Middletown Coke Company
HRSG Maintenance BACT Analysis
Addition of HRSGs

Estimating reagent utilization to remove SO2 from flue gas which would otherwise be vented

# Days of venting	10	days	per HRSG	
# HRSGs	5			
SO2 in flue gas	498.3	lb/hr	per HRSG	
	7.8	lbmol/hr	per HRSG	
Stoich. CaO needed	7.8	lbmol/hr	per HRSG	CaO + SO2 + 1/2 O2 + 2 H2O --> CaSO4.2H2O
Reagent Stoich. Ratio	1.1			
CaO required	8.6	lbmol/hr	per HRSG	
	479.6	lb/hr	per HRSG	
Reagent purity	90%			
Reagent required	532.9	lb/hr	per HRSG	
	64.0	tons	per HRSG	
	319.8	tons		

Estimating solid waste produced by removing additional SO2 during HRSG maintenance

SO2 removal efficiency	92%		
Gypsum produced	7.2	lbmol/hr	
	1232.1	lb/hr	per HRSG
Unreacted CaO in byproduct	1.6	lbmol/hr	per HRSG
	87.2	lb/hr	per HRSG
Reagent impurities in byproduct	53.3	lb/hr	per HRSG
Total solid waste	1372.6	lb/hr	per HRSG
	164.7	tons	per HRSG
	823.6	tons	

Middletown Coke Company
Spray Dryer/Baghouse Maintenance BACT Analysis
Redundant Spray Dryer/Baghouse System

Estimating reagent utilization to remove SO2 from flue gas which would otherwise be vented

# Days of venting	5	days
SO2 in flue gas	2491.7	lb/hr
	38.9	lbmol/hr
Stoich. CaO needed	38.9	lbmol/hr
Reagent Stoich. Ratio	1.1	
CaO required	42.8	lbmol/hr
	2398.2	lb/hr
Reagent purity	90%	
Reagent required	2664.7	lb/hr
	159.9	tons

$CaO + SO_2 + 1/2\ O_2 + 2\ H_2O \rightarrow CaSO_4.2H_2O$

Estimating solid waste produced by removing additional SO2 during SD/BH maintenance

SO2 removal efficiency	92%		
Gypsum produced	35.8	lbmol/hr	
	6160.6	lb/hr	per HRSG
Unreacted CaO in byproduct	7.8	lbmol/hr	per HRSG
	436.0	lb/hr	per HRSG
Reagent impurities in byproduct	266.5	lb/hr	per HRSG
Total solid waste	6863.2	lb/hr	per HRSG
	411.8	tons	per HRSG

Estimating electricity requirement

Primary SD/BH System		
Fan power requirement	4000	HP
Fan motor efficiency	85%	
Electricity consumed	3510.6	kW

Estimating water requirement for the redundant SD/BH system

Total mass flow rate into SD	1,268,868	lb/hr

Flue gas composition			
CO2	10.1%	by weight	
H2O	7.3%	by weight	
SO2	0.2%	by weight	
N2	72.9%	by weight	
O2	9.6%	by weight	
Flue gas inlet temperature	400.0	F	
Flue gas exit temperature	250.0	F	
Specific heats			
CO2	0.24	Btu/lb-degF	(from 250F to 400F)
H2O	0.47	Btu/lb-degF	(from 250F to 400F)
SO2	0.15	Btu/lb-degF	(from 250F to 400F)
N2	0.25	Btu/lb-degF	(from 250F to 400F)
O2	0.23	Btu/lb-degF	(from 250F to 400F)
Sp. Heat of water vapor	0.47	Btu/lb-degF	(from 212F to 250F)
Sp. Heat of liquid water	1.00	Btu/lb-degF	
Heat of vaporization of water	970.3 F	Btu/lb	
Average sp. heat of flue gas	0.26	Btu/lb-degF	(from 250F to 400F)

Enthalpy required		
To cool flue gas from 400F to 250F	49.74	MMBtu/hr
To heat water from 68F to 212F	144	Btu/lb
To vaporize water at 212F	970.3	Btu/lb
To heat water vapor from 212F to 250F	17.9	Btu/lb
Total enthalpy required to heat water from 68F to 250F	1132.2	Btu/lb

Water required		
Total cooling water required	43,933	lb/hr
Total cooling water required	87.8	gpm

Energy Information Administration
Official Energy Statistics from the U.S. Government

Glossary

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Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State

