STUDIES ON OZONE TREATMENT OF INDIGENOUS RAW MATERIAL PULP FOR BETTER BLEACHABILITY

Broad Area: Cleaner Technology

Project Duration: 2 year

Total Cost of the project: 25 lacs

Date of commencement: December-2011

Date of Completion: December 2013

OBJECTIVE

Improvement in bleached pulp quality in terms of optical and strength properties and reduction /removal of elemental chlorine bleaching process for improved quality of liquid discharges.

Technical Programme

- Literature survey in the area of ozone based ECF and TCF processes of different raw material pulp.
- Pulping of different raw materials to various residual lignin levels.
- Oxygen delignification of unbleached pulp.
- Ozone treatment of oxygen delignified pulp of different raw materials.
- Optimization of ozone treatment parameters and characterization of pulp after bleaching.
- Recommendations and report preparation.

Ozone in fibre line

1.Ozone can be used as a delignifying agent during pretreatment of unbleached pulp

2.Or in bleaching of pulp by partial replacement of chlorine dioxide-ZD stage

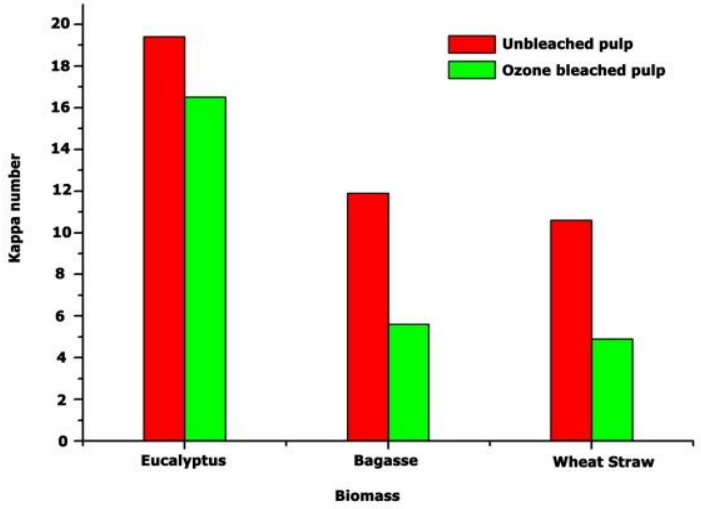
Studies on Ozone Pretreatment of Wheat straw, Bagasse and Eucalyptus pulp

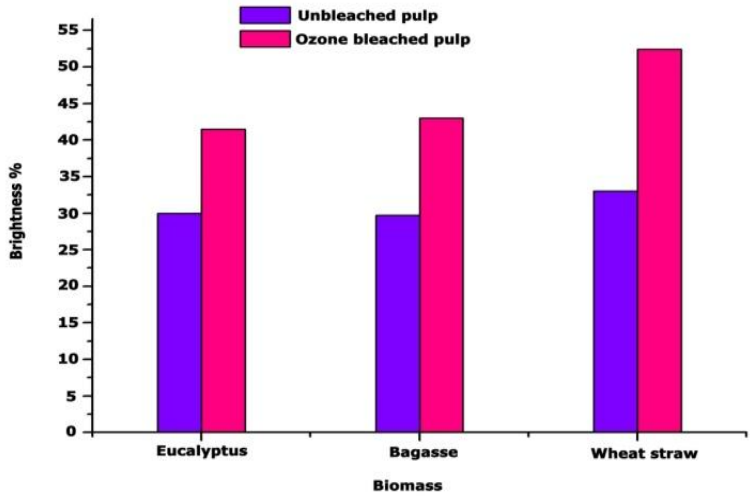
Parameters	Eucalyptus	Bagasse	Wheat straw
Unbleached pulp kappa number	19.4	11.9	10.6
Initial brightness,%ISO	30.0	29.7	33.0
Unbled pulp viscosity, cc/g	900	910	795
Ozone treatment stage			
Ozone applied,%	1.09	0.55	0.48
Ozone applied, min (flow rate 50g/hr)	1.31	0.66	0.57
pH	2.25	2.25	2.25
Consistency,%	10	10	10
Temp.^{o}C	25	25	25
Ozone bleached pulp kappa number	16.5	5.6	4.9
Ozone bleached pulp brightness,%ISO	41.5	43	52.4
Ozone bled pulp viscosity, cc/g	830	812	737
% Reduction/gain			
kappa number	14.9	52.9	53.7
Brightness,%ISO	28.3	44.77	58.7
viscosity, cc/g	7.7	10.76	7.3

