

Mill scale application of peroxyboost

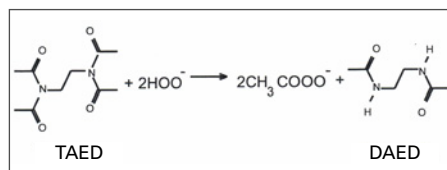
NEIL TURNER, JANE MATHEWS, GOPAL C. GOYAL, AND ROCKY W. SMITH

ABSTRACT: Mill trials with Potlatch Corporation, Lewiston, Idaho, USA, evaluated the industrial application of peracetic acid generated by reacting tetra acetyl ethylene diamine (TAED) and peroxide. The aim of the trials was to assess the potential for reducing total chlorine dioxide consumption in the bleaching sequence.

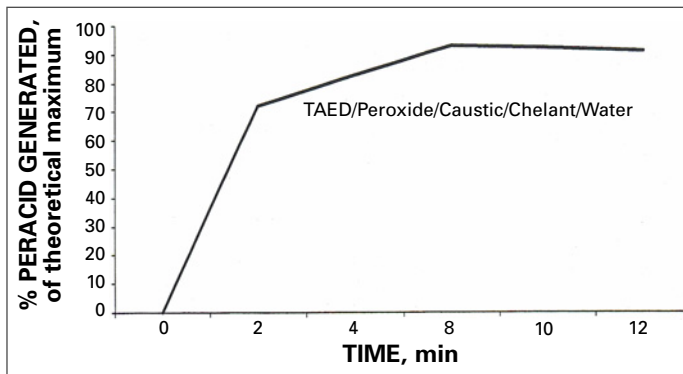
The mill trials used in-situ peracetic acid (Pa) under alkaline conditions in an O-Pa-D₁(EOP)-D₂ bleaching sequence. The peracetic acid was continuously fed to the post oxygen stage high-density storage chest using specifically designed dosing equipment. The result was a significant reduction in total chlorine dioxide usage—up to 7.90 lb/air-dried short ton of pulp. Further trials are planned to optimize the TAED addition and chlorine dioxide savings.

Application: For pulp bleaching, the use of in-situ peracetic acid generated from TAED and peroxide provides a useful option for debottlenecking mills that have limited chlorine dioxide capacity. It may also reduce bleaching costs via chlorine dioxide replacement.

Tetra acetyl ethylene diamine (TAED) provides a safe and efficient means of generating peracetic acid via reaction with hydrogen peroxide. Warwick International Limited developed a dosing system that allows the peracetic acid solution to be generated in a continuous controlled manner at the pulp mill site. The combination of TAED with peroxide to produce in-situ peracetic acid offers a safe, low capital alternative for delignifying and bleaching chemical pulps to using preformed peracids or other strong oxidizing species. The technology is marketed as PeroxyBoost™. **Figure 1** illustrates the chemistry of the reaction between TAED and peroxide.



1. The reaction of TAED with peroxide.



2. Rate of generation of in-situ peracetic acid.

TAED can be added to the pulp bleaching process by pre-reaction with peroxide and caustic soda in the presence of a stabilizing chelant. Using this approach, peracetic acid can be generated safely, at low concentration, and delivered continuously to the bleach plant. **Figure 2** shows the rate of generation of in-situ peracetic acid.

Peracetic acid is known to delignify and bleach pulps through nucleophilic and electrophilic mechanisms (1). The dual electrophilic/nucleophilic character results from the electron withdrawing CH₃CO group, which leads to δ⁺ and δ⁻ charges on the two oxygen molecules on the peroxide linkage.

Delignification and bleaching via electrophilic attack by peracetic acid can be

performed under near neutral to acidic conditions (pK_a = pH ~8.25). This is because, at a pH range below the pK_a, the acid species will predominate. Some mills have used peracetic acid under acidic conditions in fully bleached high-density storage chests to increase final pulp brightness (2). With peracetic acid generated by the reaction between TAED and peroxide, the process may benefit from the nucleophilic character of the peracetate anion, which predominates at a pH range higher than the pK_a. In pulp mill applications, this means that TAED could potentially be applied under brown stock or under post oxygen stage high-density

storage chest conditions, where pulp pH can be in the range 10-10.5.

The potential benefits of using in-situ peracetic acid in a kraft pulp mill include possible reductions in the amount of chlorine dioxide required to reach target brightness. This is particularly advantageous for mills that have a restricted chlorine dioxide generation capacity. A further potential benefit of in-situ peracetic acid is to allow a mill to achieve higher final pulp brightness.

