

# Enhancing the pulp quality by optimization of pH of Chlorine Dioxide solution at the D-stage of bleaching process



## Authors:

**Sanjeev Jain**  
GM (Quality Control and R & D)

**S.Bagul**  
Sr. Manager(Pulp Mill)

**R.C.Verma**  
DGM (Pulp Mill)

**C.S.Kashikar**  
Chief Operating Office(COO)



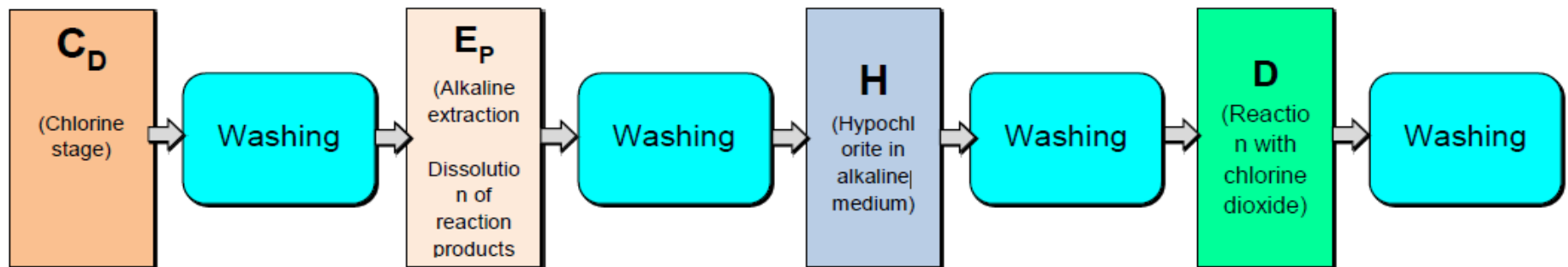
**M/s Orient Paper Mills , Amlai**  
**(Prop. : Orient Paper & Industries Limited)**  
**Dist. Shahdol, Madhya Pradesh, Pin – 484117**

# Orient Paper and Industries Ltd.

## Introduction

In Orient Paper and Industries Ltd (OPIL), the present Bleaching sequence is CD-Ep-H-D with conventional drums.

The initial brightness of unbleached pulp is 24°PV and bleached in the sequence of CD-Ep-H-D in four stages. The final pulp brightness is maintained around 88±1°PV. The bleached pulp is stored in Bleached High Density Tower.



# Orient Paper and Industries Ltd.

## Bleaching section of M/s OPIL



# Orient Paper and Industries Ltd.

## Material

In this study, the pH of the ClO<sub>2</sub> solution added in the D-stage of bleaching process was optimized maintaining the targeted pulp brightness i.e. 88+°PV and viscosity 6.5±5 cps. This was achieved by ceasing the dosage of concentrated sulphuric acid at D-stage inlet and lowering the pH of ClO<sub>2</sub> solution by addition of spent liquor (consisting of 400 gpl H<sub>2</sub>SO<sub>4</sub> and 12.5 gpl chlorate) to ClO<sub>2</sub> solution.

### Pulp bleaching conditions for different stages of C<sub>D</sub>E<sub>p</sub>HD sequence

Sr. No.	Parameters	C <sub>D</sub> E <sub>p</sub> HD				
		C <sub>D</sub> (Chlorine)	E <sub>p</sub> (Extraction)		H (Hypo Stage)	D (ClO <sub>2</sub> stage)
1.	Bleach Chemicals	Chlorine	NaOH	H <sub>2</sub> O <sub>2</sub>	Chlorine as Hypo	ClO <sub>2</sub>
2.	Strength (gpl)		>80	>60	>22	>5.7
3.	Dosage (Kg/ton)	28	25	9.0	30	7.5
4.	pH	<2	>10		>8	>5
5.	Temperature (°C)	Ambient	70-75		42-45	75-80
6.	Retention Time (mins)	45-50	60-90		180	180
7.	Brightness (°PV)	>50	>55		82-84	88+

# Orient Paper and Industries Ltd.

## Methodology

After Hypo stage (H) having pH of  $>8.0$ , the most favourable pH of vat pulp, for reaction to occur in D-stage reaction tower, is 3.5-4.5. To attain this pH, concentrated  $H_2SO_4$  was dosed along with  $ClO_2$  solution (having pH of 3.7 on an average) at the D-stage inlet.

The  $ClO_2$  solution pH, and consumption was recorded. Alongside the essential pulp properties such as pulp brightness and viscosity were investigated according to and recorded for analysis.