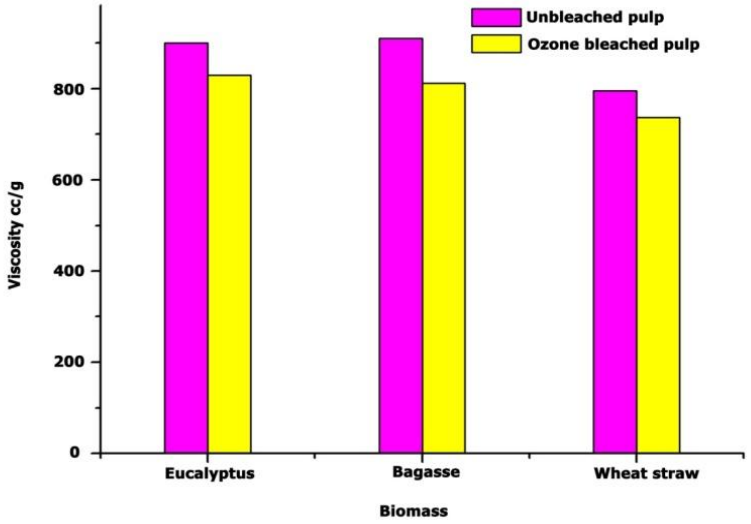
OBSERVATIONS

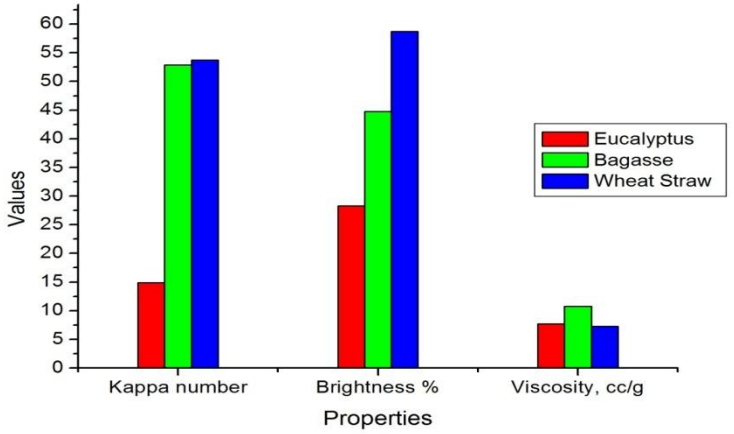
1. The unbleached pulp kappa number reduction for eucalyptus, bagasse and wheat straw is 14.9, 52.9 and 53.7% respectively.
2. Gain in brightness after ozone treatment is observed 28.3, 44.77 and 58.7%ISO respectively for eucalyptus, bagasse and wheat straw.
3. Drop in viscosity is 7.7, 10.76 and 7.3%ISO respectively for eucalyptus, bagasse and wheat straw

Effect of Ozone Treatment on Pulp Properties









ECF Bleaching of Ozone Treated Pulp

Parameters	Eucalyptus		Bagasse		Wheat straw	
	As such	After Z treatment	As such	After Z treatment	As such	After Z treatment
Unbleached pulp kappa number	19.4	16.5	11.9	5.6	10.6	4.9
Initial brightness, %ISO	30.0	41.5	29.7	43	33.0	52.4
Unbleached pulp viscosity, cc/g	900	830	910	812	795	737
DEpD Bleaching						
Chlorine dioxide (D)applied as avl Cl2 applied,%	5.0	4.3	2.5	1.2	2.2	1.0
Chlorine dioxide consumed,%	4.8	4.0	2.3	1.0	2.0	0.9
Extraction stage-Alkali applied,%	2.5	2.5	2.0	1.8	2.0	1.5
DEp bleached pulp kappa number	3.5	3.0	2.8	2.5	2.7	2.0
DEp bleached pulp brightness,%ISO	62	65	67.2	68	68	70
DEp bleached pulp viscosity, cc/g	805	725	785	745	660	631
Final D stage-Dioxide applied as D,%	1.0	0.75	0.75	0.6	0.75	0.5
DEpD Brightness,%ISO	84.9	85.2	85	86.2	85.3	86.5
DEpD viscosity, cc/g	780	700	750	726	610	600

Bleaching Sequence studied for Indigenous raw material pulp of

Eucalyptus,
Bagasse,
Wheat straw

ECF Bleaching Sequences	TCF Bleaching Sequences
DEpD	ZEPQP
ODEpD	AZEPQP
AZDEpD	OAZEPQP
OAZDEpD	

EUCALYPTUS

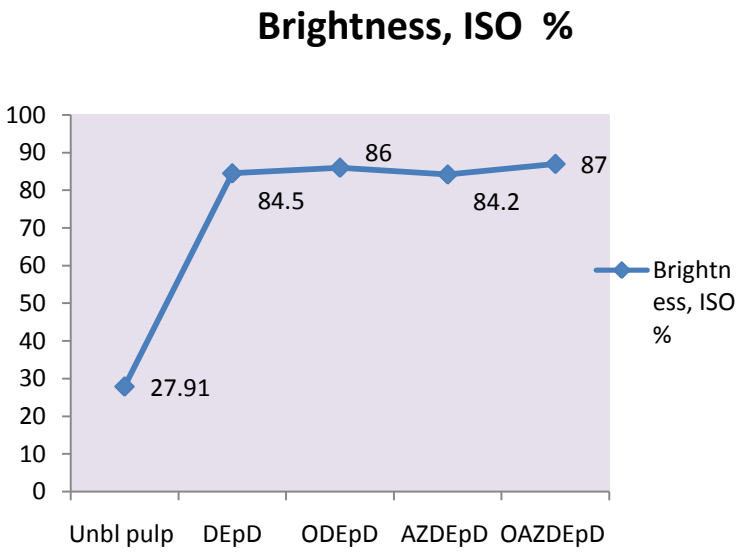
Ozone based ECF Bleaching of Eucalyptus pulp

