On the methods for assessing and the causes of brightness reversion

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Objective

Establishing proper conditions to evaluate brightness reversion of Eucalyptus pulps and determine their relevance to the reversion problem in the industry

Understanding how different pulps and their chemical composition influence the brightness reversion

Brightness reversion

Brightness stability - a prioritized area especially for bleached eucalyptus pulps

External factors of importance:

- light
- heat
- moisture
- chemicals
- air pollution
- exposure time
- pH

Internal factors of importance:

- lignin residuals
- HexA residuals
- carbonyl groups
- carboxyl groups
- metals
- extractives
- other wood components

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Bleached pulp characteristics

No.	Bleaching sequence[1]	Bright. % ISO	HexA mmol/kg	Visc. dm^3/kg	OX $mgCl^-/kg$
1	ECF *D*	90.8	6.2	866	103
2	ECF *P*	92.2	1.8	876	87
3	ECF *P*	89.6	4.1	842	74
4	ECF *P*	90.6	25.8	674	80
5	ECF *P*	89.6	29.9	734	103
6	ECF light *P*	90.9	10.7	829	28
7	TCF	89.0	47.7	813	7
8	ECF *D*	89.6	2.1	1150	171
9	TCF	90.2	37.1	811	6
10	ECF *D*	90.9	1.2	487	119

Eucalyptus Birch Acacia

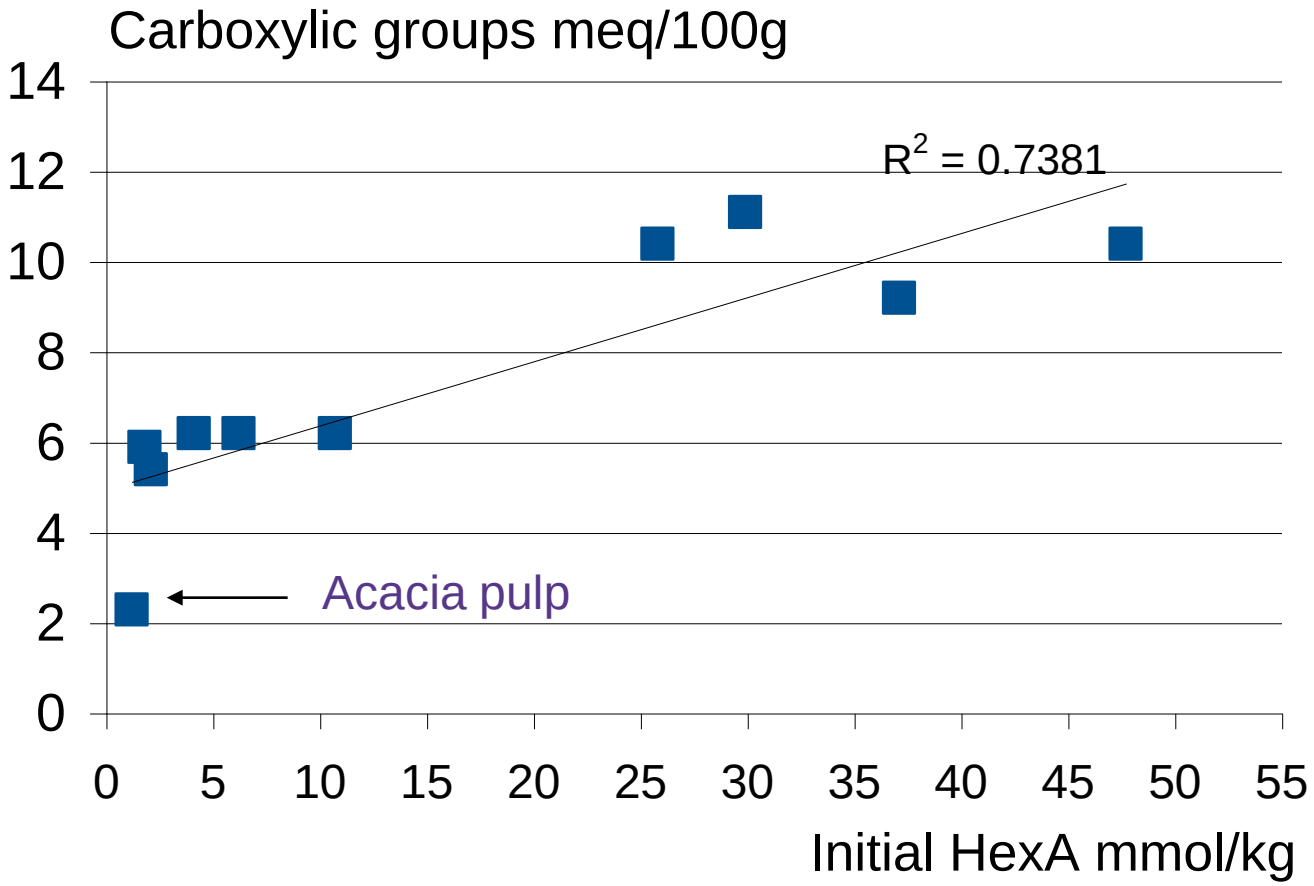
Bleached pulp characteristics

No.	Bleaching sequence[1]	Glucose %	Xylose %	Extractives (DCM) %	Carboxyls meq/100g
1	ECF *D*	83.4	15.7	0.08	6.2
2	ECF *P*	83.3	16.0	0.10	5.9
3	ECF *P*	84.6	14.7	0.10	6.2
4	ECF *P*	83.6	15.8	0.10	10.4
5	ECF *P*	83.2	16.4	0.10	11.1
6	ECF light *P*	83.2	16.0	0.11	6.2
7	TCF	81.8	15.5	0.06	10.4
8	ECF *D*	72.7	24.7	0.10	5.4
9	TCF	74.5	23.2	0.08	9.2
10	ECF *D*	83.8	13.7	0.10	2.3

Eucalyptus Birch Acacia

Carboxylic groups vs HexA

Before aging



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Aging methods

(I) 105°C for 4 h and ~0% relative humidity (RH),
(II) 70°C for 64 h and 10% pulp moisture content,
(III) 45°C for 720, 1080, 1440h and 50% RH,
(IV) 30°C for 720, 1080, 1440 h and 50% RH,
(V) 45°C for 720, 1080, 1440 h and 90% RH,
(VI) 30°C for 720, 1080, 1440 h and 90% RH.

TAPPI handsheets at pH 4.5 and 8

Results

(I) 105°C for 4 h and ~0% relative humidity (RH),

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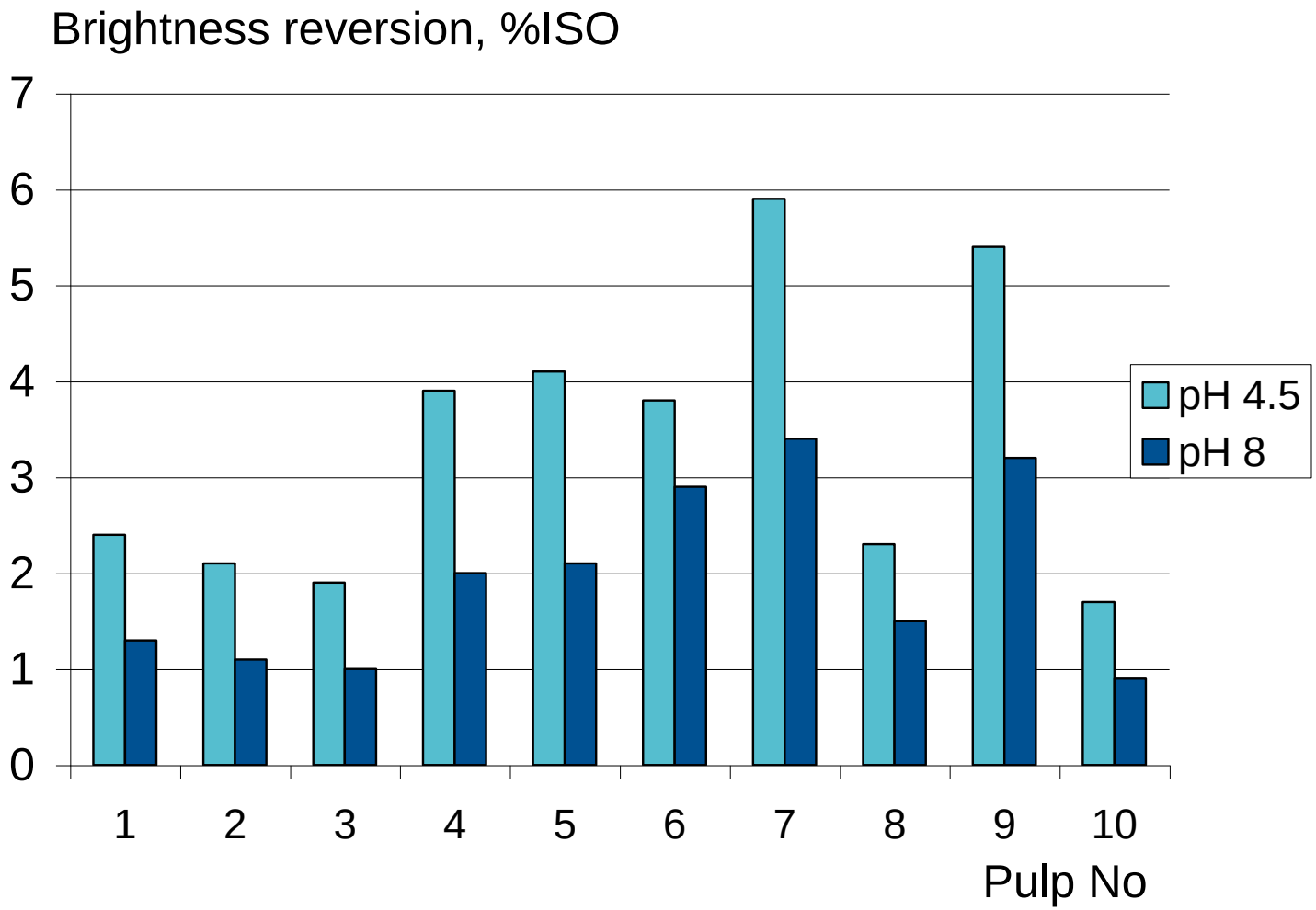
Brightness reversion at condition I