In the second phase of the experimental study, spent liquor consisting of 400 gpl  $H_2SO_4$  and 12.5 gpl chlorate was added to  $ClO_2$  solution, during chemical preparation to lower the pH of  $ClO_2$  solution from 3.7 to 1.7. This  $ClO_2$  solution of pH 1.7 was then dosed to the D-stage inlet to maintain the pH of D-stage vat pulp as 3.5-4.5. The addition of sulphuric acid at D-stage inlet was completely stopped.

## Methodology

**Hand sheet was prepared for determination of brightness and viscosity.**

**Determination of bleached pulp brightness:**

**The pulp brightness was measured using the standard method of TAPPI T452 om-18.**

**Determination of bleached pulp viscosity:**

**The viscosity of the pulp was estimated by capillary viscometer method using 1.0 M cupriethylenediamine (CED) solution using the standard method of TAPPI 230 om-08.**

# Orient Paper and Industries Ltd.

## Results and Discussion

### Impact of H<sub>2</sub>SO<sub>4</sub> dosage at D-stage inlet along with ClO<sub>2</sub> solution on ClO<sub>2</sub> bleaching

The aim of the experimental study was achieved in two phases.

#### Phase I:

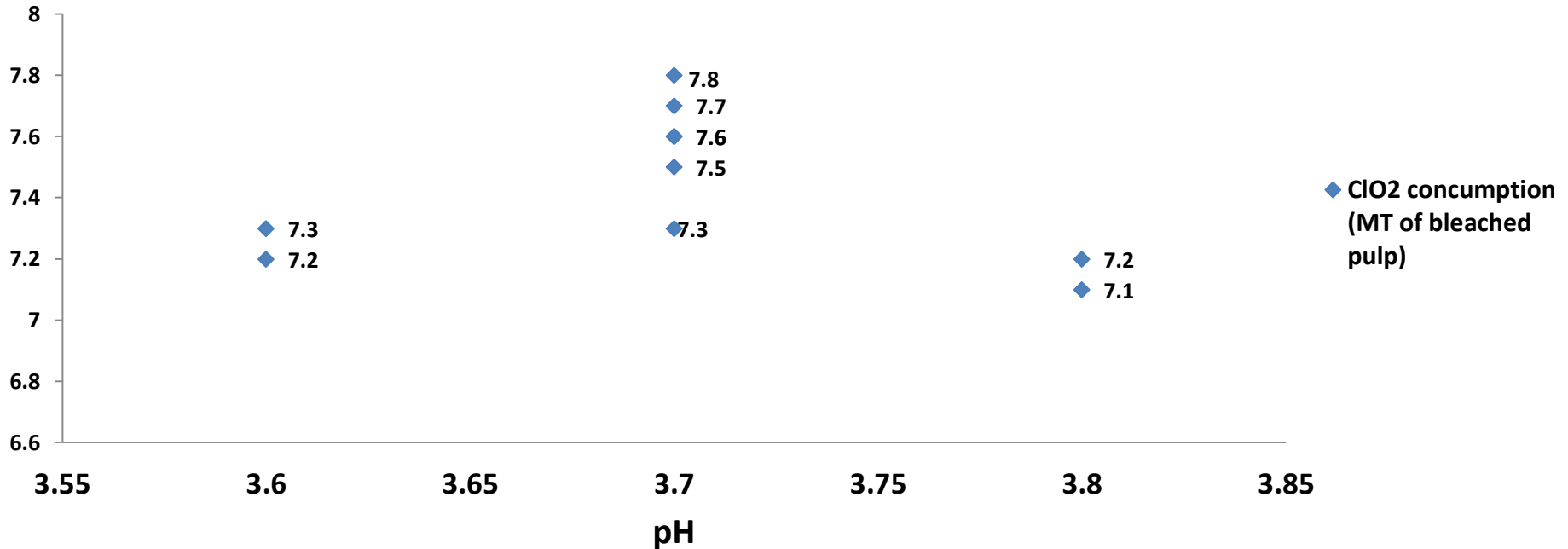
In the initial phase, the sulphuric acid was dosed along with ClO<sub>2</sub> solution at the D-stage inlet. ClO<sub>2</sub> solution pH, consumption along with pulp parameters were investigated and analyzed.

The above table records the ClO<sub>2</sub> pH, respective consumption and essential pulp attributes such as brightness and viscosity. It has been observed that on an average pH of 3.7, 7.4 MT/ Ton of ClO<sub>2</sub> solution was consumed maintaining the brightness to 88.3 °PV and pulp viscosity 6.27 cps.