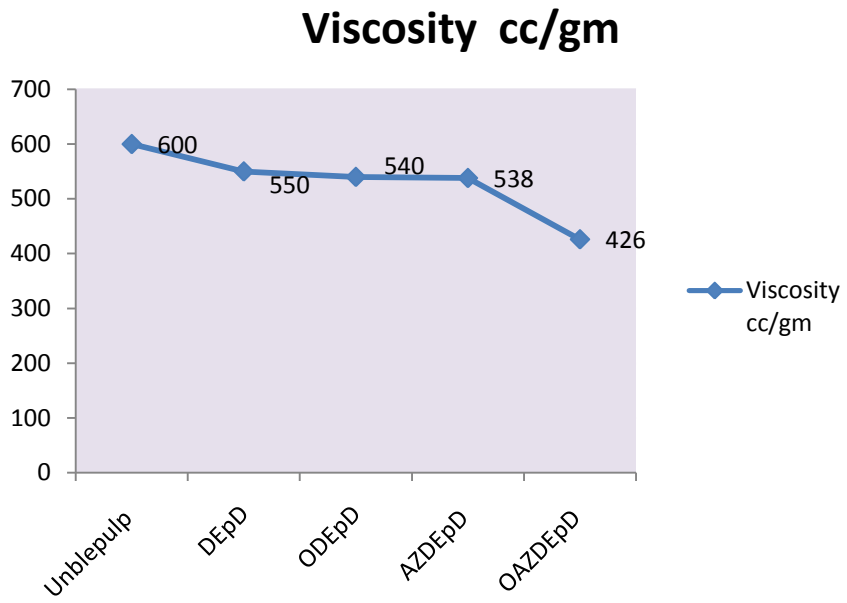
Sequence		**DEpD**	**ODEpD**	**AZDEpD**	**OAZDEpD**
Parameters	Units				
Initial Kappa Number		17.0	11.5	17.0	11.5
Brightness, ISO	%	27.91	35.3	27.91	35.3
Viscosity	cc/gm	594	581	594	581
A stage					
Brightness, ISO	%	--	--	27.0	42.8
Viscosity	cc/gm	--	--	573	517
Z- stage					
Brightness, ISO	%	--	--	33	45.5
Viscosity	cc/gm	--	--	560	484
Kappa Number		--	--	12.5	7.77
Do-stage					
Brightness, ISO	%	50	52	39.5	55.3
Viscosity	cc/gm	550	520	554	466
Ep Stage/ (PO)					
Brightness (ISO)	%	60	65	59.12	69.8
Viscosity	cc/gm	540	520	544	448
D_1 Stage/ PStage					
Brightness, ISO	%	84.5	86	84.2	87.0
Viscosity	cc/gm	550	540	538	426
Total D demand	%	2.3	1.66	1.76	1.07

Ozone based TCF Bleaching of Eucalyptus Pulp

Sequence		TCF Bleaching		
Parameters	**Units**	**Z(EP)QP**	**AZ(EP)QP**	**OAZ(EP)QP**
Initial Kappa Number		15.0	15.0	15.0
Brightness, ISO	%	33.0	33.0	33.0
Viscosity	cc/gm	550	550	550
O stage				
Initial Kappa Number		--	--	8.25
Brightness, ISO	%	--	--	49.2
Viscosity	cc/gm	--	--	383
A stage				
Initial Kappa Number		--	14.1	7.6
Brightness, ISO	%	--	33.8	50.1
Viscosity	cc/gm	--	465	371
Z- stage				
Brightness, ISO	%	33.7	35.3	52.0
Viscosity	cc/gm	437	412	354
Kappa Number		14.3	13.0	12.5
EP Stage				
Kappa Number		3.67	3.5	2.8
Brightness (ISO)	%	73.3	73.5	77.1
Viscosity	cc/gm	396	362	342
Q Stage				
DTPA	%	0.5	0.5	0.5
pH		5-6	5-6	5-6
P Stage				
Brightness, ISO	%	78.1	80.4	84
Viscosity	Cc/gm	360	345	330

Z BASED ECF BLEACHING OF EUCALYPTUS





BAGASSE

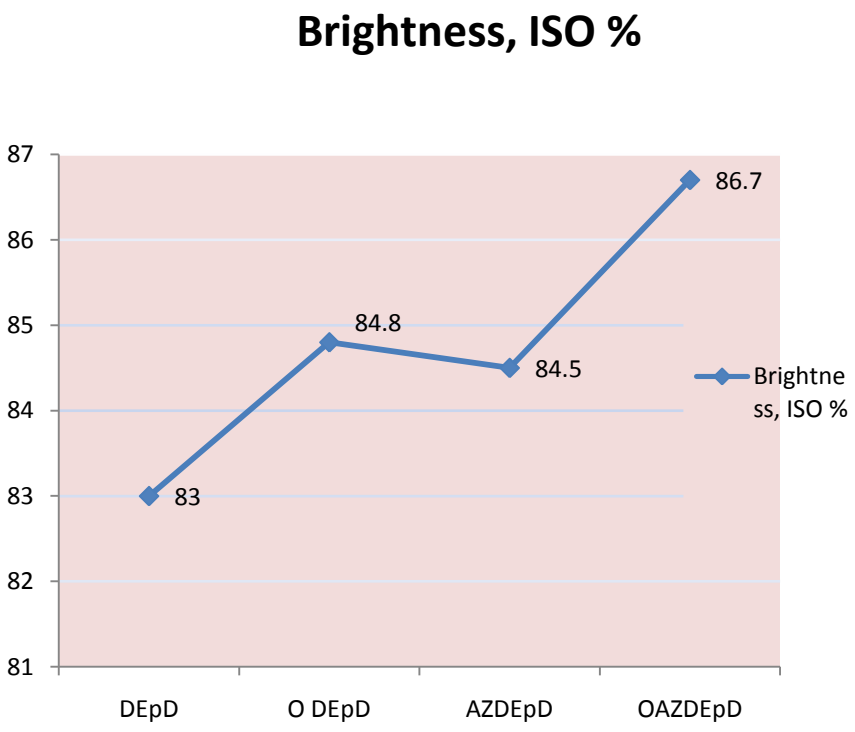
Ozone based ECF Bleaching of Bagasse pulp

