



TABLE 6-28. CAPITAL AND ANNUAL COSTS OF COLLECTION AND INCINERATION OF BLO VENT GASES FOR MODEL BLACK LIQUOR OXIDATION UNITS^a

Costs	Model BLO units		
	BLO-1	BLO-2	BLO-3
Total Capital Investment (TCI) (b)	2,500,000	3,390,000	4,830,000
Direct Annual Costs (DAC)			
Operating labor (c)			
Operator	\$18,600	\$18,600	\$18,600
Supervisor	\$2,790	\$2,790	\$2,790
Maintenance (d)			
Labor	\$27,400	\$27,400	\$27,400
Material	\$27,400	\$27,400	\$27,400
Electricity (e)	\$103,000	\$209,000	\$312,000
Steam (f)	\$22,000	\$44,600	\$66,600
Total DAC	\$179,000	\$285,000	\$388,000
Indirect Annual Costs (IAC)			
Overhead (g)	\$45,700	\$45,700	\$45,700
Administrative, taxes and insurance (h)	\$100,000	\$136,000	\$193,000
Capital recovery (i)	\$356,000	\$483,000	\$688,000
Total IAC	\$502,000	\$665,000	\$927,000
Total Annual Costs	\$681,000	\$950,000	\$1,320,000

- (a) All costs in \$1991.
- (b) $TCI = \$4,800,000 \times [(model\ BLS\ rate)/(800\ ADTP/d \times 3,400\ lb\ BLS/ADTP)]^{0.6} \times (361.3\ \$1991/357.6\ \$1990)$
- (c) Operating labor = 0.5 hr/shift/condenser x 3 shifts/d x 2 condensers x 365 d/yr x \$17/hr
 Supervisor labor = 15% of operator labor
- (d) Maintenance labor = 0.5 hr/shift/condenser x 3 shifts/d x 2 condensers x 365 d/yr x \$25/hr
 Maintenance materials = 100 percent of maintenance labor
- (e) Electricity costs = Mill A electricity costs x (model vent gas flowrate/Mill A vent gas flowrate)
 Mill A electricity costs = (100 hp + 3 hp + 400 hp) x 0.746 kW/hp x 8,424 hr/yr x \$0.06/kWh
 The Mill A electricity costs are based on 100 hp to operate the mill water booster pump motor, 3 hp to operate the BLO condenser condensate pump motor, and 400 hp to operate the BLO off gas blower motor.
 The Mill A vent gas flowrate = 16,327 acfm
- (f) Steam cost = Mill A steam cost x (model vent gas flowrate/Mill A vent gas flowrate)
 Mill A steam cost = 1,600 lb steam/hr x 8,424 hr/yr x \$3/1,000 lb steam
 The Mill A steam cost is based on steam requirements of 1,600 lb steam/hr for the BLO off gas reheater.
 The Mill A vent gas flowrate = 16,327 acfm
- (g) Overhead = 0.6 x (labor + maintenance)
- (h) Administrative, taxes, and insurance = 0.04 x TCI
- (i) Capital recovery = 0.1424 x TCI, based on 7% interest and 10-yr equip. life for ductwork and condenser.

TABLE 6-29a (METRIC) . SCRUBBER REPLACEMENT COSTS FOR MODEL SDT'S^a

Model SDT	Pulp type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Baseline APCD	Control Option APCD	Gas flowrate--APCD inlet, m ³ /sec	TCI, \$	A, I & T, \$/yr	Capital recovery, \$/yr	ITAC, \$/yr
SDT-1	BI	400,000	230	scrubber	scrubber	4.4	\$292,000	\$11,700	\$32,100	\$43,800
SDT-2	BI	700,000	380	scrubber	scrubber	7.4	\$398,000	\$15,900	\$43,700	\$59,600
SDT-3	BI	1,200,000	680	scrubber	scrubber	13.4	\$566,000	\$22,600	\$62,100	\$84,700
SDT-4	BI	1,800,000	1,000	scrubber	scrubber	19.3	\$706,000	\$28,200	\$77,500	\$106,000
SDT-1	Unbl	400,000	270	scrubber	scrubber	4.4	\$292,000	\$11,700	\$32,100	\$43,800
SDT-2	Unbl	700,000	450	scrubber	scrubber	7.4	\$398,000	\$15,900	\$43,700	\$59,600
SDT-3	Unbl	1,200,000	820	scrubber	scrubber	13.4	\$566,000	\$22,600	\$62,100	\$84,700
SDT-4	Unbl	1,800,000	1,200	scrubber	scrubber	19.3	\$706,000	\$28,200	\$77,500	\$106,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-29b. Refer to Table 6-29b for footnotes, which include calculations.