S. No	ClO <sub>2</sub> sol. consumption (Kg/MT of bleached pulp)	ClO <sub>2</sub> sol. pH	Brightness (°PV)	Viscosity(cps)
1	7.5	3.7	88.4	6.1
2	7.3	3.6	88.3	6.3
3	7.2	3.8	88.0	6.2
4	7.7	3.7	88.4	6.3
5	7.6	3.7	88.1	6.0
6	7.8	3.7	88.2	6.1
7	7.3	3.7	88.6	6.2
8	7.1	3.8	88.6	6.5
9	7.6	3.7	88.6	6.6
10	7.2	3.6	88.6	6.4
Av g	7.4	3.7	88.3	6.27

# Orient Paper and Industries Ltd.

Impact of using H<sub>2</sub>SO<sub>4</sub> along with ClO<sub>2</sub> Solution on ClO<sub>2</sub> consumption



The ClO<sub>2</sub> solution consumption while addition of H<sub>2</sub>SO<sub>4</sub> along with ClO<sub>2</sub> Solution at D-stage



# Orient Paper and Industries Ltd.

## Phase II:

In the final phase of the study, the pH of the ClO<sub>2</sub> solution was lowered before addition to the D-stage inlet. This was done by the addition of spent liquor. The ClO<sub>2</sub> solution consumed in this phase was recorded along with ClO<sub>2</sub> solution pH, along with pulp brightness and viscosity.

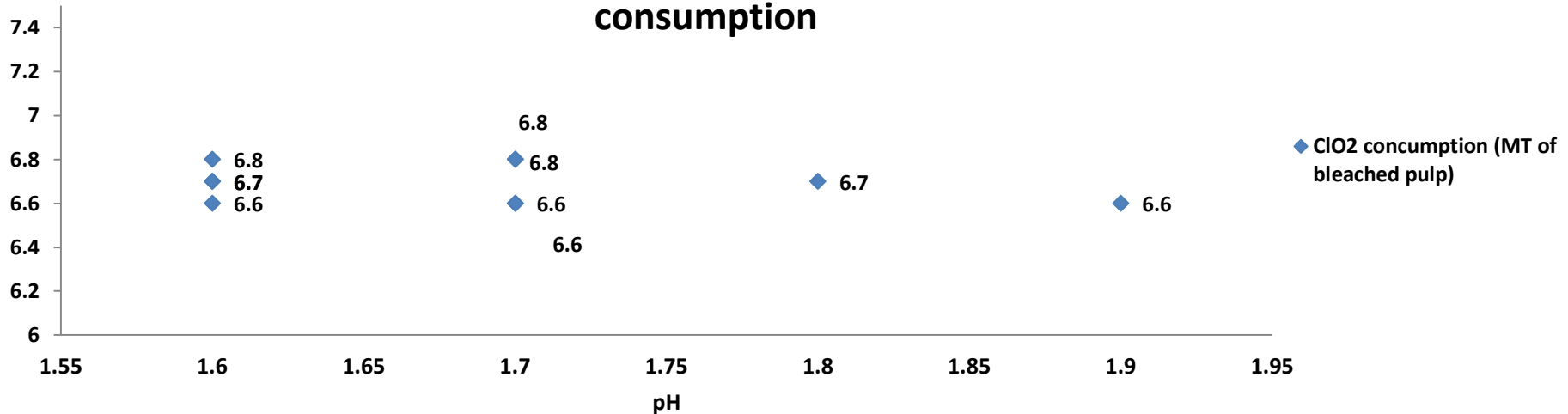
When the pH of ClO<sub>2</sub> solution was lowered by addition of spent liquor, the consumption of ClO<sub>2</sub> solution was also lowered to 6.7 (Kg /MT of bleached pulp) on an average. The brightness of pulp was maintained to targeted value (88.3°PV). While the viscosity was observed to be enhanced to 6.6 cps. This has been recorded in the attached table.

### Impact of spent liquor addition along with ClO<sub>2</sub> solution

S.N	ClO <sub>2</sub> sol. consumption (Kg/MT of bleached pulp)	ClO <sub>2</sub> sol. pH	Brightness (°PV)	Viscosity(cps)
1	6.7	1.6	87.9	6.1
2	6.6	1.7	88.5	6.7
3	6.8	1.6	88.4	6.7
4	6.7	1.8	88.3	7.0
5	6.6	1.6	87.9	6.3
6	6.8	1.7	88.0	6.0
7	6.6	1.7	87.9	6.2
8	6.8	1.9	88.6	7.2
9	6.8	1.7	88.4	6.5
10	6.7	1.6	88.8	6.9
Avg	6.7	1.7	88.3	6.6

# Orient Paper and Industries Ltd.

Impact of addition of spent liquor to lower the ClO<sub>2</sub> pH on ClO<sub>2</sub> consumption



The ClO<sub>2</sub> solution consumption while addition of sulphuric acid to the D-stage inlet was compared to the Consumption while pulp bleaching without the use of H<sub>2</sub>SO<sub>4</sub> i.e. ClO<sub>2</sub> pH lowered by addition of spent liquor was compared and analysed.