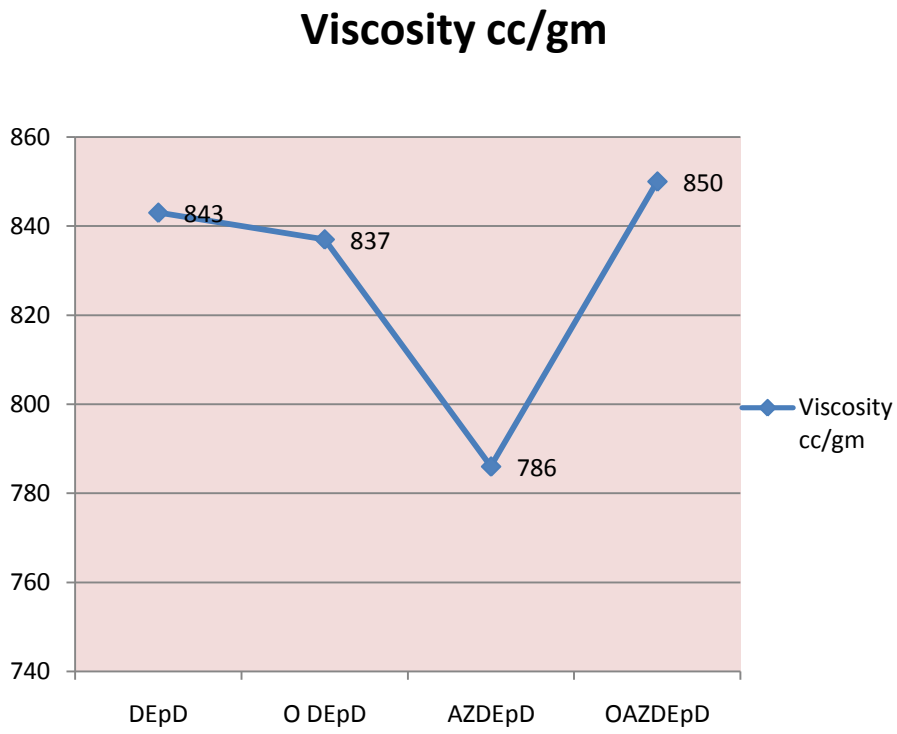
Parameters	Units	DEpD	O DEpD	AZDEpD	OAZDEpD
Initial Kappa Number		17.5	7.10	17.5	7.10
Brightness, ISO	%	30.28	44.8	30.28	44.8
Viscosity	cc/gm	947	903	947	903
A stage					
Brightness, ISO	%	--	--	33.4	45.0
Viscosity	cc/gm	--	--	912	896
Z- stage					
Brightness, ISO	%	--	--	35.7	46.1
Viscosity	cc/gm	--	--	876	888
D-stage					
Brightness, ISO	%	50	52.1	54.8	59.8
Viscosity	cc/gm	--	--	870	873
Kappa Number		--	--	4.75	2.87
Ep Stage					
Brightness (%ISO)	%	63	65	67.8	72.02
Viscosity	cc/gm	890	876	812	856
D_1 Stage					
Brightness, ISO	%	83	84.82	84.5	86.7
Viscosity	cc/gm	843	837	786	890

Ozone based TCF Bleaching of Bagasse Pulp

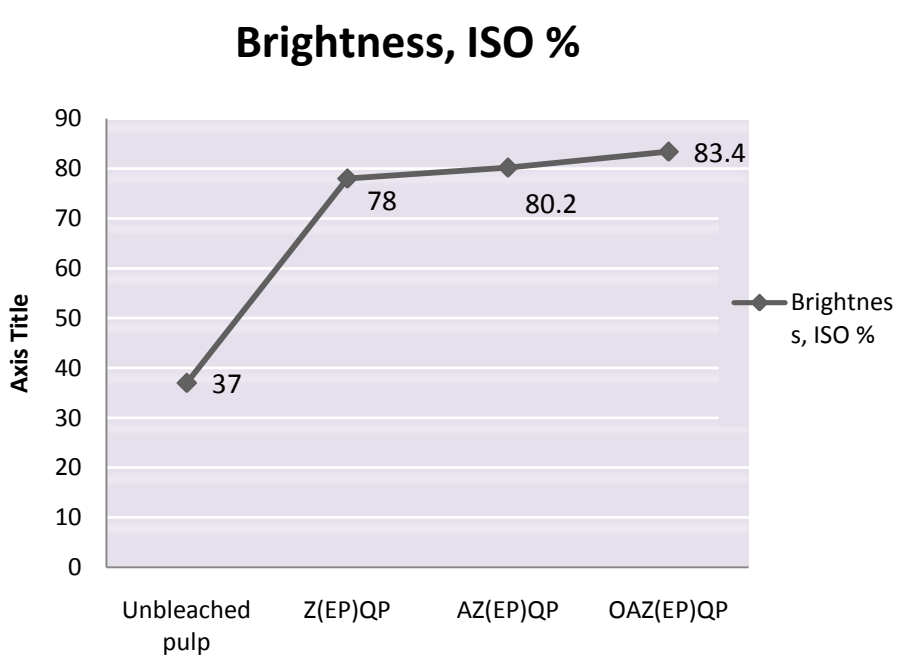
Sequence		TCF Bleaching		
Parameters	**Units**	**Z(EP)QP**	**AZ(EP)QP**	**OAZ(EP)QP**
Initial Kappa Number		12.0	12.0	12.0
Brightness, ISO	%	36.9	36.9	36.9
Viscosity	cc/gm	922	922	922
O stage				
Kappa Number		--	--	5.0
Brightness, ISO		--	--	54.1
Viscosity		--	--	832
A stage				
Initial Kappa Number		--	11.2	4.7
Brightness, ISO	%	--	37.8	55.0
Viscosity	cc/gm	--	878	794
Z- stage				
Brightness, ISO	%	40.9	49.5	56.3
Viscosity	cc/gm	881	787	721
Kappa Number		8.0	10	4.3
EP Stage				
Kappa Number		4.0	3.8	2.13
Brightness (ISO)	%	69.6	72.0	76.7
Viscosity	cc/gm	801	743	657
Q Stage				
DTPA	%	0.5	0.5	0.5
pH		5-6	5-6	5-6
P Stage				
Brightness, ISO	%	78	80.2	83.4
Viscosity	Cc/gm	726	693	601

