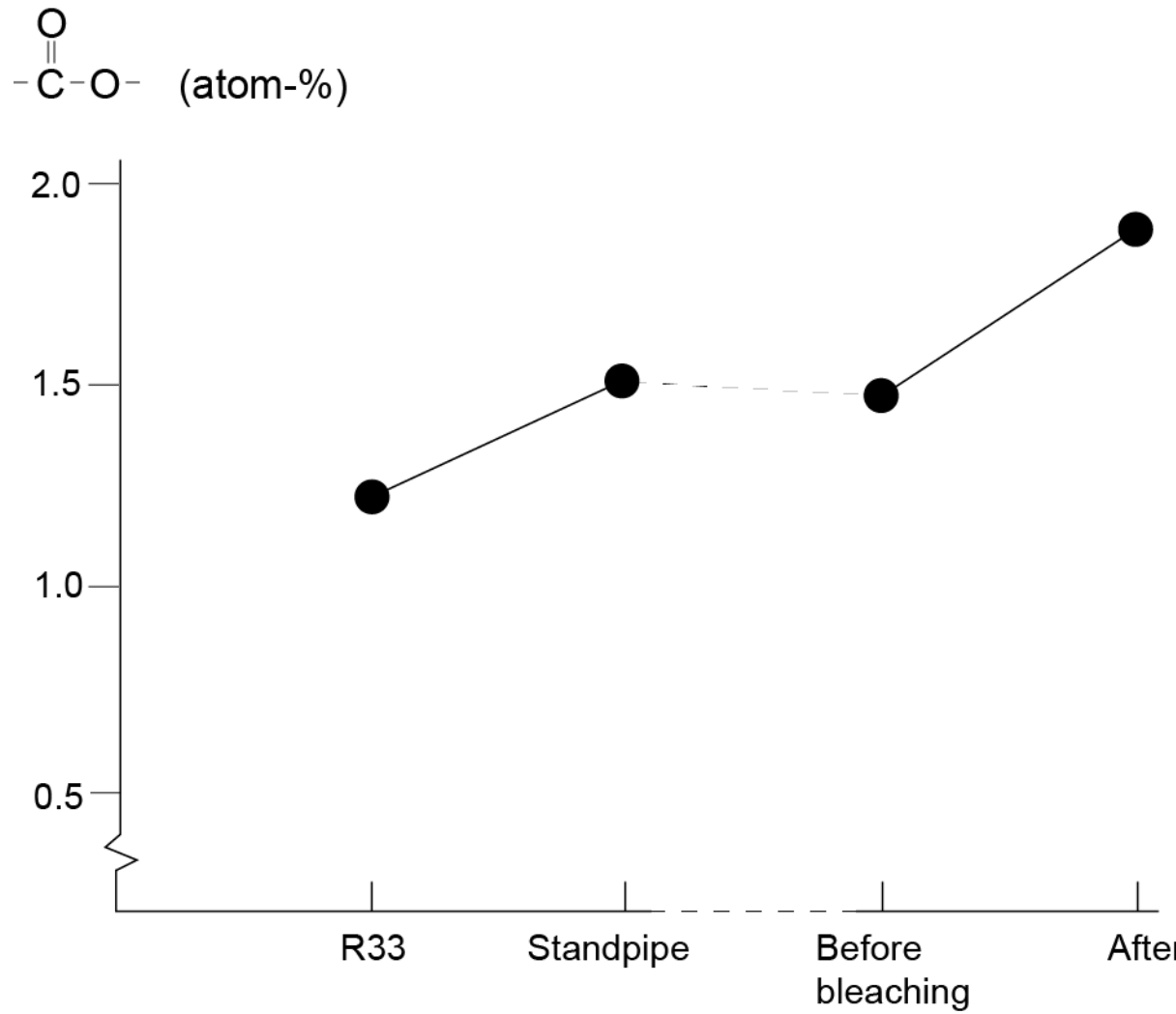
$$\left[\frac{O}{C}\right]_{Sample} = \phi\left[\frac{O}{C}\right]_{"Dirt"} + (1-\phi)\left[\frac{O}{C}\right]_{Extracted}$$