105°C 4h 0% RH



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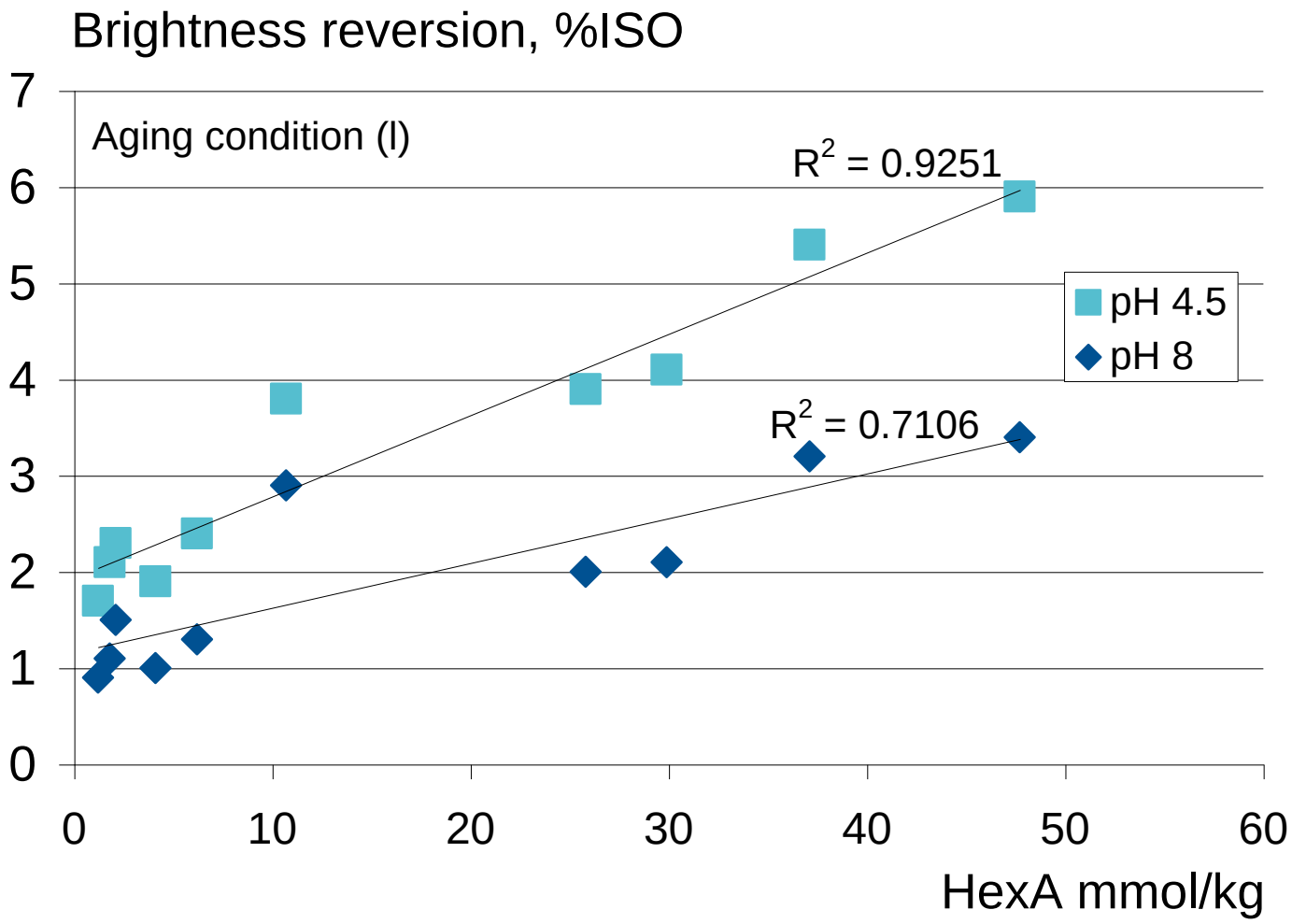
Brightness reversion vs HexA

105°C 4h 0% RH



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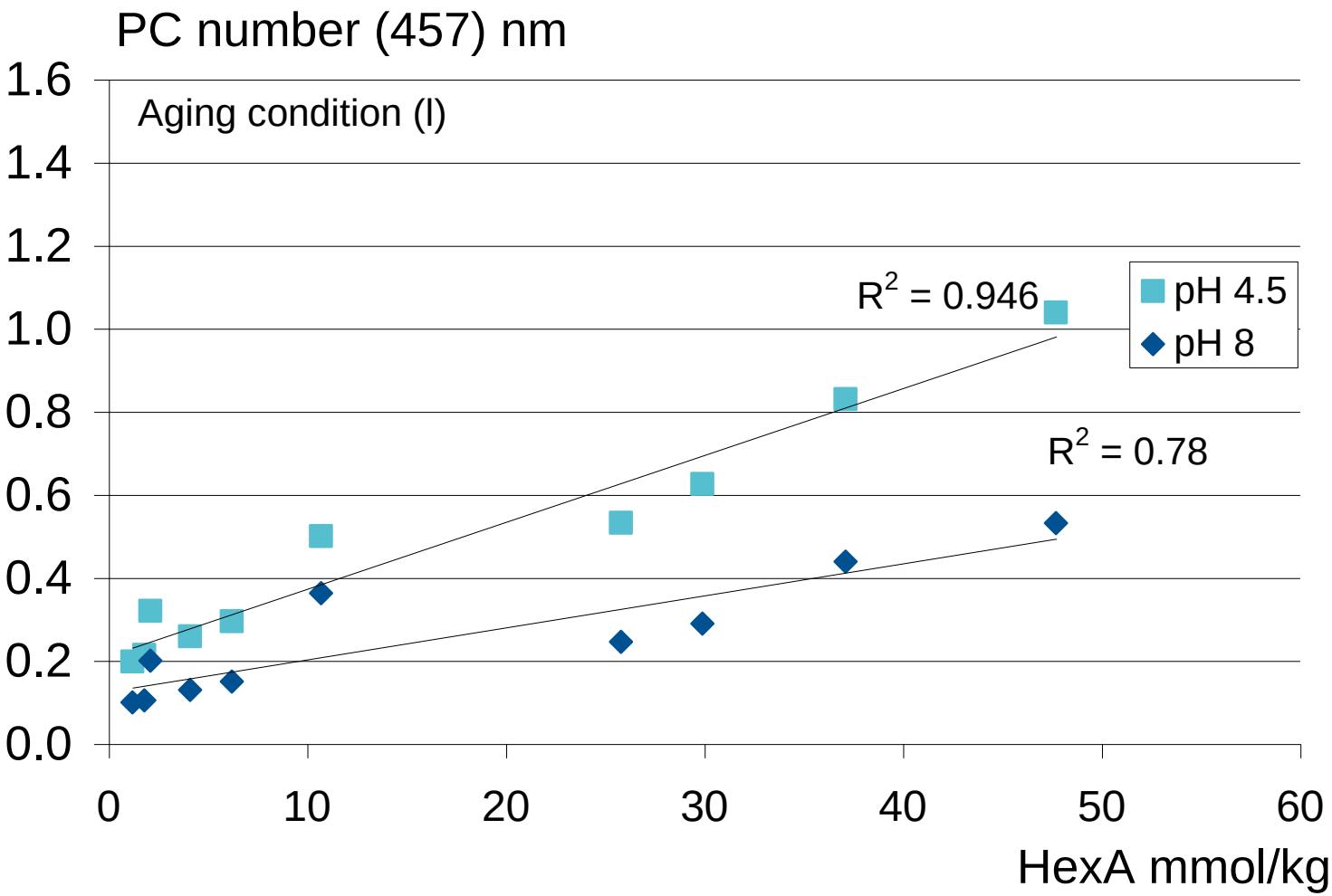
Brightness reversion vs HexA

