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Catawba Kraft Optimization - Calculations for Affected Streams and Influence on Steam Balance

Parameter		Before Opt	After Opt	Change
Operating days		358	358	0
Bleached Production	adst/yr	548500	566500	18000
	adst/day	1532	1582	50
Unbleached tons	adst/yr	564,063	582,752	18,648
	adst/day	1576	1628	52
White Liquor Charge (EA)	% on wood	15.8%	15.3%	
White Liquor Demand	gpm	1023	1023	0
Digester Heater Flow	gpm	2400	2400	0
Liquor Temp	T(F)	290	287	-3
Digester Heater Steam	#/hr			-3,983
Digester KAPPA		28	32	4
% Delignification - O2		55%	59%	4%
Bleach Feed Kappa		12.5	13.0	0.5
ClO2 demand	tpd	29.8	31.7	1.87
BP Steam	#/adst	601.0	601.0	0.0
BP Steam	#/hr			1,307
Liquor Solids	#/adst BL	3707	3585	(122)
	MM #/yr	2,033.2	2,030.7	(2.48)
	#/day	5,679,297	5,672,357	(6,940)
Blk Liquor HHV	Btu/#	5898	5885	(12)
RB heat input	MMBtu/hr	1,435	1,431	(4)
WBL Baume'		8.6	8.4	(0.2)
WBL SG		1.063	1.061	(0.00)
WBL Solids		15.6%	15.2%	(0.00)
Evaporator Feed	gpm	2,840	2,911	71
Steam Economy	#H2O/#steam	5.00	5.00	0
Evaporator Steam	#/hr change			7071
Surface Condenser H2O T	(F)	132	134.5	2.5
Flow to WW Tank	gpm	3500	3500	0
Steam Offset from Cond Water	#/hr			-4523
Net Steam change	**#/hr change**			**-128**

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Catawba Pulping Model Before Kraft Optimization

Catawba Pulping Model Before Kraft Optimization

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User Inputs	2/3/2022 14:32	
Digester Kappa	28	
Bleach feed kappa	12.5	
EA charge, % on wood	15.8%	
White liquor AA, lb/ft3	6.6	
White liquor TA, lb/ft3	7.55	
White liquor sulfidity, %AA	30%	
White liquor reduction, %	96%	
Weak black liquor solids	15.6%	
Digester yield increase factor	0	
Rail cars shipped per day	0	
Recovery boiler dust factor	5%	
Maximum liquor to powerhouse	3000	gpm
Do Kappa Factor	0.2319	
D1 ClO2 Usage	15.0	
D2 ClO2 Usage	5.0	
Screenroom yield	99%	
O2 delig yield bias	0%	
Percent delignification	55.4%	

Model Results		
Bleached production, ADT/D	**1532**	
Total production, w/ shipping	**1532**	
Wood usage, GT/ADT	4.38	
Liquor burn rate, gpm	542	
TPD black liquor solids	2839	Tons/day
gpm weak black liquor	2840	gpm to powerhouse
White liquor required	1023	gpm
Slaker rate required	1100	gpm
ClO2 required	29.8	TPD
	38.9	lbs/ADT
White liquor causticity	**82.9%**	
Black liquor per ton	3413	lbs BLS/ADT brown
	3707	lbs BLS/ADT bleached
Liquor heating value	5898	BTU/lb BLS
Digester yield	**45.6%**	
O2 Delignification yield	96.59%	
Bleach plant yield	97.24%	
Deadload, lb/ft3	1.86	
Overall yield, OD	42.4%	
Lime required @ 90% avail	457	total
Kiln capacity required	434	reburned

Evaporation Requirements		
Total weak black liquor	2840	gpm
Feed liquor solids	15.6%	
Feed density	8.79	lb/gal
Product liquor required	542	gpm
Product liquor solids	67%	
Product density	11.4	lb/gal
gpm conversion, prod/feed	0.180	
#1 set feed liquor	950	gpm
#1 set product liquor	171	gpm
Water evaporated	384,463	lb/hr
#2 set feed liquor	945	gpm
#2 set intermediate liquor	0	gpm
#2 set product liquor	170	gpm
Water evaporated	382,525	lb/hr
#3 set feed liquor	945	gpm
#3 set intermediate liquor	0	gpm
#3 set product liquor	170	gpm
Water evaporated	382,525	lb/hr
Total weak fed	2840	gpm
Total product made	511	gpm
Total product, w/ dust recycle	537	gpm

#1 set product liquor solids	0.67	Solids
liquor density	11.4	lb/gal
#1 set steam economy	5	Economy

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Catawba Puping Model After Kraft Optimization