TABLE 6 - 29b (ENGLISH) . SCRUBBER REPLACEMENT COSTS FOR MODEL SDT'S^a

Model SDT	Pulp type	Black liquor firing rate, lb BLS/d	Equivalent ADTP/d	Baseline APCD	Control Option APCD	Gas flowrate-- APCD inlet, acfm	TCI, \$ (b)	A, I & T, \$/yr (c)	Capital recovery, \$/yr (d)	ITAC, \$/yr (e)
SDT-1	BI	900,000	250	scrubber	scrubber	9,400	\$292,000	\$11,700	\$32,100	\$43,800
SDT-2	BI	1,500,000	420	scrubber	scrubber	15,700	\$398,000	\$15,900	\$43,700	\$59,600
SDT-3	BI	2,700,000	750	scrubber	scrubber	28,300	\$566,000	\$22,600	\$62,100	\$84,700
SDT-4	BI	3,900,000	1,100	scrubber	scrubber	40,900	\$706,000	\$28,200	\$77,500	\$106,000
SDT-1	Unbl	900,000	300	scrubber	scrubber	9,400	\$292,000	\$11,700	\$32,100	\$43,800
SDT-2	Unbl	1,500,000	500	scrubber	scrubber	15,700	\$398,000	\$15,900	\$43,700	\$59,600
SDT-3	Unbl	2,700,000	900	scrubber	scrubber	28,300	\$566,000	\$22,600	\$62,100	\$84,700
SDT-4	Unbl	3,900,000	1,300	scrubber	scrubber	40,900	\$706,000	\$28,200	\$77,500	\$106,000

(a) All costs in \$1991

(b) $TCI = (\$280,000 \times [361.3 \times \$1991/342.5 \times \$1988] + \$50,000) \times (\text{model inlet gas flowrate}/[8,071 \text{ acfm}/0.65])^{0.6}$

(c) Administrative, insurance, and taxes (A, I & T) = $0.04 \times TCI$

(d) Capital recovery = $0.1098 \times TCI$ (based on 15-yr scrubber life and 7% interest)

(e) Incremental total annual cost (ITAC) = A, I & T + capital recovery

TABLE 6-30a (METRIC). MODEL SDT/SCRUBBER DESIGN PARAMETERS^a

Design parameters	Model SDT's		
	SDT-5	SDT-6	SDT-7
Baseline APCD:	mist eliminator	mist eliminator	mist eliminator
Control option APCD:	scrubber	scrubber	scrubber
Black liquor firing rate, kg BLS/d:	400,000	700,000	1,200,000
Equivalent ADMP/d:			
Bleached pulp	230	380	680
Unbleached pulp	270	450	820
Gas flowrate--APCD inlet (Q), m ³ /sec:	4.4	7.4	13.4
Existing pressure drop, mm Hg:	1.3	1.3	1.3
New pressure drop, mm Hg:	13	13	13
Operating days per year:			
Equipment	351	351	351
Labor	365	365	365
Operating hours per year:			
Equipment	8,424	8,424	8,424
Labor	8,760	8,760	8,760

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-30b.

TABLE 6-30b (ENGLISH). MODEL SDT/SCRUBBER DESIGN PARAMETERS

Design parameters	Model SDT's		
	SDT-5	SDT-6	SDT-7
Baseline APCD:	mist eliminator	mist eliminator	mist eliminator
Control option APCD:	scrubber	scrubber	scrubber
Black liquor firing rate, lb BLS/d:	900,000	1,500,000	2,700,000
Equivalent ADTP/d:			
Bleached pulp	250	420	750
Unbleached pulp	300	500	900
Gas flow rate--APCD inlet, acfm:	9,400	15,700	28,300
Existing pressure drop, in. H2O:	0.7	0.7	0.7
New pressure drop, in. H2O:	7	7	7
Operating days per year:			
Equipment	351	351	351
Labor	365	365	365
Operating hours per year:			
Equipment	8,424	8,424	8,424
Labor	8,760	8,760	8,760

TABLE 6-31. CAPITAL AND ANNUAL COSTS TO REPLACE MIST ELIMINATORS WITH SCRUBBERS FOR MODEL SDT'S^a

Costs	Model SDT's		
	SDT-5	SDT-6	SDT-7
Total Capital Investment (TCI) (b):	\$584,000	\$796,000	\$1,130,000
Direct Annual Costs (DAC):			
Operating labor (c):			
Operator	\$37,200	\$37,200	\$37,200
Supervisor	\$5,580	\$5,580	\$5,580
Maintenance (d):			
Labor	\$27,400	\$27,400	\$27,400
Material	\$27,400	\$27,400	\$27,400
Utilities (e):			
Electricity	\$5,420	\$9,050	\$16,300
Water	\$9,500	\$15,900	\$28,600
Wastewater treatment (f):	\$0	\$0	\$0
Total DAC:	\$113,000	\$123,000	\$142,000
Indirect Annual Costs (IAC):			
Overhead (g):	\$32,900	\$32,900	\$32,900
Admin., taxes and insurance (h):	\$23,400	\$31,800	\$45,200
Capital recovery (i):	\$64,100	\$87,400	\$124,000
Total IAC:	\$120,000	\$152,000	\$202,000
Total Annual Costs (TAC):	\$233,000	\$275,000	\$344,000
Incremental Total Annual Costs (ITAC) (j):	\$190,000	\$232,000	\$301,000