105°C 4h 0% RH



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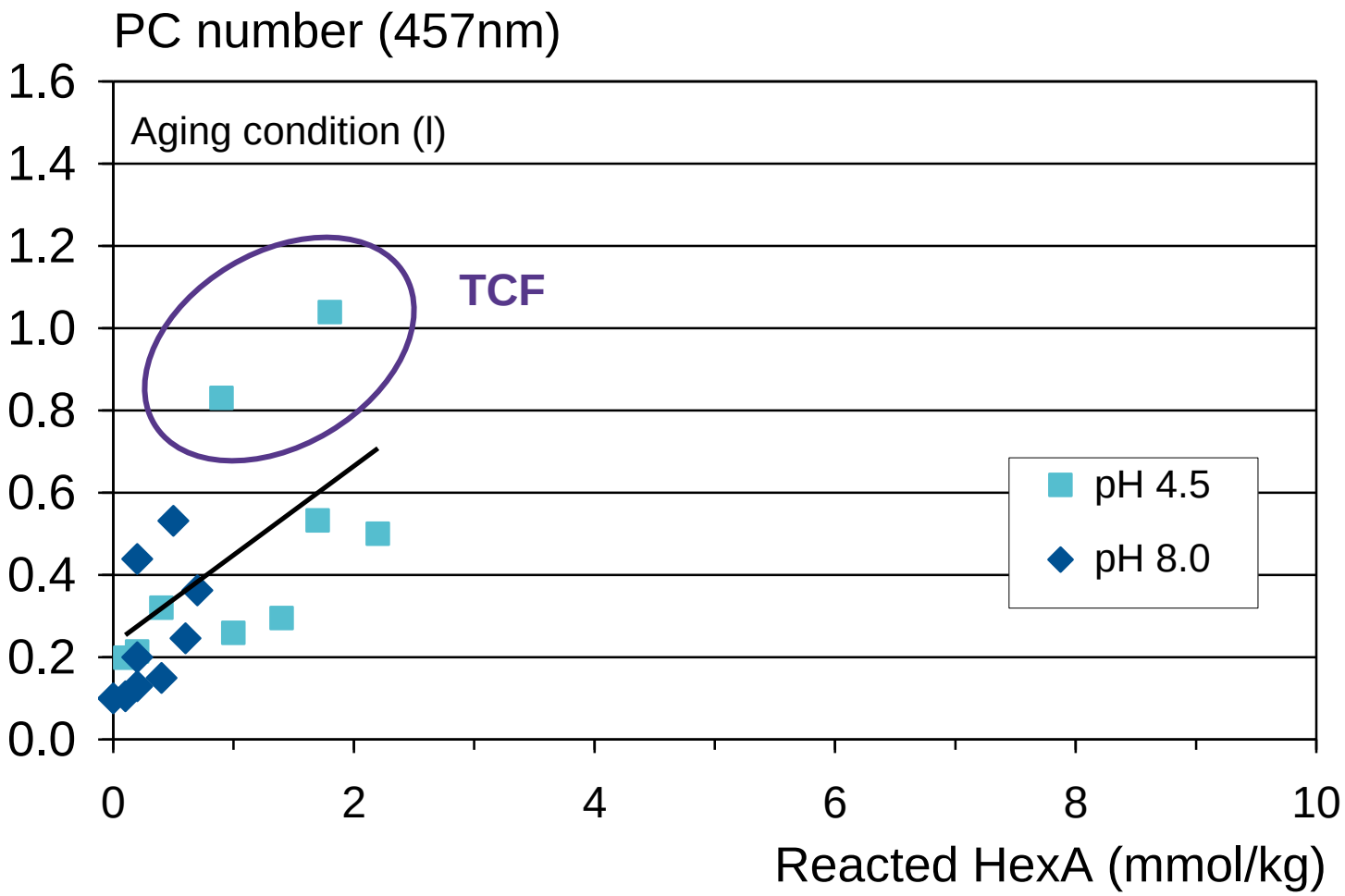
Brightness reversion vs HexA

105°C 4h 0% RH



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Results

(II) 70°C for 64 h and 10% pulp moisture content,

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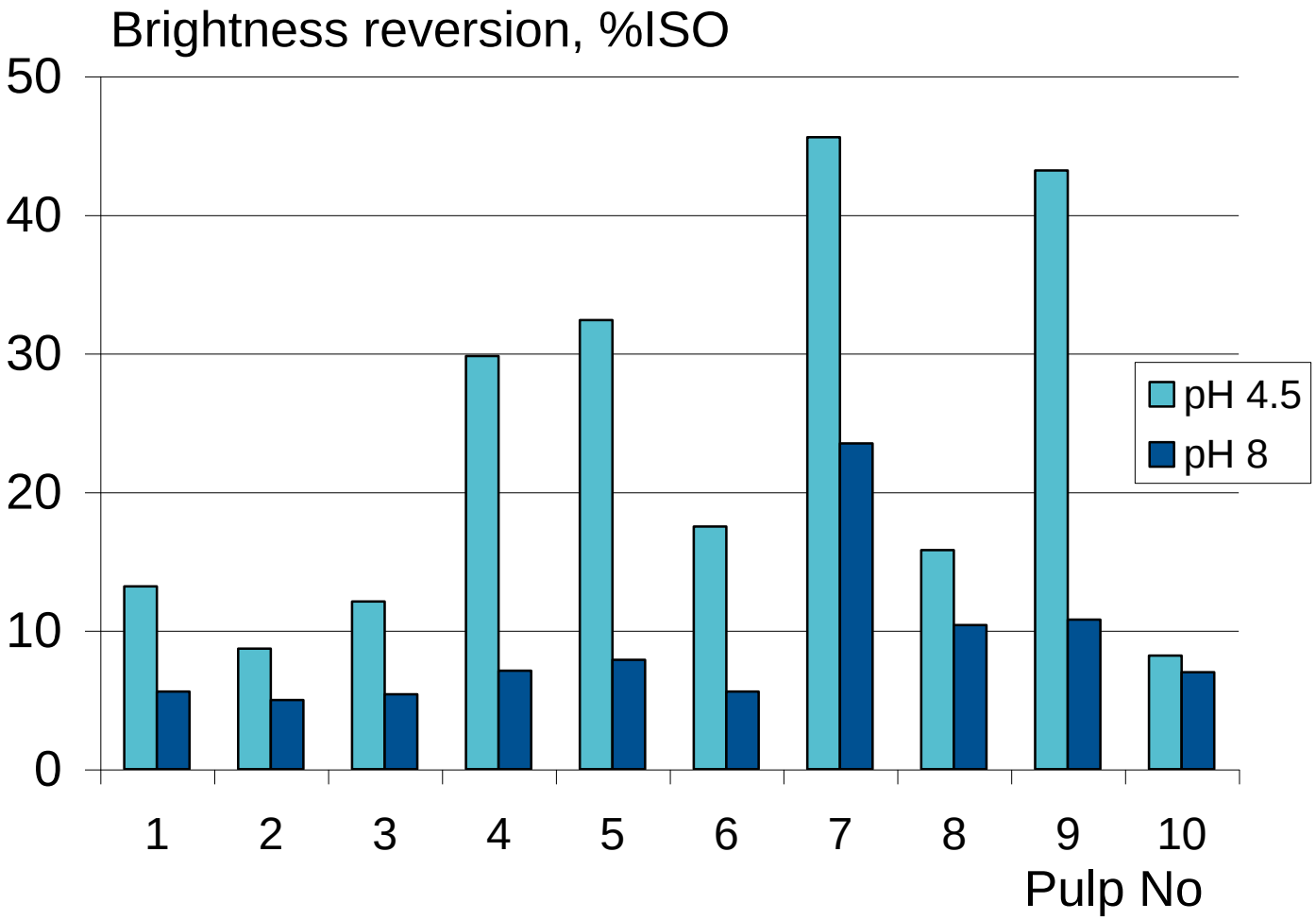
Brightness reversion