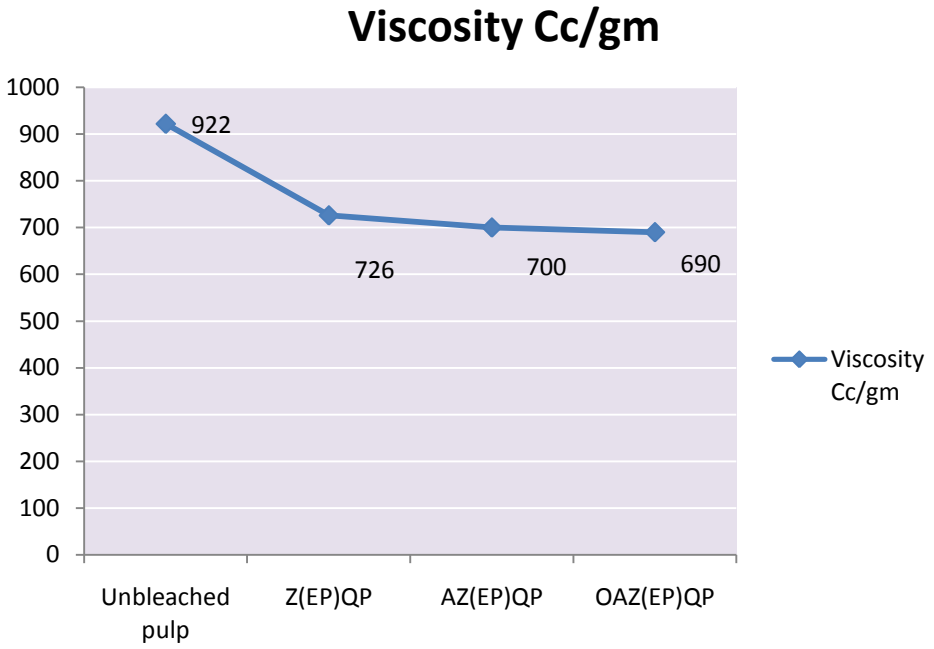
Z BASED ECF BLEACHING OF BAGASSE





Z BASED TCF BLEACHING OF BAGASSE





WHEAT STRAW

Ozone based ECF Bleaching of Wheat Straw Pulp

Parameters	Units	DEpD	ODEpD	AZDEpD	OAZDEpD
Kappa number		15.0	9.0	15.0	9.0
Brightness, ISO	%	33.6	49.0	33.6	49.0
Viscosity	cc/gm	904	831	904	831
A stage					
Brightness, ISO	%	--	--	34.5	50.1
Viscosity	cc/gm	--	--	887	811
Z- stage					
Viscosity	cc/gm	--	--	801	790
Kappa Number		--	--	11.0	6.0
D-stage					
Brightness, ISO	%	55	65.3	52.5	74.6
Viscosity	cc/gm			756	767
Ep Stage					
Brightness (ISO)	%	59.0	55.0	59.8	79.4
Viscosity	cc/gm	755	765	731	760
D_1 Stage					
Brightness, ISO	%	84.6	85.6	83.2	87.0
Viscosity	Cc/gm	668	668	730	754

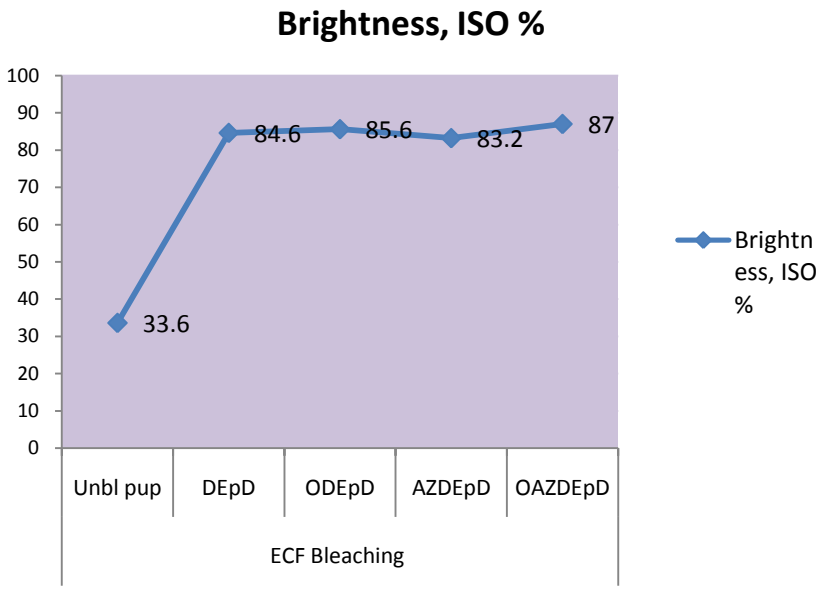
Ozone based TCF Bleaching of Wheat Straw Pulp