Catawba Pulping Model After Kraft Optimization

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User Inputs	2/3/2022 14:32	
Digester Kappa	32	
Bleach feed kappa	13	
EA charge, % on wood	15.3%	
White liquor AA, lb/ft3	6.6	
White liquor TA, lb/ft3	7.55	
White liquor sulfidity, %AA	30%	
White liquor reduction, %	96%	
Weak black liquor solids	15.2%	
Digester yield increase factor	0	
Rail cars shipped per day	0	
Recovery boiler dust factor	5%	
Maximum liquor to powerhouse	3000	gpm
Do Kappa Factor	0.2353	
D1 ClO2 Usage	15.0	
D2 ClO2 Usage	5.0	
Screenroom yield	99%	
O2 delig yield bias	0%	
Percent delignification	59.4%	

Model Results		
Bleached production, ADT/D	**1582**	
Total production, w/ shipping	**1582**	
Wood usage, GT/ADT	4.29	
Liquor burn rate, gpm	541	
TPD black liquor solids	2835	Tons/day
gpm weak black liquor	2911	gpm to powerhouse
White liquor required	1023	gpm
Slaker rate required	1100	gpm
ClO2 required	31.7	TPD
	40.1	lbs/ADT
White liquor causticity	**82.9%**	
Black liquor per ton	3270	lbs BLS/ADT brown
	3585	lbs BLS/ADT bleached
Liquor heating value	5885	BTU/lb BLS
Digester yield	**46.7%**	
O2 Delignification yield	96.02%	
Bleach plant yield	97.21%	
Deadload, lb/ft3	1.86	
Overall yield, OD	43.2%	
Lime required @ 90% avail	457	total
Kiln capacity required	434	reburned

Evaporation Requirements		
Total weak black liquor	2911	gpm
Feed liquor solids	15.2%	
Feed density	8.77	lb/gal
Product liquor required	541	gpm
Product liquor solids	67%	
Product density	11.4	lb/gal
gpm conversion, prod/feed	0.175	
#1 set feed liquor	1000	gpm
#1 set product liquor	175	gpm
Water evaporated	406,919	lb/hr
#2 set feed liquor	956	gpm
#2 set intermediate liquor	0	gpm
#2 set product liquor	167	gpm
Water evaporated	388,831	lb/hr
#3 set feed liquor	956	gpm
#3 set intermediate liquor	0	gpm
#3 set product liquor	167	gpm
Water evaporated	388,831	lb/hr
Total weak fed	2911	gpm
Total product made	509	gpm
Total product, w/ dust recycle	535	gpm

#1 set product liquor solids	0.67	Solids
liquor density	11.4	lb/gal
#1 set steam economy	5	Economy

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Catawba Pulping Model After Kraft Optimization

Black Liquor Solids and Heating Value Calculations

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Pulping Inputs	
Bleached Production, ADT/D	**1582**
Post-Oxygen Kappa	13
Digester Kappa	32
EA Charge, % od	15.3%
AA Charge, lbs/eq. Cook	9300
WL AA, lb/ft3	6.6
WL TA, lb/ft3	7.6
WL Sulfidity	30%
WL Reduction	96%
Extractives in liquor	1.0%
Wood lignin content	27%
OWL Charge in O2, lbs/ADT	66.5
Screenroom yield	99%
Black Liquor Solids, Digester	
Organics, lbs/ADT unbl. pulp	2055
Lignin, lbs/ADT unbl. pulp	856
Organics, other than lignin	1199
NaOH, lbs/ADT unbl. pulp	626.8
Na2S, lbs/ADT unbl. pulp	261.9
Na2SO4, lbs/ADT unbl. pulp	25.0
Na2CO3, lbs/ADT unbl. pulp	170.8
Inorganics, lbs/ADT unbl. pulp	1084
Organic/Inorganic ratio	1.90
Digester BL solids, lbs/ADT UP	**3140**
Digester BL solids, lbs/ADT BP	3364
BL solids/ADT unbleached O2 pulp	**3270**
Black Liquor Solids, O2 Delig	
Organics, lbs/ADT unbl. pulp	74.6
NaOH, lbs/ADT O2 pulp	66.5
Na2S2O3, lbs/ADT O2 pulp	26.3
Na2SO4, lbs/ADT O2 pulp	2.5
Na2CO3, lbs/ADT O2 pulp	17.0
Inorganics from O2, lbs/ADT	112.3
O2 Solids, lbs/ADT O2 pulp	186.9
Total solids, lbs/ADT O2 pulp	3457
Total solids, lbs/ADT blch pulp	**3585**

Virgin solids to boiler	**236**	**Mlbs/hr DS**
Virgin solids firing rate	**5.67**	**MMlbs/day DS**
Virgin heat input	**1391**	**MMBTU/hr**
Liquor firing rate, gpm @ 5% recycle	**541**	**gpm**