70°C 64h



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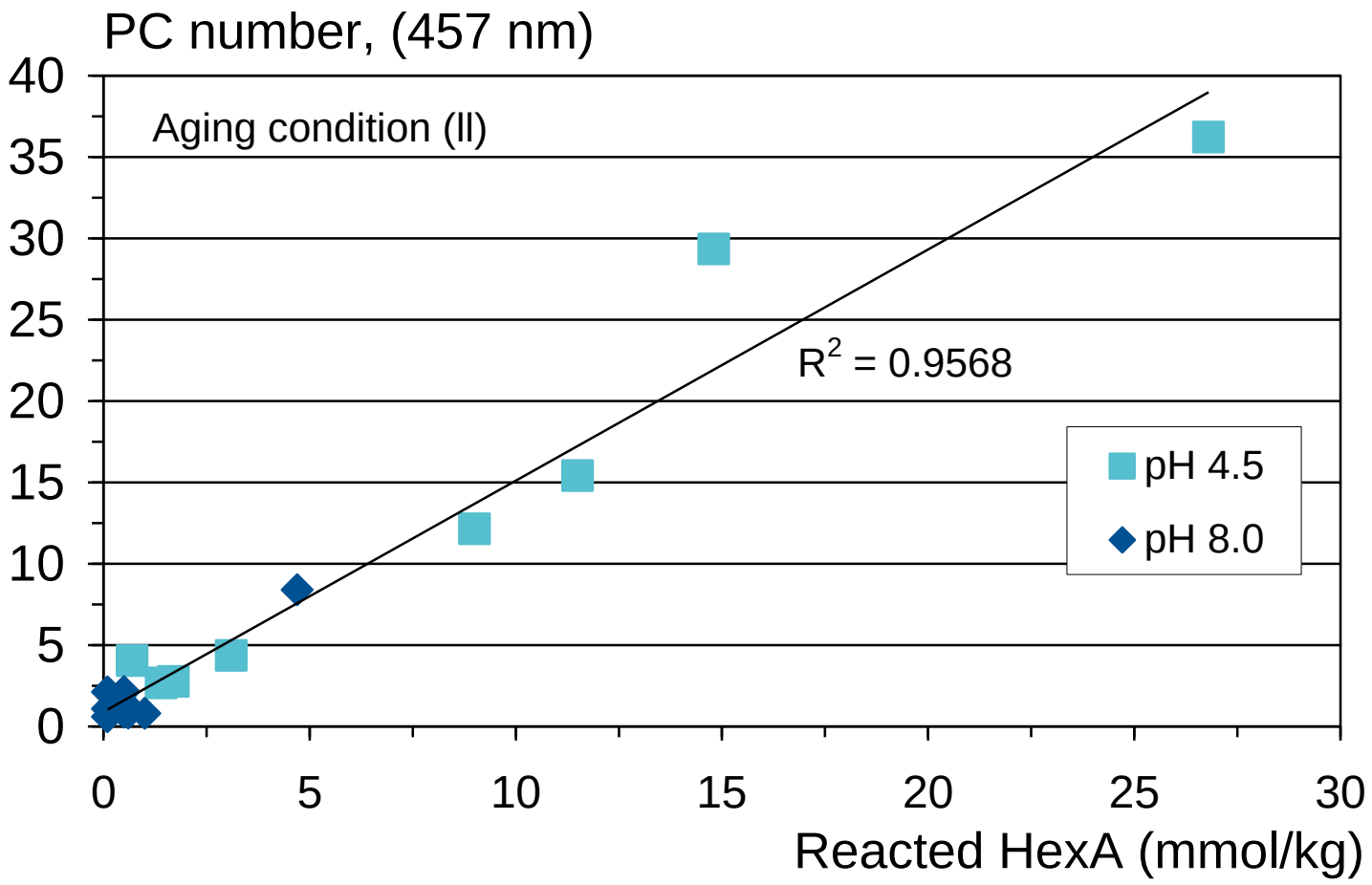
PC number vs reacted HexA

70°C 64h



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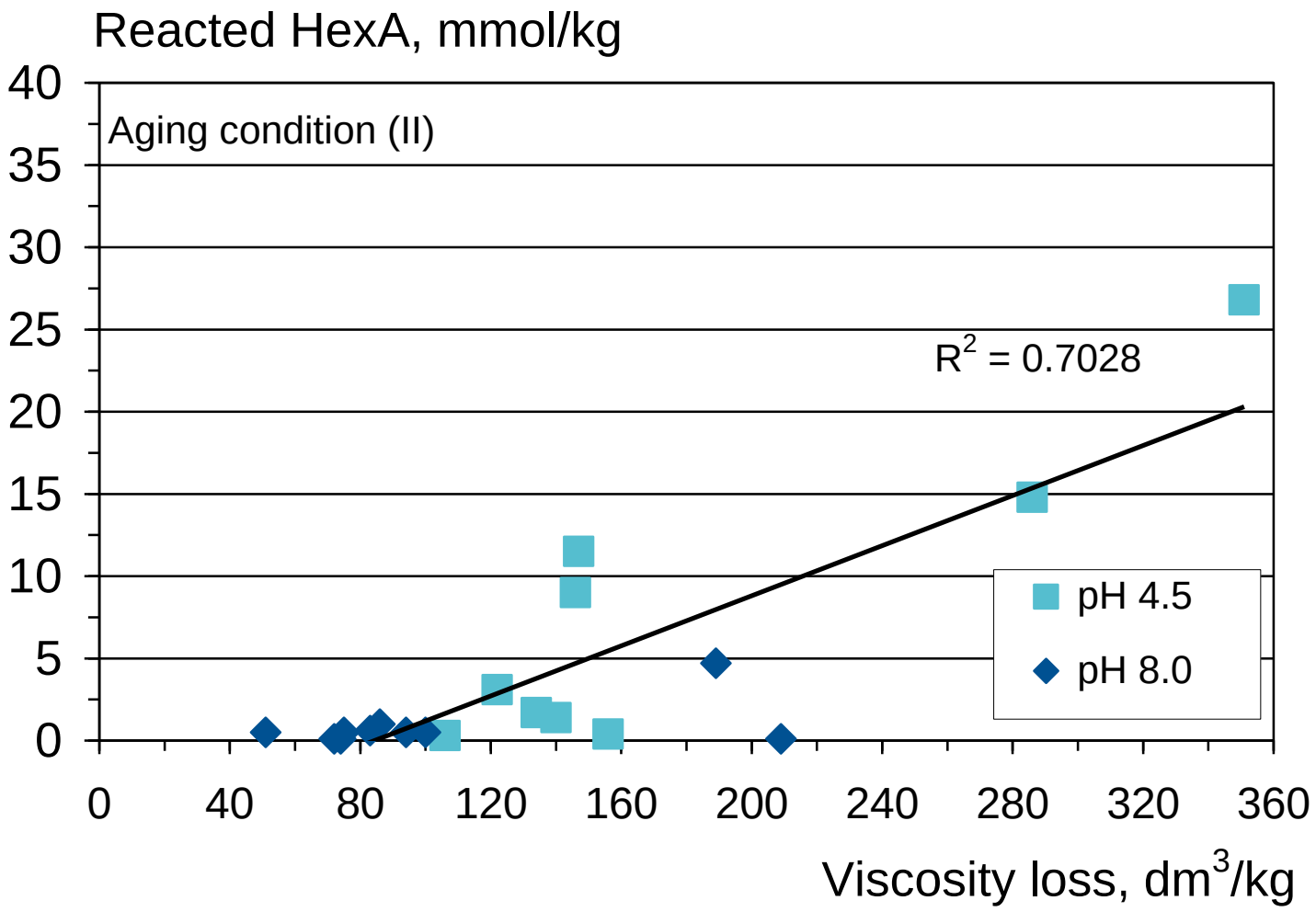
Reacted HexA vs viscosity loss