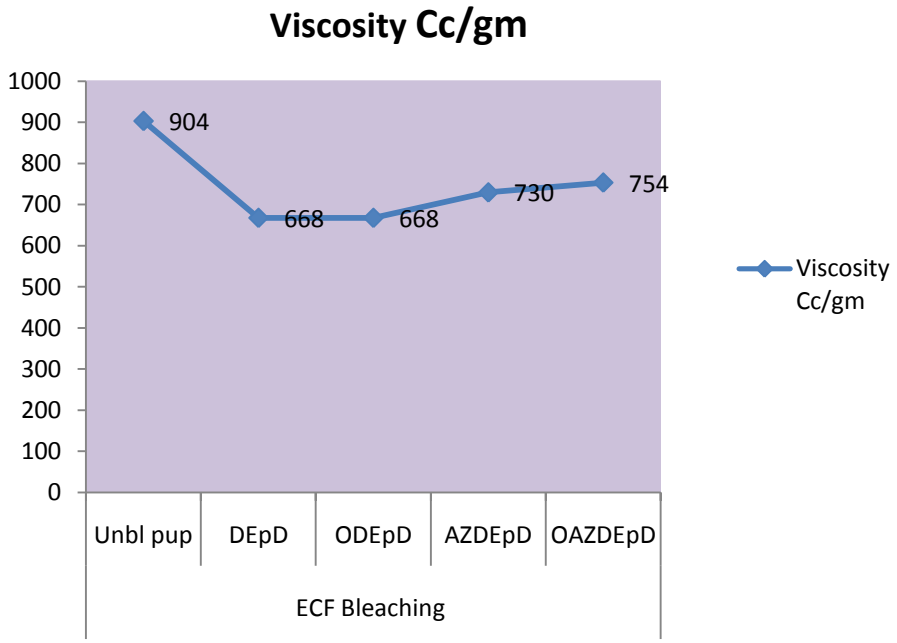
Parameters	Units	Z(EP)QP	AZ(EP)QP	OAZ(EP)QP
Initial Kappa Number		14.4	14.4	14.4
Brightness, ISO	%	34.04	34.04	34.04
Viscosity	cc/gm	1028	1028	1028
O stage				
Kappa Number				7.6
Brightness,	ISO			41.8
Viscosity	Cc/g			988
A stage				
Brightness, ISO	%		37.0	46.3
Viscosity	cc/gm		988	794
Z- stage				
Brightness, ISO	%	37.1	38.0	53.9
Viscosity	cc/gm	937	926	915
Kappa Number		12.8	12.6	6.2
EP Stage				
Brightness (ISO)	%			72.4
Viscosity	cc/gm			823
Q Stage				
DTPA	%	0.5	0.5	0.5
P Stage				
Brightness, ISO	%	76.13	78.0	79.4
Viscosity	Cc/gm			726

Observations (Bleaching of Eucalyptus Pulp)

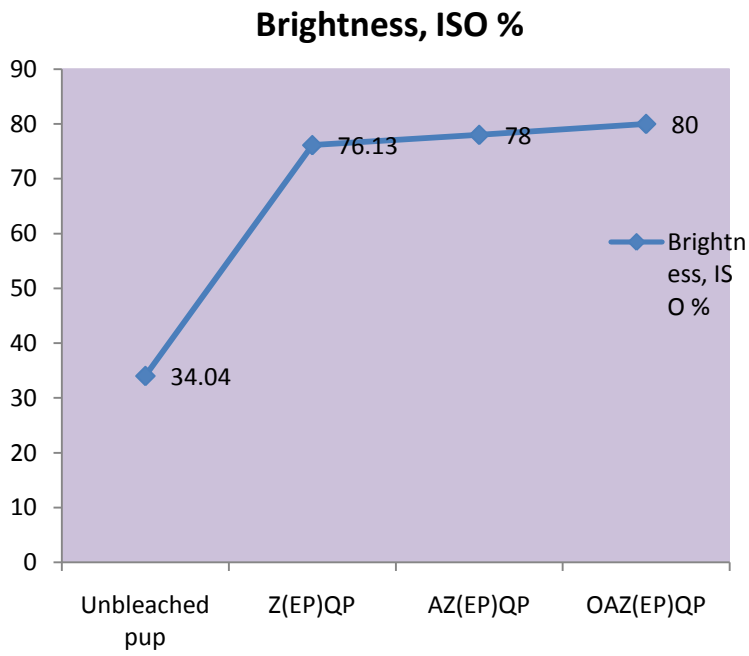
1. Partial replacement of D with Z, resulted into reduction of substantial demand of chlorine dioxide in first D stage.
2. There is 53% and 66% reduction in first stage D demand after Z treatment in AZDEpD and OAZDEpD sequence respectively compared to DEpD Sequence
3. Loss of viscosity after AZ and OAZ is 3.5 and 16.5% respectively

