Study on the hydrogen peroxide in paper fibre bleaching: model construction and verification

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Problem Statement

- Paper for recycling is composed of different fibres[1] with dissimilar reactivity to the bleaching.
- Wood pulped fibre types: chemical (pulped using chemicals), mechanical (pulped using rotating discs at high T/P) or semi-mechanical (combination of chemical and mechanical pulping).
- Target: evaluate the prediction of ISO Brightness after bleaching by hydrogen peroxide of cellulose fibre mixtures.

Methodology of bleaching by H_2O_2

- Part 1, **Screening:** virgin fibres of Kraft (unbleached chemical pulp), TMP (thermo-mechanical pulp), CTMP (chemo-thermo mechanical pulp) and Bleached (bleached chemical pulp). 50 % H_2O_2 on dry mass of fibres. Variables: number of additions -reaction time;
- Part 2, **Model bleaching:** best bleaching sequence (part 1) on 30 model samples with known virgin fibre composition.
- Part 3, **Real-life sample bleaching**: industrial samples with known composition were bleached using same "best" bleaching sequence.

Part 1, Screening

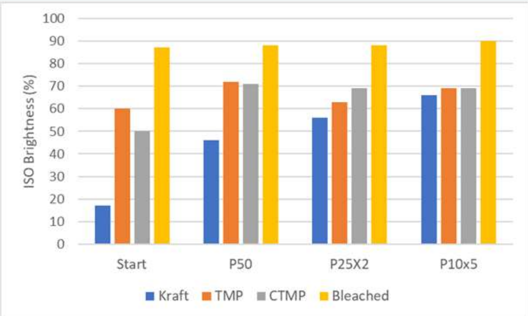

Figure 1: ISO Brightness before and after bleaching sequences of virgin fibres; P50: H_2O_2 addition, 50% w/w oven dried fibres (odf), P25x2: H_2O_2 addition 25% w/w odf for two times, P10x5: H_2O_2 addition, 10% w/w odf for five times

The best compromise is the P10x5 sequence. The major improvement is observed on the Kraft fibres.

Part 2, Model bleaching

Multivariate linear regression ($Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4$) for P10x5 sequence.
The independent variables were ratios of the virgin fibres and brightness as dependent variable.

Table 1: Multivariate linear regressions

Step	R square	Intercept	Kraft (X_1)	TMP (X_2)	CTMP (X_3)	Bleached (X_4)
Start	0,932	74,051	-0,602	-0,156	-0,247	0,000
P10(1)	0,943	80,376	-0,581	-0,130	-0,166	0,000
P10(2)	0,952	84,925	-0,447	-0,150	-0,182	0,000
P10(3)	0,937	86,325	-0,336	-0,163	-0,166	0,000
P10(4)	0,915	88,244	-0,279	-0,195	-0,175	0,000
P10(5)	0,884	88,284	-0,213	-0,196	-0,185	0,000

Correlations >0.88. Bleached fibres do not influence the bleaching. Instead,-other three types of fibres have a negative effect on brightness.

Part 3, Real-life sample bleaching

Figure 2 Comparison between predicted and measured ISO brightness for real-life samples

The model covers the trendline but predicts higher values ➔ There are variables not taken into account that influence negatively the bleaching.

Conclusion

The model is not exhaustive in predicting the bleaching of real-life samples.

Two possible causes:

1) **Contaminants/additives** not present in the model samples;
2) **"Hornification"** (Figure 3): the fibres are wet when repulped. When dried ➔ peroxide cannot bleach the internal layers of the fibres.

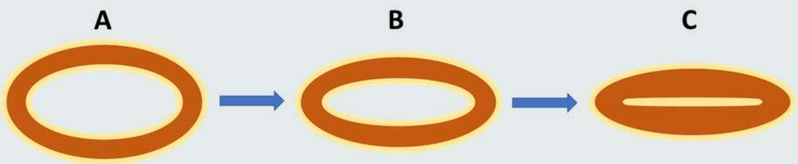

Figure 3 Representation of the hornification process. A: virgin fibre (cross section) is pulped; B: fibres during drying; C: dried fibre after recycling ➔ completely collapsed

[1] S. Adamopoulos and J.V. Oliver, *Wood and Fiber Science*. 2006, 38(4), 567-575

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