70°C 64h



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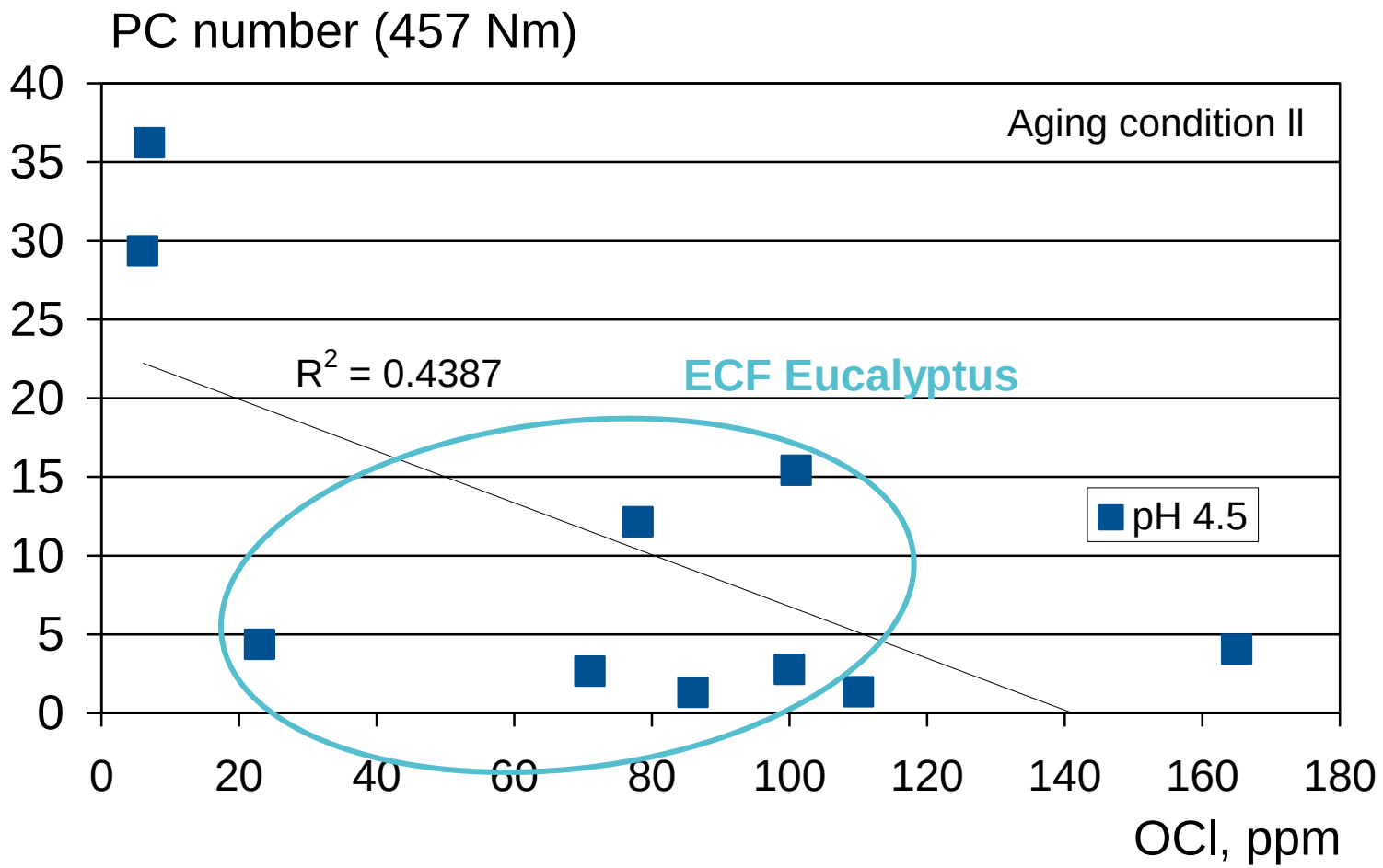
PC number vs OCl in pulp

70°C 64h



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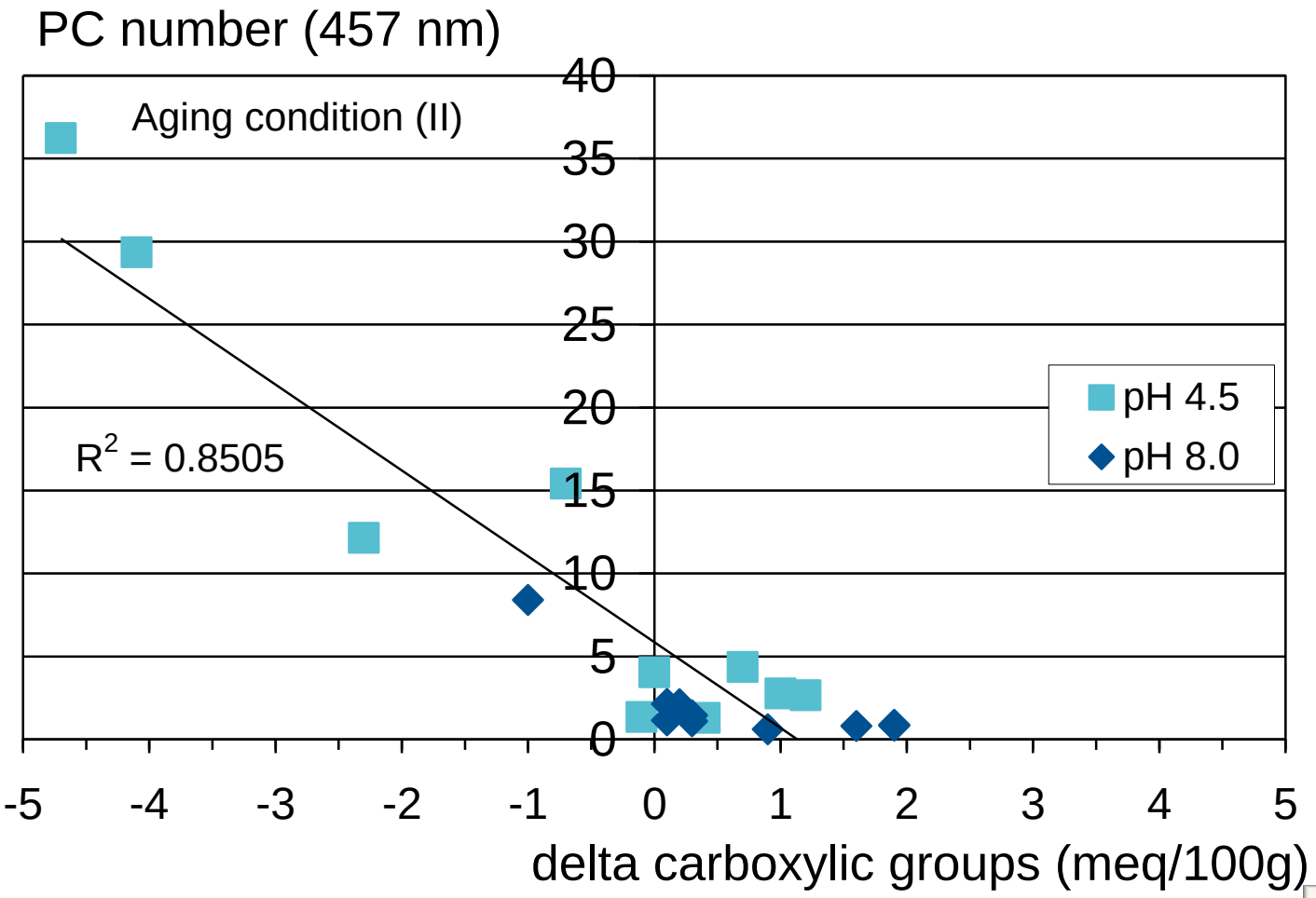
PC number vs delta carboxylic groups