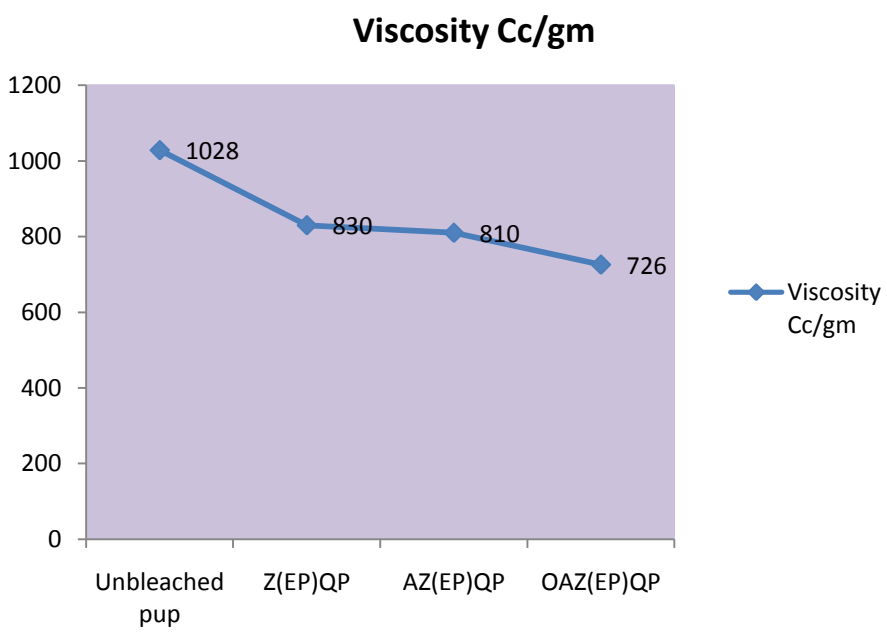
Z BASED ECF BLEACHING OF WHEAT STRAW



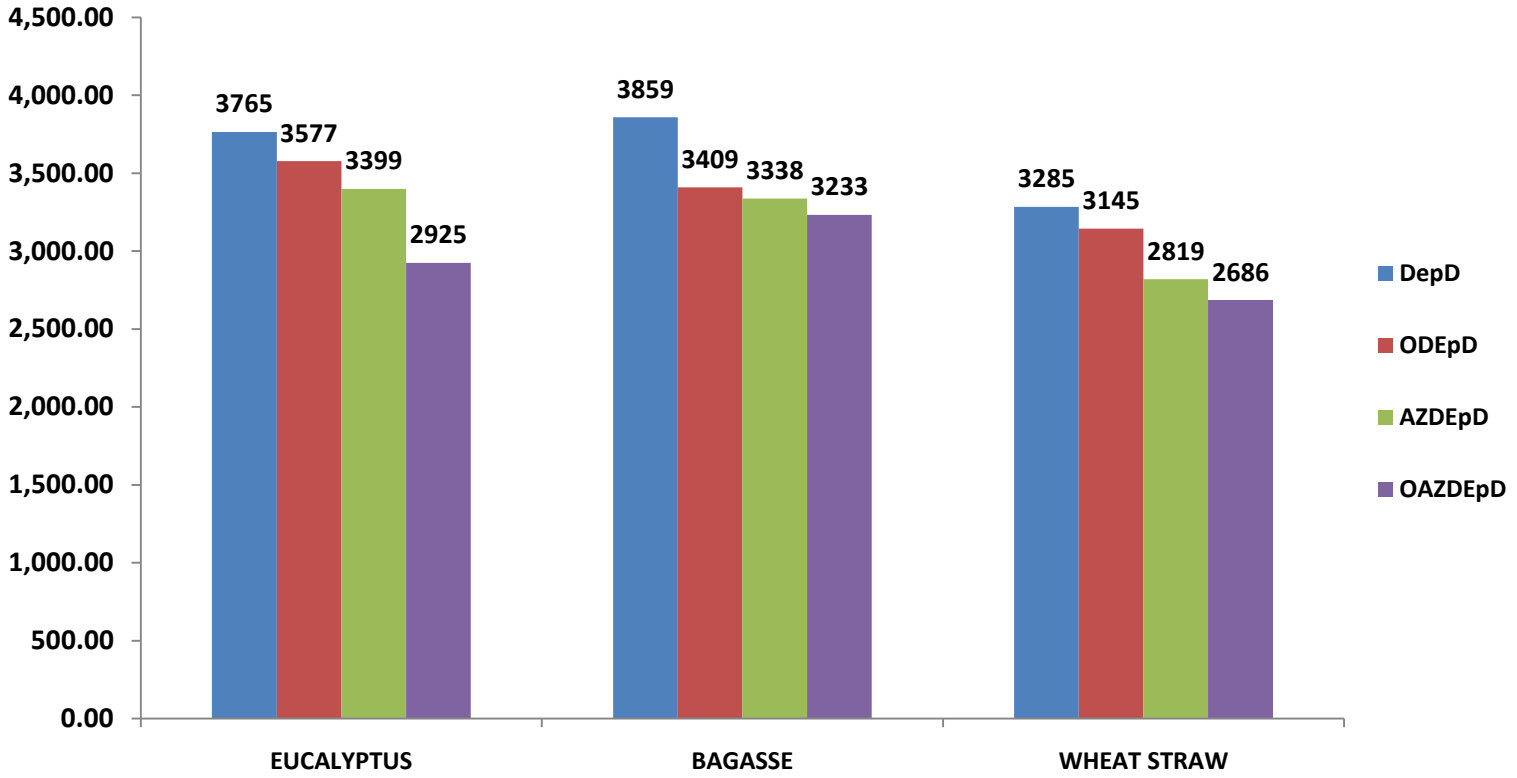


Z BASED TCF BLEACHING OF WHEAT STRAW

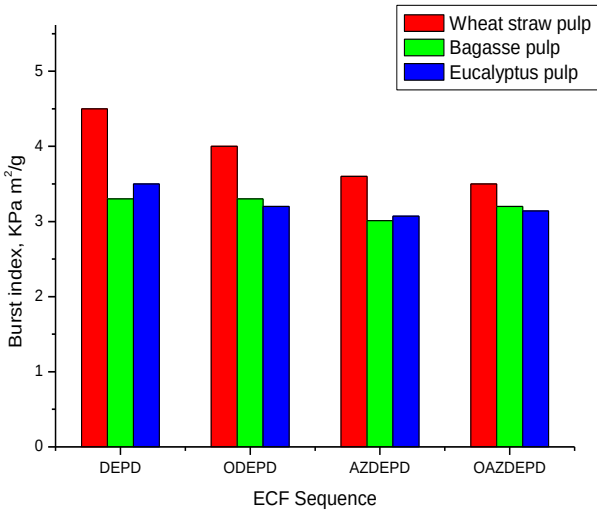


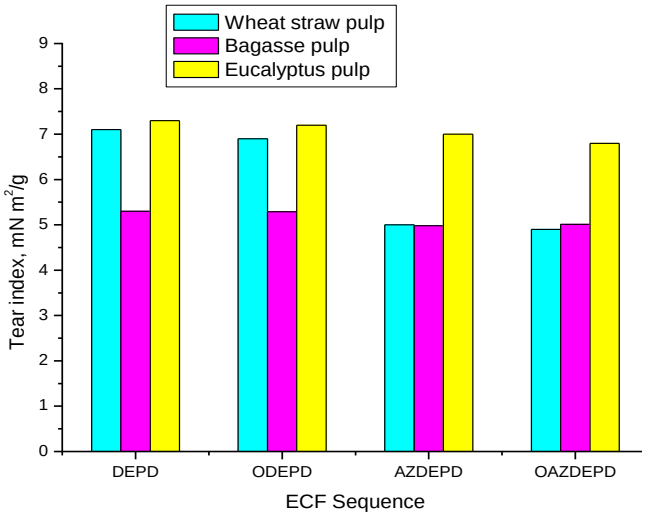


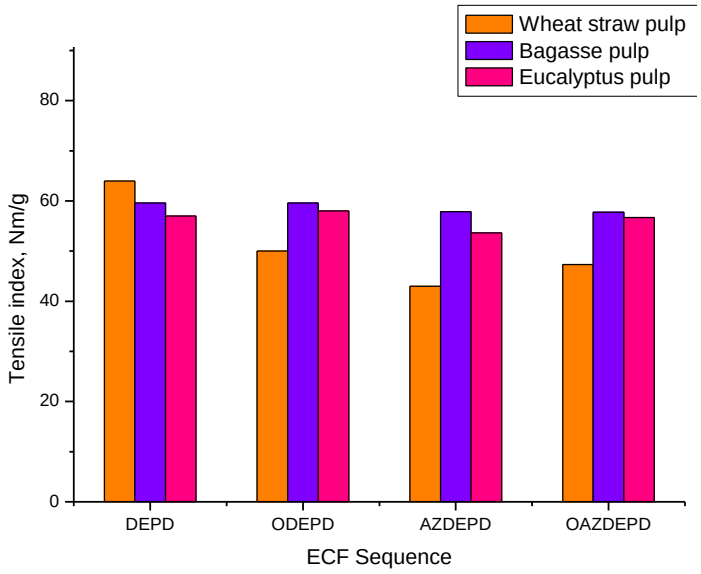
Cost of Chemicals for ECF Bleaching of Pulp



STRENGTH PROPERTIES OF ECF BLEACHED PULP







Conclusions:

- From an economics point of view, ozone is a highly competitive bleaching chemical which, when compared at equal bleaching power, is typically 1.2 to 1.5 times less costly than chlorine dioxide.
- ECF sequences combining ozone and chlorine dioxide are economically competitive with sequences using chlorine dioxide only, even when capital expenses for modifying process equipment are taken into consideration. They have the advantage of improved performance and added flexibility in regard to effluent characteristics, and position the mill on the pathway to (nearly) effluent-free bleaching.

- In combination with (pressurized) hydrogen peroxide (EP), ozone makes it possible to produce fully bleached TCF pulp while maintaining expenditures in bleaching chemicals at levels that are comparable, if not lower, than those pertaining to ECF bleaching

- Bleaching plants that do yet have oxygen delignification can achieve desired AOX levels of by adopting Z/D-based ECF bleaching.

Major Achievements of the Project

- Development of Infrastructure for ozone treatment of pulp to carry out ozone optimization study for Indian paper Industry.
- The efficacy of ozone on indigenous raw material pulp is as effective as for softwood pulp.
- The ECF and TCF bleaching sequence can be economic by adopting ozone in fiber line
- Light ECF sequence using ZD in first stage can help in reduction of chlorine dioxide consumption and so the cost of bleaching too.
- Full brightness can be obtained using oxygen and ozone based TCF bleaching