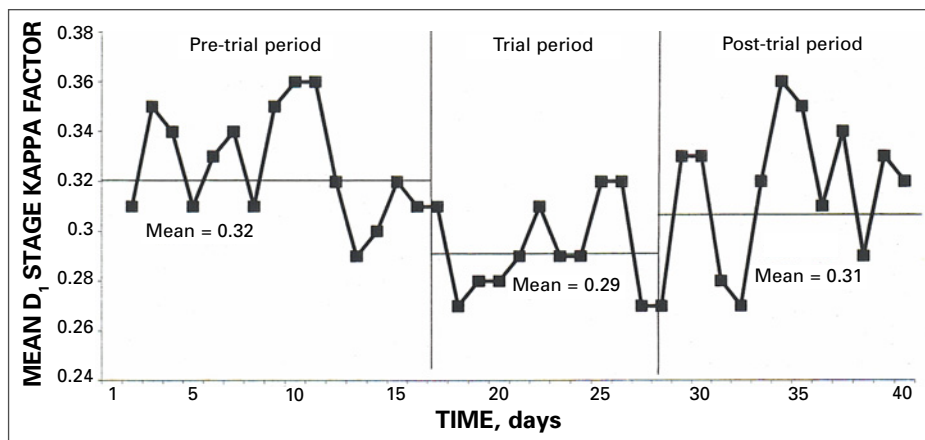
This paper describes results from mill trials performed at the Potlatch Corporation, Lewiston Mill, Idaho, USA, to evaluate the efficacy of in-situ peracetic acid. The bleaching sequence investigated involved the use of in-situ peracetic acid under alkaline conditions in the post oxygen stage high-density storage chest. The aim of the trial was to determine the levels of chlorine dioxide that could be reduced while still maintaining final pulp brightness.

MILL TRIAL OPERATION

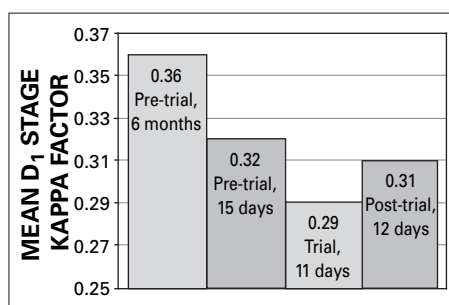
TAED/peroxide in-situ

peracetic acid addition point

Post oxygen stage high-density storage chest; O-Pa-D₁-(Eop)-D₂ bleaching sequence. The in-situ peracetic acid solution was fed into the suction side of a medium consistency pump, which feeds pulp exiting the post oxygen stage wash-



3. Daily, mean D₁-stage kappa factor from before during and after the trials.



4. Overall, mean D₁-stage kappa factor values.

er into a high-density storage chest. Operating conditions in the storage chest were 60°C/140°F, entry pH 10-10.5, exit pH 9-9.5, 10% pulp consistency with a retention time of 1-4 hours (depending on the varying level of pulp in the high density storage chest). TAED dosage was in the range 0.1%-0.2%. Average TAED dosage during the trials was 0.17%.

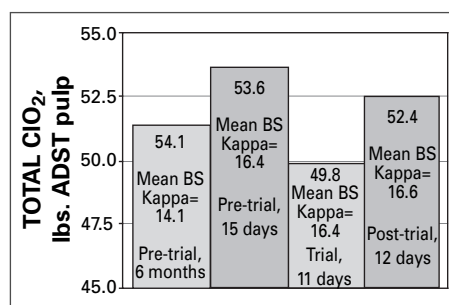
Kappa measurements were performed on samples of pulp entering and exiting the high-density storage chest. Chlorine dioxide charge into the D₁ stage was controlled by the mill's distributed control system, which uses compensated kappa factor control.

The aim of the trial was to determine the level of reduction in chlorine dioxide charge while maintaining target final pulp brightness.

RESULTS AND DISCUSSION

Addition of in-situ peracetic acid in the post oxygen stage HD chest.

Figure 3 shows the daily average D₁ kappa factor values. We noted a signifi-



5. Total chlorine dioxide usage across the O-Pa-D₁-(Eop)-D₂ bleaching sequence.

cant reduction in D₁ kappa factor once the trial began, and D₁ kappa factor increased when the trial was stopped. Average D₁ kappa factor during the trial was 0.07 lower than the 6 month pre-trial average, 0.03 lower for the 15 day pre-trial average, and 0.02 lower than the 15 day period immediately after the trial.