# Orient Paper and Industries Ltd.

**Comparative chart representing the variation in ClO<sub>2</sub> consumption and pulp viscosity with and without dosage of H<sub>2</sub>SO<sub>4</sub>**

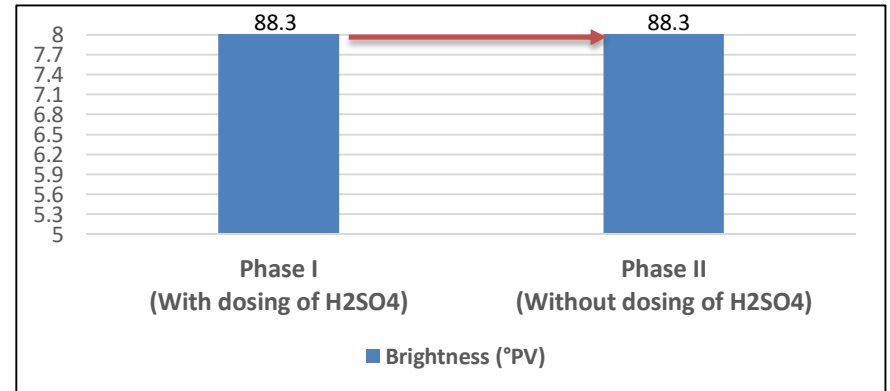
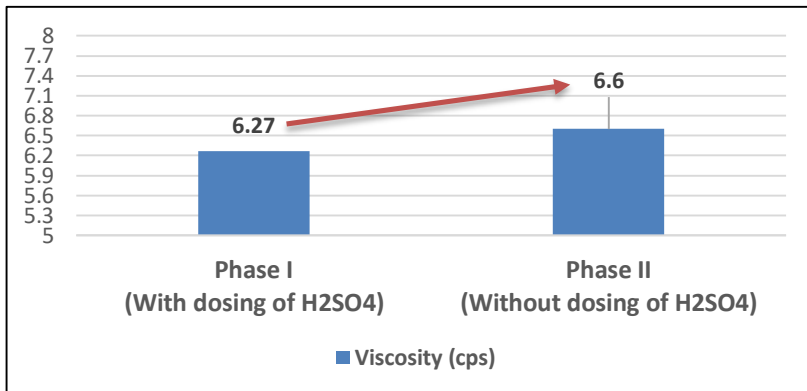
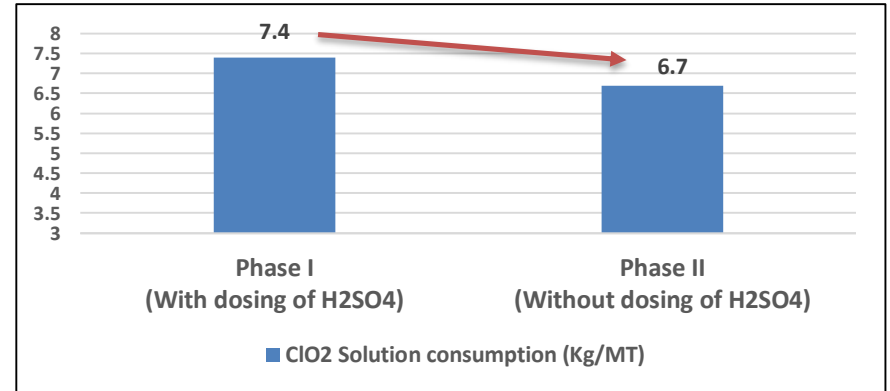
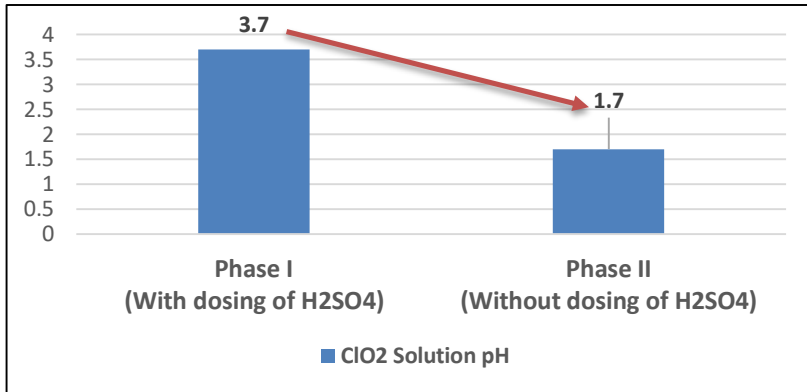
The comparative table clearly highlights that the consumption of ClO<sub>2</sub> solution was found to be 7.4 Kg/MT of bleached pulp when H<sub>2</sub>SO<sub>4</sub> was dosed at the inlet of D-stage while it reduced to 6.7 Kg/MT of bleached pulp when the pH of ClO<sub>2</sub> was lowered with spent liquor before dosing (i.e. in the absence of H<sub>2</sub>SO<sub>4</sub>). The viscosity of pulp also enhanced from 6.1 cps to 6.6 cps when spent liquor was dosed in bleaching system eliminating the dosage H<sub>2</sub>SO<sub>4</sub>.