70°C 64h



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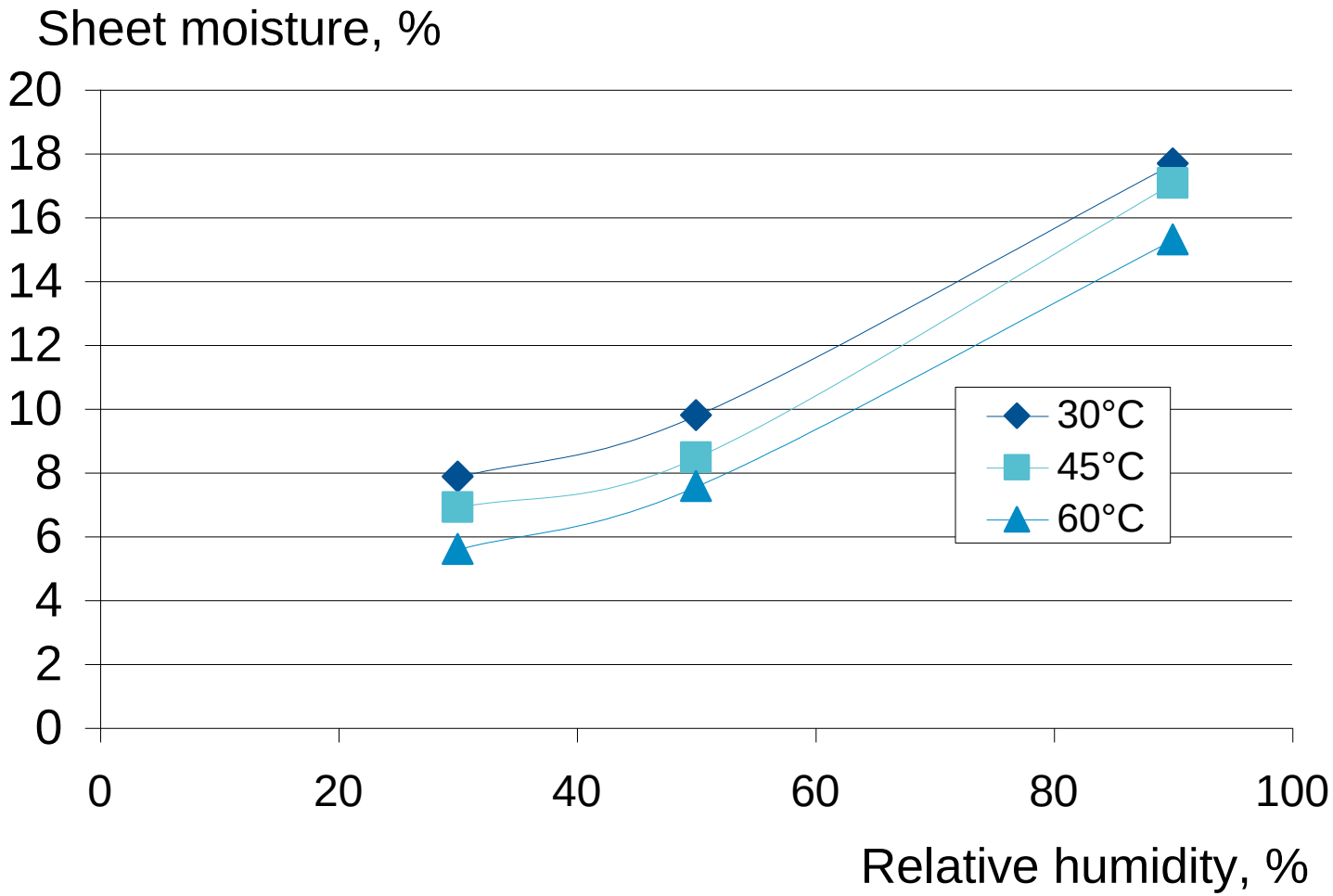
Ageing methods

(III) 45°C for 720, 1080, 1440h and 50% RH,
(IV) 30°C for 720, 1080, 1440 h and 50% RH,
(V) 45°C for 720, 1080, 1440 h and 90% RH,
(VI) 30°C for 720, 1080, 1440 h and 90% RH.

TAPPI handsheets at pH 4.5 and 8

Sheet moisture

at different relative humidity and temperature



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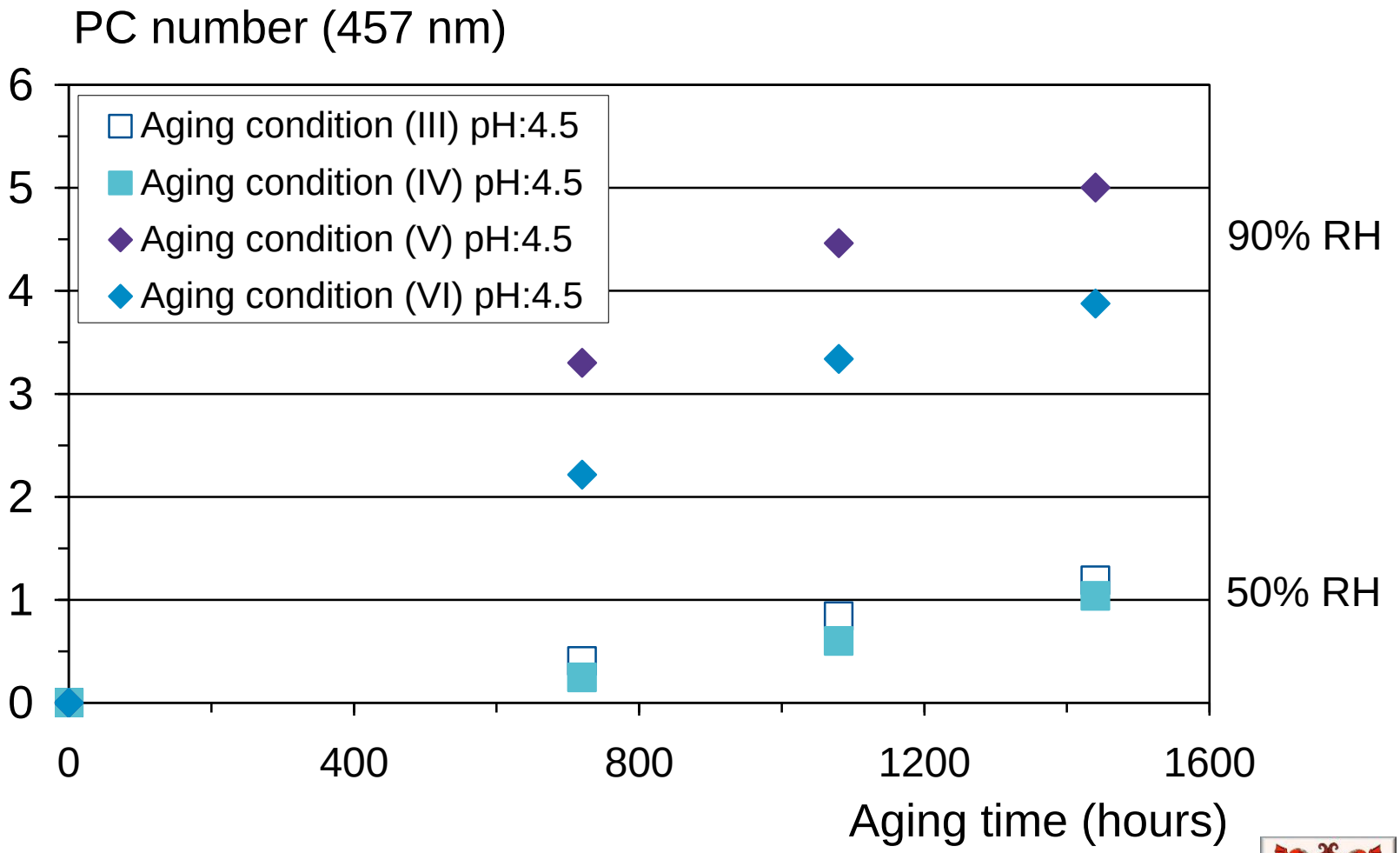
PC number vs aging time