Electric Power Monthly with data for February 2009
Report Released: May 15, 2009
Next Release Date: Mid-June 2009

Table 5.6.B. xls format Electric Power Monthly

Table 5.6.B. Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State, Year-to-Date through February 2009 and 2008
(Cents per kilowatthour)

Census Division and State	Residential		Commercial[1]		Industrial[1]		Transportation[1]		All Sectors	
	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008
New England	**17.95**	**16.54**	**16.38**	**14.64**	**12.34**	**12.63**	**9.65**	**9.89**	**16.11**	**15.03**
Connecticut	19.68	18.29	16.2	15.5	14.23	14.01	13.09	14.13	17.44	16.46
Maine	16.03	15.36	14.13	13.14	12.28	12	--	--	14.47	13.71
Massachusetts	18.05	16.55	18.11	14.97	11.8	12.85	7.84	7.85	16.17	15.18
New Hampshire	16.37	14.81	15.08	13.43	14.37	12.64	--	--	15.54	13.88
Rhode Island	17.39	15.28	14.97	13.43	13.87	12.74	--	--	15.8	14.1
Vermont	14.59	14.06	12.51	12.12	9.57	8.96	--	--	12.66	12.06
Middle Atlantic	**14.2**	**13.8**	**13.12**	**12.86**	**8.61**	**8.35**	**12.78**	**11.24**	**12.8**	**12.36**
New Jersey	15.9	14.24	14.08	13.32	11.73	11.41	NM	13.44	14.56	13.44
New York	17.43	17.52	15	15.01	11.35	11.07	13.92	12.17	15.54	15.44
Pennsylvania	10.92	10.62	9.33	9.07	7.18	6.92	7.2	7.45	9.43	9.04
East North Central	**10.27**	**9.44**	**8.91**	**8.33**	**6.71**	**6.04**	**8.65**	**6.54**	**8.82**	**8**
Illinois	11.07	9.78	8.52	7.97	7.81	7.22	8.45	6.17	9.3	8.45
Indiana	8.77	7.95	8.19	7.21	5.88	5.19	9.59	9.19	7.54	6.61
Michigan	11.07	10.32	9.3	8.96	7.04	6.53	10.81	11.47	9.35	8.68
Ohio	9.5	9.06	9.21	8.81	6.71	5.92	9.85	9.34	8.57	7.9
Wisconsin	12.11	10.89	9.66	8.66	6.77	6.08	--	--	9.63	8.53
West North Central	**8.11**	**7.55**	**6.79**	**6.4**	**5.43**	**4.87**	**5.75**	**6.13**	**7**	**6.44**
Iowa	9.04	8.43	6.88	6.45	4.96	4.23	--	--	6.95	6.23
Kansas	8.7	7.67	7.62	6.6	6.05	5.1	--	--	7.66	6.61
Minnesota	9.66	9.1	7.57	7.39	6.07	5.76	7.64	8.52	7.92	7.46
Missouri	7.14	6.66	5.91	5.65	4.89	4.31	4.29	4.27	6.34	5.85
Nebraska	7.2	6.58	6.7	6.05	5.06	4.51	--	--	6.45	5.84
North Dakota	6.72	6.77	6.35	6.57	5.48	5.31	--	--	6.3	6.33
South Dakota	7.68	7.48	6.67	6.51	5.58	5.14	--	--	6.97	6.72
South Atlantic	**10.95**	**9.78**	**9.81**	**8.76**	**6.72**	**5.78**	**10.53**	**10.31**	**9.86**	**8.68**
Delaware	13.22	12.58	11.97	11.23	9.96	9.7	--	--	12.1	11.44
District of Columbia	12.82	10.69	13.85	13.15	10.97	10.86	12.4	12.24	13.55	12.61
Florida	12.52	11.07	11.17	9.73	9.6	7.77	10.56	9.71	11.75	10.23
Georgia	9.55	8.79	9.12	8.56	6.28	5.83	6.64	6.36	8.71	8
Maryland	14.57	12.85	12.36	11.71	10.69	10.09	11.72	11.97	13.32	12.13
North Carolina	9.66	9.01	7.93	7.28	5.73	5.23	6.71	7.81	8.43	7.7
South Carolina	9.95	9.18	8.67	7.94	5.73	4.91	--	--	8.28	7.33
Virginia	10.09	8.36	8.26	6.51	7.07	5.27	8.33	6.95	8.97	7.16
West Virginia	7.51	6.59	6.58	5.82	4.89	4.04	7.64	7.53	6.43	5.45
East South Central	**9.39**	**8.16**	**9.43**	**8.18**	**5.99**	**4.95**	**12.24**	**8.55**	**8.24**	**6.94**
Alabama	10.34	9.2	10.32	9.04	6.21	5.26	--	--	8.93	7.64
Kentucky	8.14	7.16	7.6	6.69	4.91	4.2	--	--	6.57	5.64
Mississippi	9.73	9.05	9.82	9.21	6.96	5.75	--	--	8.9	7.97
Tennessee	9.44	7.74	9.86	8.12	6.99	5.33	12.24	8.55	8.93	7.12
West South Central	**11.4**	**10.29**	**9.67**	**9.19**	**7.23**	**7.11**	**9.81**	**8.75**	**9.68**	**8.99**
Arkansas	9.12	8.21	7.88	6.88	6.12	5.19	--	--	7.9	6.83
Louisiana	8.97	8.66	9.13	8.87	6.54	6.44	11.17	11.05	8.22	7.94