S.No	ClO <sub>2</sub> sol. consumption (Kg/MT of bleached pulp)		Viscosity (cps)	
	Phase I (With dosing of H <sub>2</sub> SO <sub>4</sub> )	Phase II (Without dosing of H <sub>2</sub> SO <sub>4</sub> )	Phase I (With dosing of H <sub>2</sub> SO <sub>4</sub> )	Phase II (Without dosing of H <sub>2</sub> SO <sub>4</sub> )
1	7.5	6.7	6.1	6.1
2	7.3	6.6	6.3	6.7
3	7.2	6.8	6.2	6.7
4	7.7	6.7	6.3	7.0
5	7.6	6.6	6.0	6.3
6	7.8	6.8	6.1	6.0
7	7.3	6.6	6.2	6.2
8	7.1	6.8	6.5	7.2
9	7.6	6.8	6.6	6.5
10	7.2	6.7	6.4	6.9
Avg	7.4	6.7	6.27	6.6

# Orient Paper and Industries Ltd.

## Conclusion

Comparative trend between Phase I and Phase II of the experimental study:



## Conclusion

- 1. The consumption of ClO<sub>2</sub> solution was found to lower when spent liquor was used in bleaching system instead of dosing H<sub>2</sub>SO<sub>4</sub> in the D-stage inlet. It was observed that the consumption reduced by 9.45%.**
- 2. The pulp brightness was found to be maintained at 88.3°PV.**
- 3. The viscosity of pulp which denotes the pulp strength also enhanced from 6.1 cps to 6.6 cps i.e., by 5.26%**

## Significance of the study

- 1. The study conducted aiming to eliminate sulphuric acid dosage in pulp bleaching system has significant benefits. Sulphuric acid is highly viscous and corrosive chemical. The use of H<sub>2</sub>SO<sub>4</sub> in the pulp bleaching system has several cons. Owing to its high acidity and corrosive nature, it corrodes the machinery parts such as MC pump those are involved in the pulp bleaching system. Thus, reducing the life of machinery.**
- 2. Moreover, the spent liquor passing out with effluent from ClO<sub>2</sub> plant is reused in the process flow, thus, making the process environmentally sustainable. Use of spent liquor instead of sulphuric acid has also aided in maintaining consistent ClO<sub>2</sub> pH.**

# Orient Paper and Industries Ltd.

## Significance of the study

The enhancement in pulp strength indicated by viscosity would further fetch multiple advantages such:

- Improvement in machine runnability, speed, productivity, and end product quality as well.
- Hence, it can be concluded that the use of spent liquor D-stage pulp bleaching system and elimination of sulphuric acid dosage to lower the pH can be potential methodology with multifold advantages.
- By adoption of this bleaching technology, one can not only improve the machinery life but also reduce chemical consumption successfully.

# Orient Paper and Industries Ltd.

## Path forward

**Presently, Hypo bleaching sequence is being used in OPIL, which will be converted into ECF bleaching very shortly, project is already under process. The new sequence of bleaching in post ECF project will be DOEPD1D2. Henceforth, ClO<sub>2</sub> solution consumption will be optimised further.**



# Orient Paper and Industries Ltd.

# THANK YOU



**M/s Orient Paper and Industries Ltd.**



**Amlai, Distt: Shahdol-484117 (Madhya Pradesh)**



**coo-office@opil.in**