DOE F 4600.6
(09-92)
Replaces EIA-459F
All Other Editions Are Obsolete

OMB Control No.
1910-0400

U.S. DEPARTMENT OF ENERGY
FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

OMB Burden Disclosure Statement

Public reporting for this collection of information is estimated to average 47.5 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Office of Information Resources Management, AD-241.2 - GTN, Paperwork Reduction Project (1910-0400), U.S. Department of Energy, 1000 Independence Avenue, S.W., Washington, DC 20585; and to the Office of Management and Budget (OMB), Paperwork Reduction Project (1910-0400), Washington, DC 20503

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FC07-96ID13442	High-Efficiency Chlorine Dioxide Delignification	4/1/98 through 6/30/98

4. Name and Address	5. Program/Project Start Date
Thomas J. McDonough 500 10th Street, NW, Atlanta, GA 30318 (404) 894 - 97017, thomas.mcdonough@ipst.edu	8/9/96
	6. Completion Date Extended 1 yr to 7/9/99

DOE/ID/13442--T1

7. Approach Changes

☒ None

8. Performance Variances, Accomplishments, or Problems

- *Comparative conventional D_0(EO) bleaching of pulps from conventional and modified processes showed slightly* improved bleachability for the latter and confirmed high efficiencies and low chlorate yields at low kappa factor
- Effectiveness of ultralow-AOX ClO_2 delignification process demonstrated
- Process for high-efficiency delignification identified
- Completed experiments to study mechanism by which low kappa factors give high efficiency
- Determined relationship between hexeneuronic acid content and unbleached kappa number of hardwood pulps
- Presented paper at 1998 International Pulp Bleaching Conference

☐ None

9. Open Items

- Molecular weight analysis of softwood kraft continues
- Isolation and analysis of conventional and vapor phase bleached, unbleached hardwood pulp residual lignins continuing
- Analysis of data from low-kappa-factor efficiency study underway
- Further development of high-efficiency delignification process in progress

☐ None

10. Status Assessment and Forecast

- Project behind schedule by 6+ months due to Olympics related startup delay and loss of postdoctoral research fellow. Replacement PDF now fully productive and current progress in NMR and molecular weight studies is good. One co-p.i. (AJR) currently on 6-month sabbatical in Sweden. One-year no-cost extension was requested and has been granted.

☐ No Deviation from Plan is Expected

11. Description of Attachments

- Brief summary of results obtained during the second quarter of 1998 is attached.

☐ None

12. Signature of Recipient and Date	13. Signature of U.S. Department of Energy (DOE) Reviewing Representative and Date
Thomas J. McDonough, July 31, 1998	

DISCLAIMER

DISCLAIMER

Portions of this document may be illegible electronic image products. Images are produced from the best available original document.

High-Efficiency Chlorine Dioxide Delignification

U.S. Dept. of Energy Project DE-FC07-96ID13442

Summary of Progress
April 1 - June 30, 1998

Arthur J. Ragauskas and Thomas J. McDonough
Institute of Paper Science and Technology

We have been pursuing strategies for improving the efficiency of utilization and environmental performance of ClO_2 in the delignification of kraft pulps. These strategies will apply several of the findings of this project. These strategies combine a pretreatment followed by ClO_2 treatment under conditions selected to result in high efficiency, and a suitably altered alkaline extraction stage. The potential for patentability of these strategies is currently being investigated. Detailed results will be presented after we have made a determination of their patentability.

In addition, a series of experiments was completed in which we compared the response to conventional D(EO) delignification of conventional kraft pulps and pulps from a laboratory simulation of Ahlstrom's Lo-Solids® extended delignification (modified) process. These experiments were conducted over a range of kappa numbers for both pulping processes, and at high and low kappa factors. The results (Table 1) showed that the modified pulps were slightly easier to bleach in the conventional process, an observation which parallels the corresponding observation made earlier, when the same pulps were bleached with the "Rapid D_0" short-retention process. As in previous work, there was a slight deterioration in bleachability as the unbleached kappa number was decreased. The bleachabilities of these pulps will be correlated with the structural features of the residual lignins they contain, to add to our database of lignin structure-bleachability relationships.

In other experiments, two sets of hardwood pulps of varied unbleached kappa number were subjected to determinations of their hexeneuronic acid contents. Pulps representing both conventional batch and extended (RDH) kraft pulping processes were included. Hexeneuronic acids are carbohydrate-derived components formed during kraft pulping by demethoxylation of a hemicellulose, 4-O-methyl-D-glucuronoxylan ("xylan"). Their presence in bleachable grade pulps is significant for two reasons: (1) they falsely inflate the unbleached kappa number, and (2) they consume electrophilic bleaching chemicals, such as chlorine dioxide. The analyses we performed consisted of acid hydrolysis under standard conditions, followed by spectrophotometric determination of the hydrolysis product (2-furoic acid) in the hydrolyzates. An alternate method is to determine the kappa number reduction that accompanies hydrolysis. The results we obtained are shown in Figure 1. It is apparent from the figure that, at a given kappa number, the two pulp types did not differ with respect to their hexeneuronic acid contents. On the other hand, there was a significant effect of unbleached kappa number. As the kappa number was decreased below 30 by extending the kraft cook, the hexeneuronic acid content first increased, then passed through a maximum, following which it decreased sharply. This finding will have considerable practical implication in the manufacture of hardwood kraft pulps for bleachable grades.