Pulp No 4



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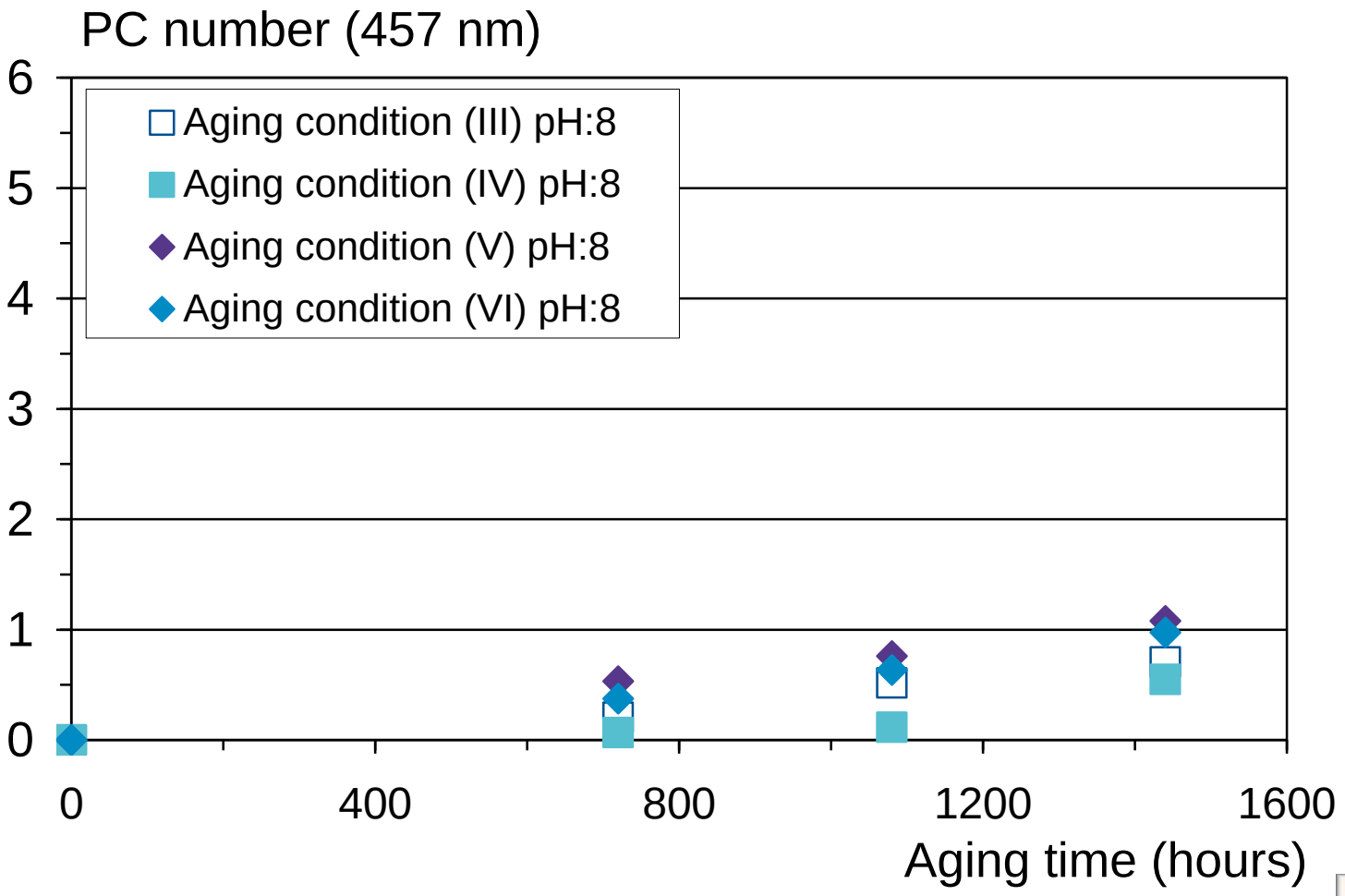
PC number vs aging time

Pulp No 4



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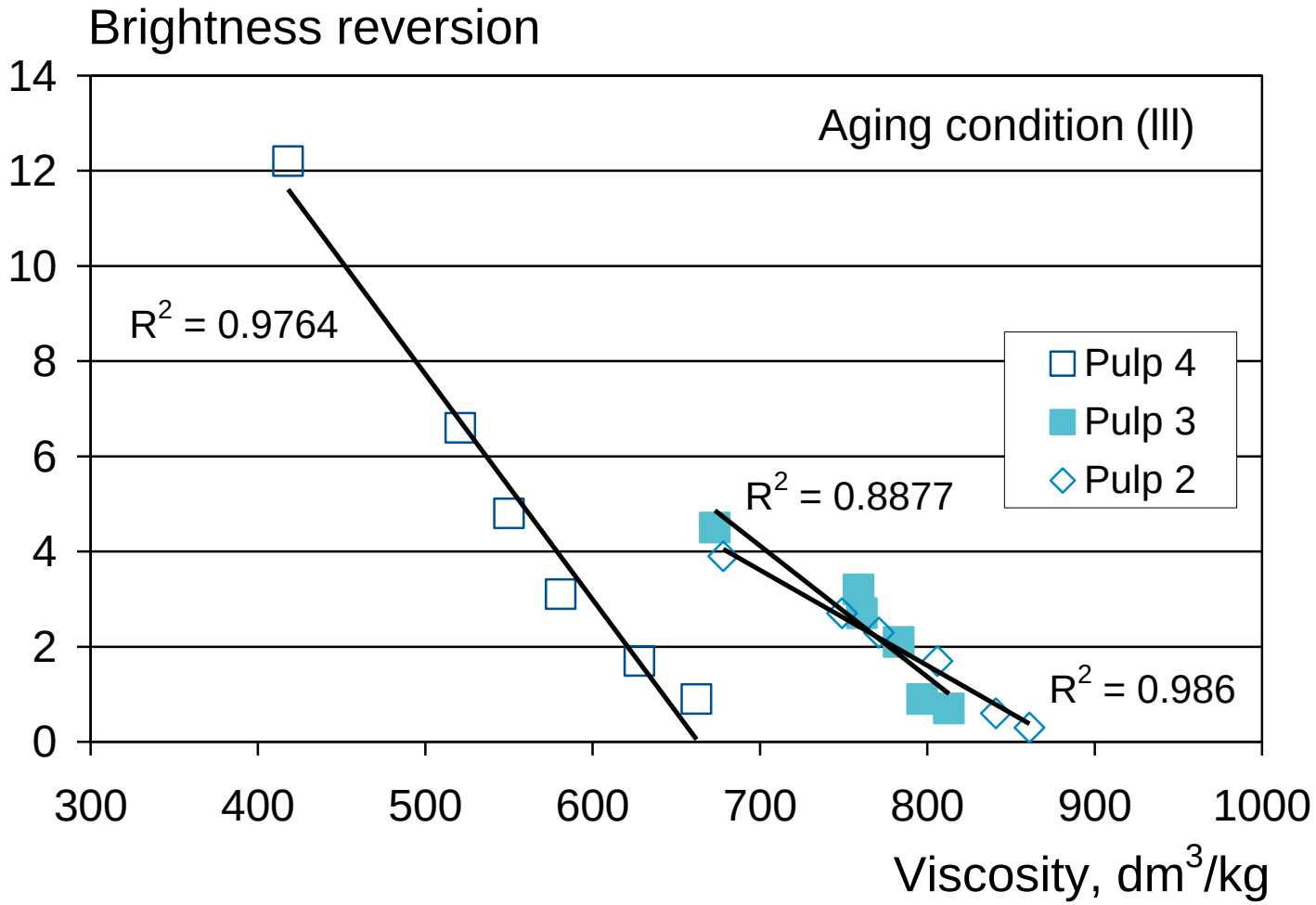
Brightness reversion vs viscosity

30°C 50% RH, pH 4.5



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Comparison and ranking between different methods

ECF *P* Eucalyptus pulps pH 4.5

Method	(I)	(II)	(III)	(IV)	(V)	(VI)
Pulp No (PC number)	4 (0.5)	4 (12.1)	4 (1.19)	4 (1.01)	4 (5.00)	4 (3.88)
Pulp No (PC number)	3 (0.3)	3 (2.7)	3 (0.73)	3 (0.46)	3 (1.21)	3 (1.05)
Pulp No (PC number)	2 (0.2)	2 (1.3)	2 (0.29)	2 (0.28)	2 (0.45)	2 (0.34)