Oklahoma	8.47	7.74	7.31	7.04	5.33	5.17	--	--	7.3	6.82
Texas	12.88	11.48	10.32	9.85	7.92	7.98	9.65	8.59	10.68	9.94
Mountain	**9.29**	**8.83**	**7.84**	**7.62**	**5.53**	**5.51**	**7.66**	**7.32**	**7.7**	**7.45**
Arizona	9.65	8.92	8.48	8.08	5.97	5.98	--	--	8.55	8.08
Colorado	9.36	9.1	7.21	7.48	5.86	5.71	7.21	6.99	7.68	7.67
Idaho	7.13	6.39	6.01	5.17	4.27	3.64	--	--	6.06	5.3
Montana	8.48	8.55	8.14	8.16	5.44	5.69	--	--	7.26	7.25
Nevada	12.35	12.05	10.28	10.27	7.06	7.61	8.74	9.48	9.68	9.83
New Mexico	9.75	9	8.42	7.91	5.94	5.98	--	--	8.16	7.71
Utah	8.04	7.78	6.4	6.17	4.29	4.19	8.02	7.33	6.24	6.02
Wyoming	7.88	7.42	6.89	6.27	4.52	4.1	--	--	5.82	5.38
Pacific Contiguous	**11.58**	**11.35**	**10.69**	**10.01**	**7.44**	**7.43**	**8.09**	**7.85**	**10.42**	**10.05**
California	14.7	14.19	12.1	11.23	9.28	9.34	8.14	7.88	12.54	11.98
Oregon	8.51	8.48	8.28	7.89	4.73	4.68	6.62	6.74	7.63	7.46
Washington	7.66	7.5	7.11	6.75	5.24	5.26	5.85	5.8	6.98	6.76
Pacific Noncontiguous	**21.02**	**22.66**	**18.23**	**19.54**	**16.76**	**20.39**	**--**	**--**	**18.77**	**20.84**
Alaska	17.09	15.19	14.16	12.23	12.3	14.27	--	--	14.94	13.74
Hawaii	24.73	29.21	22.39	26.63	18.49	22.81	--	--	21.71	26.05
U.S. Total	**11.12**	**10.26**	**10.09**	**9.43**	**6.94**	**6.38**	**11.23**	**10.04**	**9.79**	**8.99**

[1] See Technical notes for additional information on the Commercial, Industrial, and Transportation sectors.

Notes: See Glossary for definitions. Values for 2007 are final. Values for 2008 and 2009 are preliminary estimates based on a cutoff model sample. See Technical Notes for a discussion of the sample design for the Form EIA-826. Utilities and energy service providers may classify commercial and industrial customers based on either NAICS codes or demands or usage falling within specified limits by rate schedule. Changes from year to year in consumer counts, sales and revenues, particularly involving the commercial and industrial consumer sectors, may result from respondent implementation of changes in the definitions of consumers, and reclassifications. Retail sales and net generation may not correspond exactly for a particular month for a variety of reasons (i.e., sales data may include imported electricity). Net generation is for the calendar month while retail sales and associated revenue accumulate from bills collected for periods of time (28 to 35 days) that vary dependent upon customer class and consumption occurring in and outside the calendar month. Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration, Form EIA-826, "Monthly Electric Sales and Revenue Report with State Distributions Report."