Calculated Variables		
Bleached Yield	97.21%	
O2 Delig Yield	96.02%	
Digester Yield	46.7%	
O2 Delig Production, ADT/D	1641	
Digester Production, ADT/D	1709	
Wood Usage, ODT/D Chips	3293	
WL NaOH, lb/ft3 as NaOH	5.96	
WL Na2S, lb/ft3 as Na2S	2.49	
WL Na2CO3, lb/ft3 as Na2CO3	1.6	
WL Na2SO4, lb/ft3 as Na2SO4	0.238	
WL EA, lbs/ft3 as Na2O	5.6	
WL CE, %	82.9%	
ft3 WL/ADT unbleached pulp	105.1	
ft3 OWL/ADT O2 pulp	10.4	
OWL NaOH, lb/ft3 as NaOH	6.37	
OWL Na2S2O3, lb/ft3	2.52	
HHV Estimate, Digester		
Lignin, BTU/lbs BLS	3162	
Carbohydrates, BTU/lbs BLS	2227	
Extractives, BTU/lbs BLS	199	
Na2S, BTU/lbs BLS	463	
Total BTU/lbs BLS	**6051**	
HHV Estimate, O2 Delig		
Lignin, lbs/ADT O2 pulp	1006	
Carbohydrates, lbs/ADT O2 pulp	1124	
Lignin, BTU/lbs BLS	3375	
Carbohydrates, BTU/lbs BLS	1896	
Extractives, BTU/lbs BLS	181	
Na2S, BTU/lbs BLS	420	
Na2S2O3, BTU/lbs BLS	13.28	
Total BTU/lbs BLS (w/ O2 Del)	**5885**	
BL solids, based on digester, lbs/ADT		3327
		2835
		2911

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Black Liquor Solids and Heating Value Calculations

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Pulping Inputs	
Bleached Production, ADT/D	**1532**
Post-Oxygen Kappa	12.5
Digester Kappa	28
EA Charge, % od	15.8%
AA Charge, lbs/eq. Cook	9300
WL AA, lb/ft3	6.6
WL TA, lb/ft3	7.6
WL Sulfidity	30%
WL Reduction	96%
Extractives in liquor	1.0%
Wood lignin content	27%
OWL Charge in O2, lbs/ADT	54.25
Screenroom yield	99%
Black Liquor Solids, Digester	
Organics, lbs/ADT unbl. pulp	2150
Lignin, lbs/ADT unbl. pulp	901
Organics, other than lignin	1249
NaOH, lbs/ADT unbl. pulp	663.1
Na2S, lbs/ADT unbl. pulp	277.1
Na2SO4, lbs/ADT unbl. pulp	26.4
Na2CO3, lbs/ADT unbl. pulp	180.7
Inorganics, lbs/ADT unbl. pulp	1147
Organic/Inorganic ratio	1.87
Digester BL solids, lbs/ADT UP	**3297**
Digester BL solids, lbs/ADT BP	3510
BL solids/ADT unbleached O2 pulp	**3413**
Black Liquor Solids, O2 Delig	
Organics, lbs/ADT unbl. pulp	63.5
NaOH, lbs/ADT O2 pulp	54.25
Na2S2O3, lbs/ADT O2 pulp	21.5
Na2SO4, lbs/ADT O2 pulp	2.0
Na2CO3, lbs/ADT O2 pulp	13.8
Inorganics from O2, lbs/ADT	91.6
O2 Solids, lbs/ADT O2 pulp	155.1
Total solids, lbs/ADT O2 pulp	3568
Total solids, lbs/ADT blch pulp	**3707**

Virgin solids to boiler	**237**	**Mlbs/hr DS**
Virgin solids firing rate	**5.68**	**MMlbs/day DS**
Virgin heat input	**1396**	**MMBTU/hr**
Liquor firing rate, gpm @ 5% recycle	**542**	**gpm**

Calculated Variables	
Bleached Yield	97.24%
O2 Delig Yield	96.59%
Digester Yield	45.6%
O2 Delig Production, ADT/D	1591
Digester Production, ADT/D	1648
Wood Usage, ODT/D Chips	3254
WL NaOH, lb/ft3 as NaOH	5.96
WL Na2S, lb/ft3 as Na2S	2.49
WL Na2CO3, lb/ft3 as Na2CO3	1.6
WL Na2SO4, lb/ft3 as Na2SO4	0.238
WL EA, lbs/ft3 as Na2O	5.6
WL CE, %	82.9%
ft3 WL/ADT unbleached pulp	111.2
ft3 OWL/ADT O2 pulp	8.5
OWL NaOH, lb/ft3 as NaOH	6.37
OWL Na2S2O3, lb/ft3	2.52
HHV Estimate, Digester	
Lignin, BTU/lbs BLS	3168
Carbohydrates, BTU/lbs BLS	2209
Extractives, BTU/lbs BLS	194
Na2S, BTU/lbs BLS	466
Total BTU/lbs BLS	**6038**
HHV Estimate, O2 Delig	
Lignin, lbs/ADT O2 pulp	1027
Carbohydrates, lbs/ADT O2 pulp	1186
Lignin, BTU/lbs BLS	3340
Carbohydrates, BTU/lbs BLS	1937
Extractives, BTU/lbs BLS	179
Na2S, BTU/lbs BLS	431
Na2S2O3, BTU/lbs BLS	10.49
Total BTU/lbs BLS (w/ O2 Del)	**5898**

BL solids, based on digester, lbs/ADT	3452
	2839
	2840