Residual lignin and effluent structural analyses by NMR and gel permeation chromatography are continuing to generate data for the development of structure-bleachability relationships. Analysis of this data is in progress.

Table 1. Conventional D(EO) Bleaching Parameters

			D_0 Stage						(EO) Stage				Total				
Pulp Type	Kappa No.	Bright-ness	Kappa Factor	Kappa No.	Delta Kappa/ TAC	AOX Yield, %	Cl^- Yield, %	ClO_3^- Yield, %	Kappa No.	Bright-ness	AOX Yield, %	Cl^- Yield, %	Delta Kappa/ TAC	AOX Yield, %	Cl^- Yield, %	ClO_3^- Yield, %	Cl Recovery, %
Conv.	29.6	26.0	0.05	25.0	3.1	5.4	(13)	1	15.3	36.1	3.5	12	9.7	8.9	25	1	35
			0.20	14.8	2.5	8.8	48	15	5.7	49.2	2.6	10	4.0	11.5	58	15	84
	21.3	28.9	0.20	10.5	2.5	8.3	51	16	4.1	52.1	2.6	10	4.0	10.9	61	16	89
	14.9	29.1	0.20	7.6	2.4	7.0	55	15	3.2	54.3	2.4	9	3.9	9.4	64	15	89
Lo-Solids	28.7	25.2	0.05	24.9	2.6	4.9	54	5	14.3	35.1	3.5	13	10.0	15.3	67	5	81
			0.20	14.5	2.5	8.5	52	17	4.7	49.2	0.9	8	4.2	9.3	60	17	87
	18.8	28.1	0.20	9.4	2.5	8.5	52	15	3.2	54.3	2.7	10	4.1	11.2	62	15	89
	15.6	28.8	0.20	7.9	2.5	7.2	52	14	3	55.5	2.3	10	4.0	9.5	62	14	86

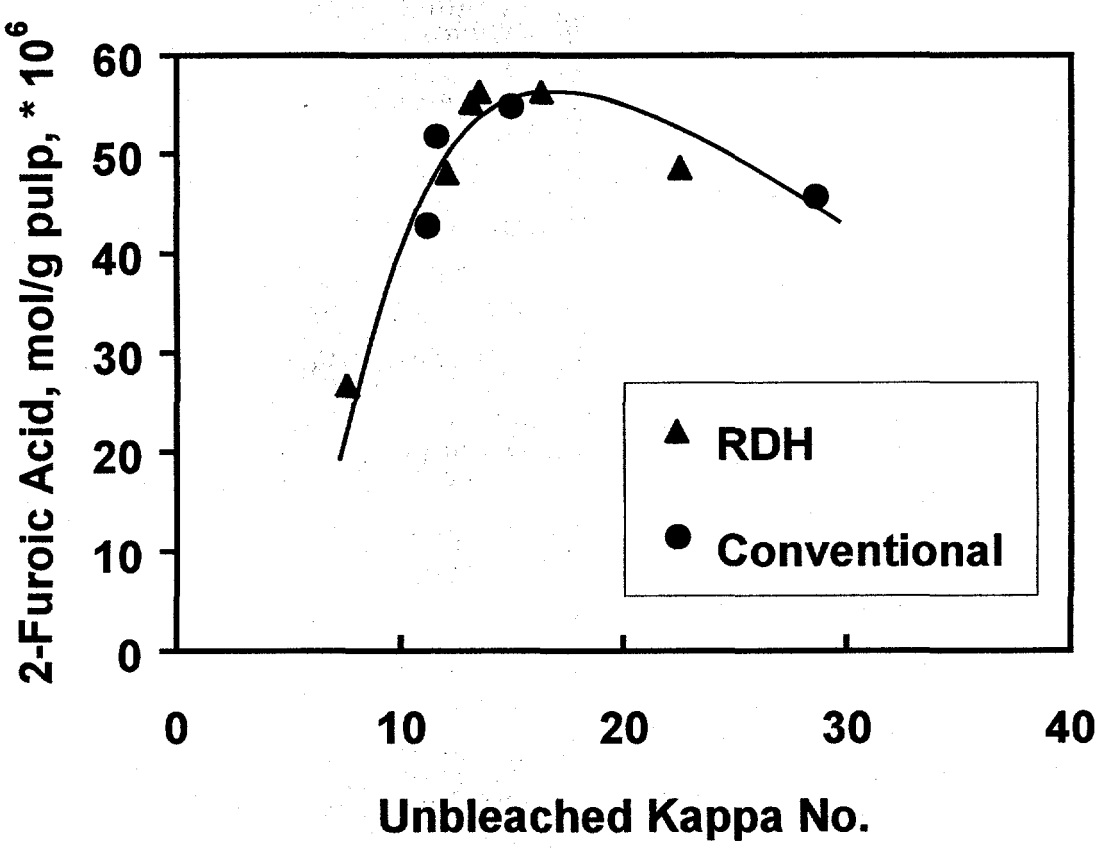

Figure 1. Hexeneuronic acid content of unbleached RDH and conventional kraft pulps from sweetgum.