More Tables on the Average Retail Price of Electricity	**Formats**		
Table ES. Summary Statistics for the United States	html	pdf	xls
Table 5.3. Average Retail Price of Electricity to Ultimate Customers: Total by End-Use Sector	html		xls
Table 5.6.A. Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State	html		xls
Table ES1.A. Total Electric Power Industry Summary Statistics,	html		xls
Table ES1.B. Total Electric Power Industry Summary Statistics,Year-to-Date	html		xls
Average Price by State by Provider (EIA-861)			xls
Current and Historical Monthly Retail Sales, Revenues and Average Revenue per Kilowatthour by State and by Sector (Form EIA-826)			xls
Form EIA-861 Database			DBF
Table 7.4. Average Retail Price of Electricity to Ultimate Customers by End-Use Sector	html	pdf	xls
"Electric Sales, Revenue and Average Price"	html		

see also:
Electric Power Monthly
Electric Power Annual
annual electricity statistics back to 1949
projected electricity capacity to 2030
international electricity statistics

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LIME[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2008, 19.8 million tons (21.8 million short tons) of quicklime and hydrate was produced (excluding commercial hydrators) at a value of about $1.8 billion. At yearend, there were 32 companies producing lime, which included 22 companies with commercial sales and 10 companies that produced lime strictly for internal use (for example, sugar companies). These companies had 81 primary lime plants (plants operating lime kilns) in 30 States and Puerto Rico. The 4 leading U.S. lime companies produced quicklime or hydrate in 24 States from 36 lime plants and 12 separate hydrating plants. Combined, these plants accounted for about 70% of U.S. lime production. Principal producing States, each with production of more than 1 million tons, were Alabama, Kentucky, Missouri, Nevada, Ohio, Pennsylvania, and Texas. Major markets for lime were, in descending order of consumption, steelmaking, flue gas desulfurization (fgd), construction, water treatment, mining, precipitated calcium carbonate, and pulp and paper.

Salient Statistics—United States:	2004	2005	2006	2007	2008[e]	2009
Production[2]	20,000	20,000	21,000	20,200	19,800	
Imports for consumption	232	310	298	375	325	
Exports	100	133	116	144	175	
Consumption, apparent	20,100	20,200	21,200	20,400	20,000	
Quicklime average value, dollars per ton at plant	64.80	72.10	78.10	84.60	89.20	94.2
Hydrate average value, dollars per ton at plant	89.80	91.10	98.30	102.40	106.30	
Stocks, yearend	NA	NA	NA	NA	NA	
Employment, mine and plant, number	5,350	5,300	5,300	5,300	5,400	
Net import reliance[3] as a percentage of apparent consumption	1	1	1	1	1	

Recycling: Large quantities of lime are regenerated by paper mills. Some municipal water-treatment plants regenerate lime from softening sludge. Quicklime is regenerated from waste hydrated lime in the carbide industry. Data for these sources were not included as production in order to avoid duplication.

Import Sources (2004-07): Canada, 80%; Mexico, 19%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-08
Calcined dolomite	2518.20.0000	3% ad. val.
Quicklime	2522.10.0000	Free.
Slaked lime	2522.20.0000	Free.
Hydraulic lime	2522.30.0000	Free.

Depletion Allowance: Limestone produced and used for lime production, 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: In 2008, lime sales were steady through most of the year, but suffered a downturn when the economy slowed in the second half of the year and especially when steel production decreased in the fourth quarter. Prices continued to increase, with quicklime prices increasing about $5 per metric ton and hydrate prices increasing about $4 per ton. These price increases do not include the fuel surcharges applied by many of the companies. In some cases, these surcharges were calculated based on the price per barrel of crude oil. With the dramatic decrease in oil prices, these surcharges would have been reduced or eliminated in the latter part of the year. Evidence of future price increases was indicated by one major lime supplier announcing across-the-board price increases of $30 per short ton (where contracts allowed) effective January 1, 2009.