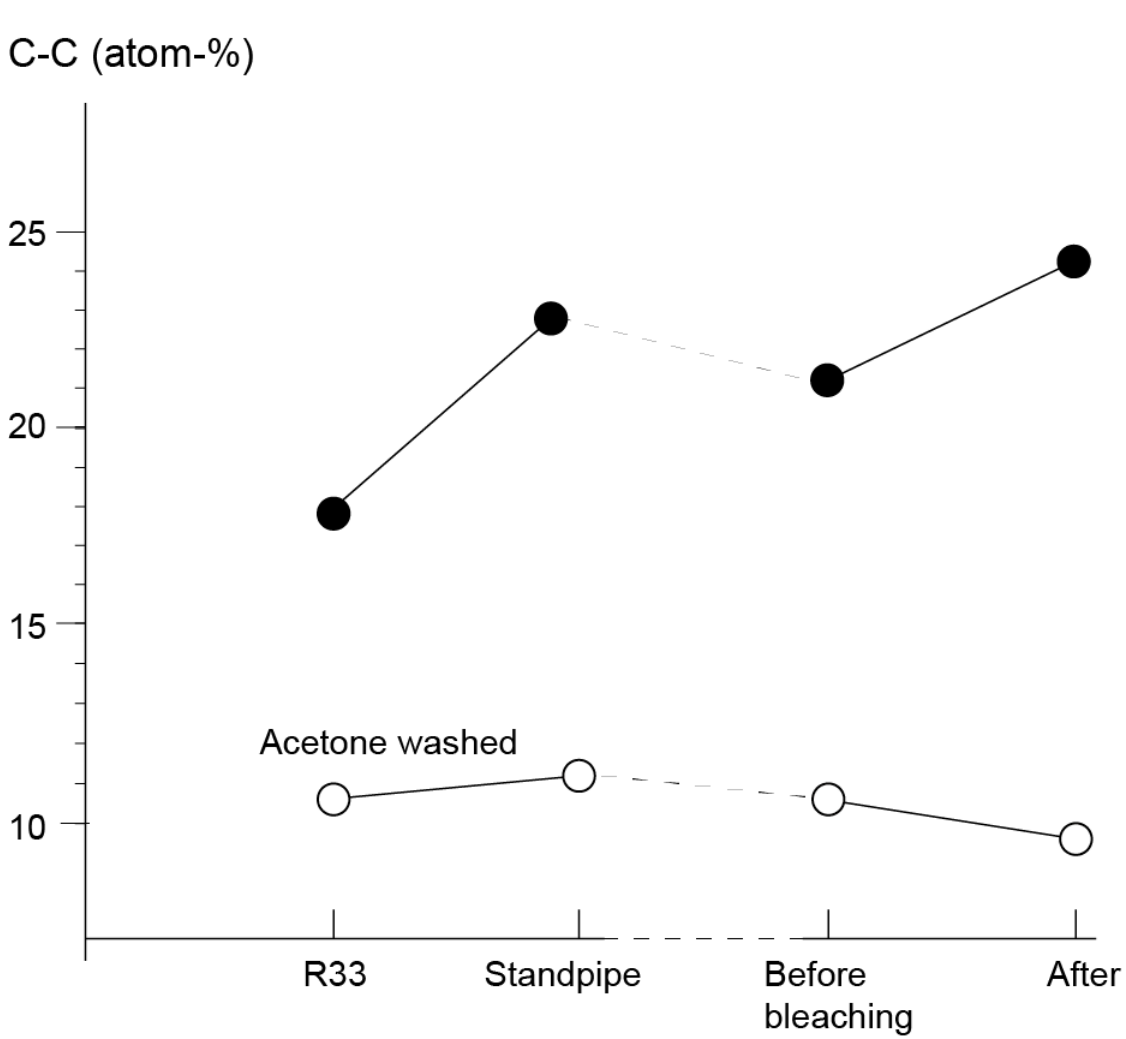


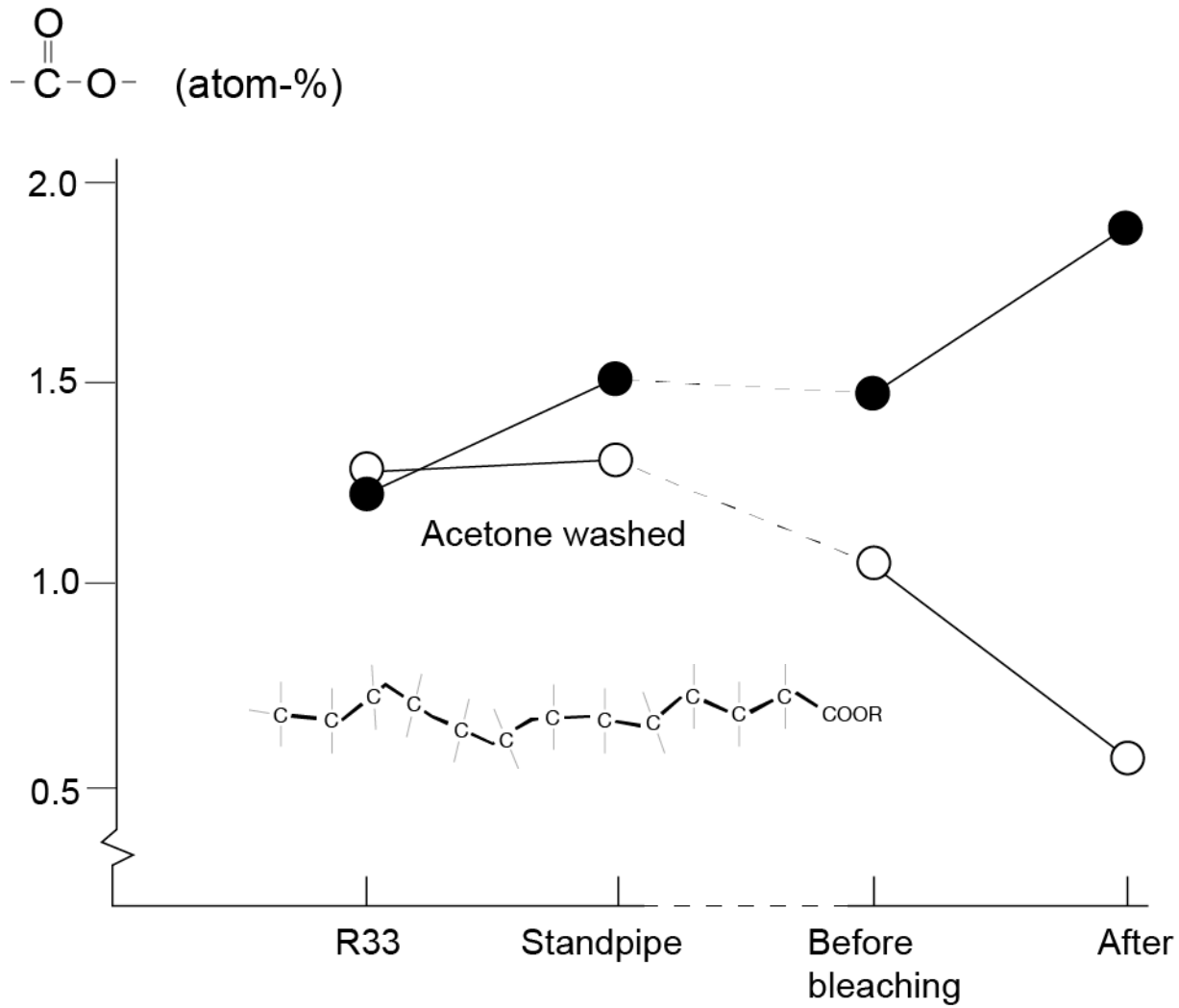



C-C (atom-%)
25
20
15
10
R33
Standpipe
Before bleaching
After


C-C (atom-%)
25
20
15
10
R33
Standpipe
Before bleaching
After


O
C O
(atom-%)
2.0
1.5
1.0
0.5
R33
Standpipe
Before bleaching
After


C-C (atom-%)
25
20
15
10
Acetone washed
R33
Standpipe
Before bleaching
After


O
C O
(atom-%)
2.0
1.5
1.0
0.5
Acetone washed
COOR
R33
Standpipe
Before bleaching
After

Conclusions

Tensile index decreases 1-4 units in the first dilution after refining and up to 7 units in bleaching

The fiber surfaces become more hydrophobic / contact angle increase

Bulk extractive content increase but no correlation to tensile index

Acetone washing can restore a big part of the tensile index

Surface composition (ESCA) => higher surface coverage of extractives; triglycerides, fatty and resin acids.

Some decrease remains to be investigated