Equation 1 shows the calculation of chlorine dioxide reduction in the D₁ stage, based on kappa factor difference. D₁ stage kappa factor reduction was converted into pounds of chlorine dioxide saved using Eq 1. Based on the O-stage kappa average of 16.4 during the trials, this equates to a D₁ stage chlorine dioxide reduction during the trials of 2.5-8.7 lb/air-dried short ton (ADST) pulp compared with that used before and after the trials. Figure 4 presents the overall mean kappa factor values.

$$\text{Chlorine dioxide reduction (lbs/ADST)} = \frac{\text{O-stage kappa} \times \text{kappa factor difference} \times 20}{2.63} \quad (1)$$

Total chlorine dioxide usage across the O-Pa-D₁-(Eop)-D₂ bleaching sequence.

Figure 5 shows the total chlorine dioxide usage during the trials. Overall, the combined chlorine dioxide usage in the D₁ and D₂ stages during the trials was 3.8 lb lower than the usage immediately before the trial and 2.6 lb/ADST pulp lower than immediately after the trial. This is a good comparison because the oxygen stage kappa was similar for these periods (mean ~16.4).

Kappa reduction from the in-situ peracetic acid stage

A 1.2 unit kappa drop was effected by the in-situ peracetic acid stage. This equates to an 8% kappa reduction. Increased delignification might be obtained by running the peracetic acid stage under neutral or slightly alkaline conditions (in the range of pH 7-8). This will allow greater potential for electrophilic attack by peracetic acid on the lignin.

Economic impact

Savings in bleaching costs by reduced chlorine dioxide usage through TAED application will vary and depend on the mills' chlorine dioxide cost structure. At the time of the trial, the chlorine dioxide cost of the mill was such that 1.13 lb of chlorine dioxide had to be replaced by 1 lb of TAED use.

If a mill's chlorine dioxide capacity is limited, then the use of TAED may be a no- or low-capital option, compared to the upgrade of the chlorine dioxide generator, and may have a significantly higher payback.

Affect on strength properties

A discussion of a full PFI curve data on TAED treated pulp is beyond the scope of this paper. However, lab evaluation of strength properties by PFI refining of TAED-treated pulp was identical to control pulp. Additionally, during the mill trial, no changes were observed on the paper machine runnability, suggesting that the strength properties of TAED-treated pulp remained unchanged.

CONCLUSIONS

We achieved a significant reduction in total chlorine dioxide consumption adding in-situ peracetic acid into the post oxygen stage high-density storage chest under alkaline conditions. Overall

BLEACHING

chlorine dioxide reduction was in the range of 2.5-8.7 lb/ADST pulp.

Looking at the broader picture for the use of in-situ peracetic acid in kraft pulp bleaching, this level of chlorine dioxide reduction provides opportunities for mills to debottleneck restricted chlorine dioxide capacity and thus potentially increase pulp production.

Further trials are planned to optimize the in-situ peracetic acid addition: chlorine dioxide savings replacement ratio to confirm that net reductions in bleaching costs can be achieved. **TJ**

ACKNOWLEDGEMENTS

The authors thank all personnel from the Lewiston mill who contributed to the trials and to this paper. Special thanks are given to Joel Nitcy and David Trzil, Potlatch Corporation. Special thanks are also given to Jeffery S. Hsieh and Wei Wang, of Georgia Institute of Technology, for performing the pre-trial laboratory studies.

LITERATURE CITED

1. Lachenal, Q., Ledon, H., Paperi Puu 81(7): 506(1999).

2. Ruohoniemi, K., Heiko, J., Laakso, I, et al., Proceedings of the 1998 International Pulp Bleaching Conference, Book 1, p. 145, Helsinki, Finland.

Received: June 6, 2003

Revised: May 4, 2004

Accepted: May 5, 2004

This paper is also published on TAPPI's web site <www.tappi.org> and summarized in the August *Solutions! for People, Processes and Paper* magazine (Vol. 87 No. 8).

INSIGHTS FROM THE AUTHORS

We choose to study the use of in-situ peracetic acid generated from TAED and peroxide to find an alternative bleaching chemical for mills in which ClO_2 capacity is limited. Previous research in the area of in-situ generation has not been investigated.

The most difficult aspect was convincing the people at Potlatch Corp.'s Lewiston mill to run a mill trial. By showing the mill manager lab results we were able to convince them to run the mill trial. The most rewarding part of the work was to prove that in-situ generation of Pa can be carried out at a mill scale.

We feel that mills can benefit from the information in this study because it could help them reduce bleaching cost and/or extend their ClO_2 capacity. The next step is to apply the process in other mills and explore its use in bleached high density tower.

Turner and Mathews are with Warwick International Limited, Mostyn, Holywell, Flintshire, UK; Goyal (now with International Paper) was with Potlatch Corporation, Cloquet, Minnesota, USA; and Smith (photo not available) is with Weyerhaeuser Company, 100 Clinchfield St., Kingsport, Tennessee, USA. Email Gopal Goyal at gopal.goyal@ipaper.com.



Turner



Mathews



Goyal