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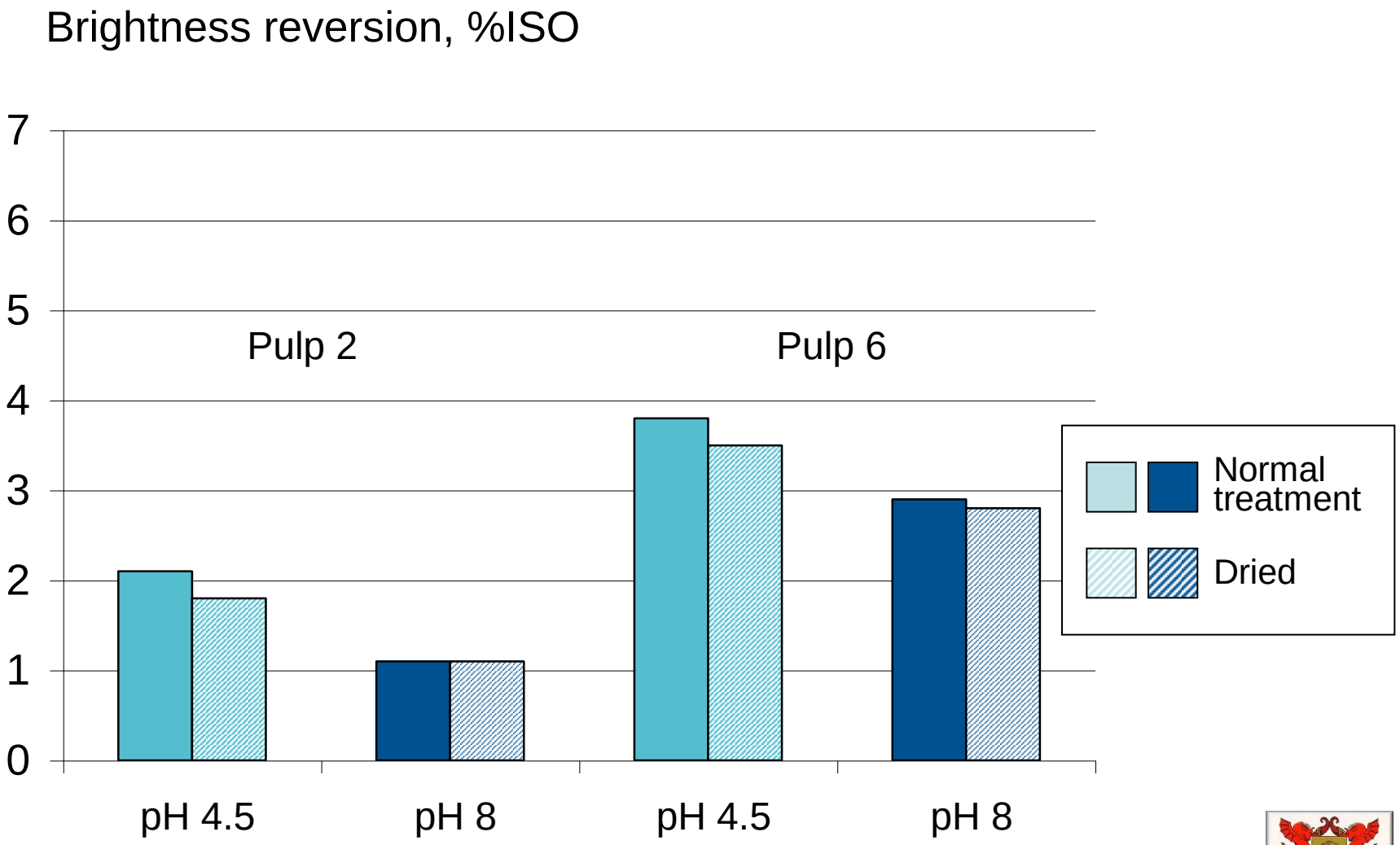
Brightness reversion at condition (I)

Different pre-treatment of the handsheets



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Conclusions

- The method (dry, wet, high/low RH, high/low temperature, short/long time) has in most cases no effect on overall brightness reversion trends but significantly influences the absolute reversion values.
- Dry and wet heat-induced brightness reversion correlates positively and significantly with pulp hexenuronic acid content.
- Pulps produced by TCF and ECF bleaching sequences with low charge of chlorine dioxide are more prone to reversion than regular ECF pulps.

Conclusions

- Brightness reversion causes a decrease in pulp kappa number, HexA and viscosity values, especially for aging at pH 4.5.
- Pulp carboxyl group content decreases during humid aging at high brightness reversion.
- Pulp brightness stability is substantially improved by raising pulp slurry pH from 4.5 to 8.0.
- Pulp organically bound chlorine content has no significant effect on the extent of reversion.

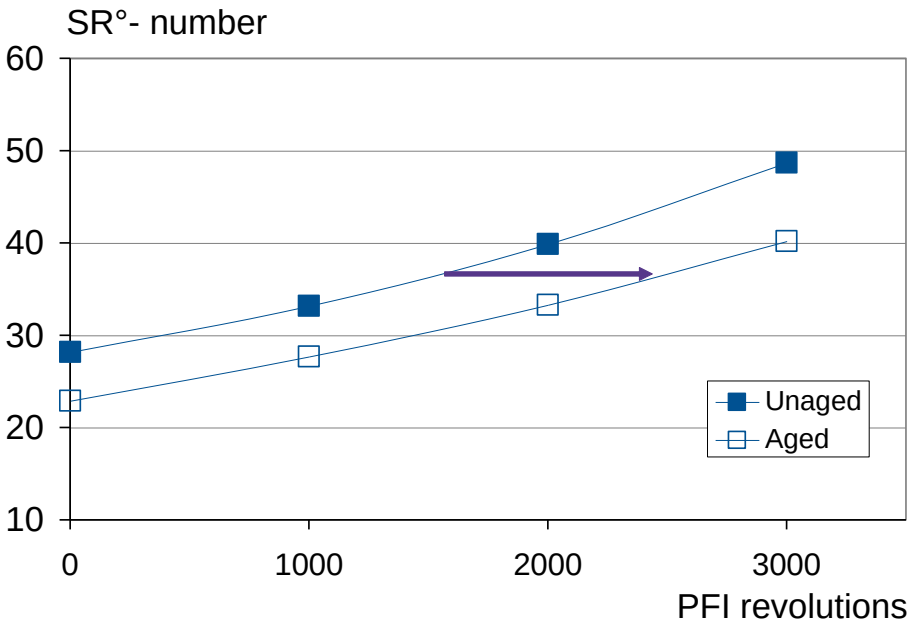
Conclusions

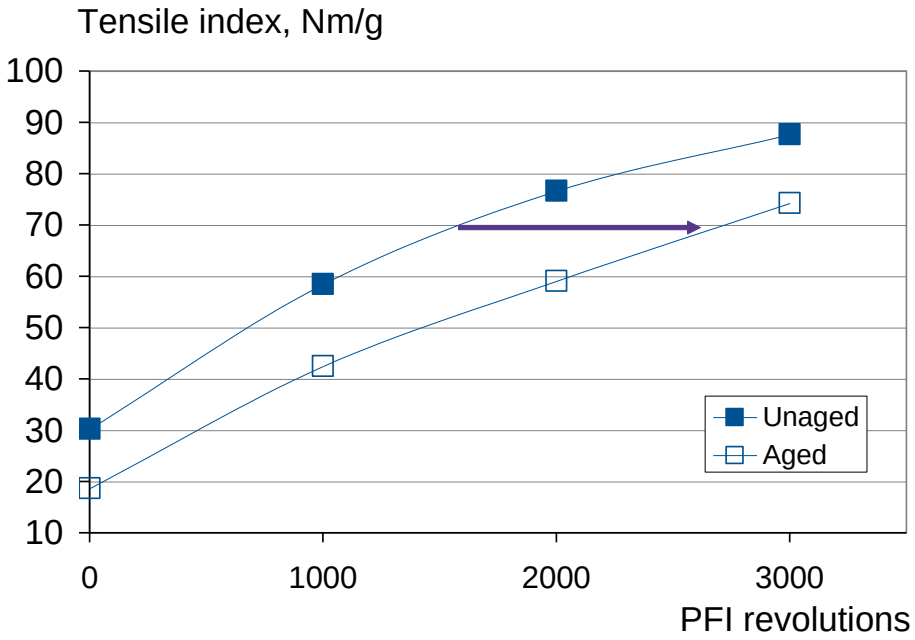
- Relative humidity in the range of 50-90% influence reversion much more strongly than temperature in the interval 30-45°C.
- Hand sheet moisture content decreases from 9.9 to 8.5% by raising surrounding temperature from 30 to 45°C at 50% RH, and increases from 9.9% to 17.8% by increasing RH from 50 to 90% at 30°C.

Beatability

- Aging of pulp decreases the carboxylic group content at pH 4.5 at sheetforming
- High content of carboxylic groups (and HexA) increase the beatability of bleached pulps
- The PFI revolutions needed to reach the same ˚SR and tensile index, consequently increase

Beatability





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