In February, Carmeuse North America (Pittsburgh, PA) and Oglebay Norton Co. (Cleveland, OH) finalized the agreement under which Carmeuse acquired Oglebay Norton. The new combined company was renamed Carmeuse Lime and Stone. The acquisition will allow Carmeuse to expand into the limestone reagent fgd market, and to diversify into filler materials and industrial sands.[4]

Prepared by **M. Michael Miller [(703) 648-7716, mmiller1@usgs.gov, fax: (703) 648-7757]**

Heat Exchanges and Tanks		370.6	2000
Process Machinery		439.4	2000
Pipe, valves and fittings		545.9	2000
Process Instruments		368.5	2000
Pumps and Compressions		665.3	2000
Electrical equipment		339.4	2000
Structural supports		408.7	2000
Construction Labor		299.2	2000
Buildings		385.6	2000
Engineering Supervision		340.6	2000
	2001		
CE INDEX		394.3	2001
Equipment		437.3	2001
Heat Exchanges and Tanks		363.9	2001
Process Machinery		439.5	2001
Pipe, valves and fittings		548.1	2001
Process Instruments		362.9	2001
Pumps and Compressions		683.2	2001
Electrical equipment		341.2	2001
Structural supports		413.9	2001
Construction Labor		302.3	2001
Buildings		385.6	2001
Engineering Supervision		341.5	2001
	2002		
CE INDEX		395.6	2002
Equipment		437.5	2002
Heat Exchanges and Tanks		356.9	2002
Process Machinery		444.2	2002
Pipe, valves and fittings		555.8	2002
Process Instruments		363.5	2002
Pumps and Compressions		699.2	2002
Electrical equipment		341.4	2002
Structural supports		415.4	2002
Construction Labor		305.8	2002
Buildings		390.4	2002
Engineering Supervision		345.3	2002
	2003		
CE INDEX		402	2003
Equipment		445.1	2003
Heat Exchanges and Tanks		363.6	2003
Process Machinery		450.3	2003
Pipe, valves and fittings		570.7	2003
Process Instruments		363.4	2003
Pumps and Compressions		705.4	2003
Electrical equipment		341.6	2003
Structural supports		428.6	2003
Construction Labor		309.3	2003
Buildings		400.6	2003
Engineering Supervision		347.3	2003
	2004		
CE INDEX		444.237	2004
Equipment		508.111	2004
Heat Exchanges and Tanks		464.826	2004

← Notes 5, 6 & 7 on the Additional HRSGs Option.

12/2/2008	December	Buildings	503.7
12/2/2008	December	Engineering Supervision	349.9
2009			
1/2/2009	January	CE INDEX	539.6
1/2/2009	January	Equipment	642.4
1/2/2009	January	Heat Exchanges and Tanks	603.4
1/2/2009	January	Process Machinery	620
1/2/2009	January	Pipe, valves and fittings	781.8
1/2/2009	January	Process Instruments	389.6
1/2/2009	January	Pumps and Compressions	902.1
1/2/2009	January	Electrical equipment	457.9
1/2/2009	January	Structural supports	671.5
1/2/2009	January	Construction Labor	324.5
1/2/2009	January	Buildings	500
1/2/2009	January	Engineering Supervision	350.3
2/2/2009	February	CE INDEX	532.3
2/2/2009	February	Equipment	631.9
2/2/2009	February	Heat Exchanges and Tanks	587
2/2/2009	February	Process Machinery	615.2
2/2/2009	February	Pipe, valves and fittings	770.6
2/2/2009	February	Process Instruments	384.6
2/2/2009	February	Pumps and Compressions	897
2/2/2009	February	Electrical equipment	458.7
2/2/2009	February	Structural supports	660.9
2/2/2009	February	Construction Labor	323.7
2/2/2009	February	Buildings	495.5
2/2/2009	February	Engineering Supervision	349.8
3/2/2009	March	CE INDEX	0
3/2/2009	March	Equipment	0
3/2/2009	March	Heat Exchanges and Tanks	0
3/2/2009	March	Process Machinery	0
3/2/2009	March	Pipe, valves and fittings	0
3/2/2009	March	Process Instruments	0
3/2/2009	March	Pumps and Compressions	0
3/2/2009	March	Electrical equipment	0
3/2/2009	March	Structural supports	0
3/2/2009	March	Construction Labor	0
3/2/2009	March	Buildings	0
3/2/2009	March	Engineering Supervision	0

← Notes 5, 6 & 7 on the Additional HRSGs Option.

12/16/08 Richard Westbrook
+ Boris + Chris + Chandra

Shipping of waste + landfilled

$ Additional HRSGs
Use 3 more & Total 3 HRSGs extra
3 extra stacks + lids
Add $
1500', add $ 1000/ft for common tunnel
Operating - ?

HRSG outage event cost - (will send)
HP 4000 HP for main fan

Unit cost for waste disposal (will send)

Labor rate $30/hour
Contingency 15% (at least)

15-year life / payback