- (a) All costs in \$1991
 (b) New scrubber TCI (models 5-7) = [scrubber replacement TCI (models 1-3)] x 2
 (c) Operator labor = 6 hr/d x 365 d/yr x \$17/hr
 Supervisor labor = 15% of operator labor
 (d) Maintenance labor = 3 hr/d x 365 d/yr x \$25/hr
 Maintenance materials = 100% of maintenance labor
 (e) Electricity = 0.000181 x inlet gas flowrate x (7 - 0.7 in. H₂O) x 8,424 hr/yr x \$0.06/kWh
 Water = 0.6 x inlet gas flowrate x 8,424 hr/yr x \$0.20/1,000 gal
 (f) Recycled to SDT
 (g) Overhead = 0.6 x maintenance
 (h) Administrative, taxes, and insurance = 0.04 x TCI
 (i) Capital recovery = 0.1098 x TCI (based on 15-yr scrubber life and 7% interest)
 (j) ITAC = TAC - operating labor costs.

TABLE 6-32a (METRIC). COSTS TO REPLACE SCRUBBERS WITH ESP'S TO CONTROL PM TO 0.15 G/DSCM FOR MODEL LIME KILNS^a

Model lime kilns	Lime rate, Mg/d	Equivalent ADMP/d	Baseline APCD	Control option APCD	Gas flowrate--ESP exit, m ³ /sec @8% O ₂	ESP plate area, m ²	SCA, m ² /(m ³ /sec)	TCI, \$	A, I & T, \$/yr	Capital recovery, \$/yr	DAC & overhead cost savings, \$/yr	ITAC, \$/yr
LK-1	90	320	scrubber	ESP	10	909	91	\$457,000	\$18,300	\$50,200	(\$172,000)	(\$104,000)
LK-2	180	680	scrubber	ESP	20	1,818	91	\$883,000	\$35,300	\$97,000	(\$215,000)	(\$82,700)
LK-3	270	1,000	scrubber	ESP	34	3,090	91	\$1,500,000	\$60,000	\$165,000	(\$278,000)	(\$53,000)

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-32b. Refer to Table 6-32b for footnotes, which include calculations. Numbers in parentheses represent cost savings.

TABLE 6-32b (ENGLISH). COSTS TO REPLACE SCRUBBERS WITH ESP'S TO CONTROL PM TO 0.067 GR/DSCF FOR MODEL LIME KILNS^a

Model lime kilns	Lime rate, ton/d	Equivalent ADTP/d	Baseline APCD	Control option APCD	Gas flowrate-- ESP exit, acfm @8% O ₂	ESP plate area, ft ² (b)	SCA, ft ² /1,000 acfm	TCI, \$ (c)	A, I & T, \$/yr (d)	Capital recovery, \$/yr (e)	DAC & overhead cost savings, \$/yr (f)	ITAC, \$/yr (g)
LK-1	100	350	scrubber	ESP	22,000	10,157	462	\$457,000	\$18,300	\$50,200	(\$172,000)	(\$104,000)
LK-2	200	750	scrubber	ESP	42,500	19,621	462	\$883,000	\$35,300	\$97,000	(\$215,000)	(\$82,700)
LK-3	300	1,100	scrubber	ESP	72,200	33,332	462	\$1,500,000	\$60,000	\$165,000	(\$278,000)	(\$53,000)

(a) All costs in \$1991. Numbers in parentheses represent cost savings.

(b) ESP plate area = model gas flowrate x SCA/1,000 acfm

(c) TCI = ESP plate area x \$45/ft² plate area

(d) Administrative, insurance, and taxes (A, I & T) = 0.04 x TCI

(e) Capital recovery = 0.1098 CRF x TCI (based on 15-yr ESP life and 7% interest)

(f) Direct annual cost (DAC) and overhead cost savings = (ESP DAC + ESP overhead costs) - (scrubber DAC + scrubber overhead costs)

(g) Incremental total annual cost (ITAC) = DAC and overhead cost savings + A, I & T + capital recovery

TABLE 6-33a (METRIC). COSTS TO REPLACE SCRUBBERS WITH ESP'S TO CONTROL PM TO 0.023 G/DSCM FOR MODEL LIME KILNS^a

Model lime kilns	Lime rate, Mg/d	Equivalent ADMP/d	Baseline APCD	Control option APCD	Gas flowrate-- ESP exit, m3/sec @8% O2	ESP plate area, m2	SCA, m2/(m3/sec)	TCI, \$	A, I & T, \$/yr	Capital recovery, \$/yr	DAC & overhead cost savings, \$/yr	ITAC, \$/yr
LK-1	90	320	scrubber	ESP	10	2,210	221	\$1,110,000	\$44,400	\$122,000	(\$149,000)	\$17,400
LK-2	180	680	scrubber	ESP	20	4,420	221	\$2,150,000	\$86,000	\$236,000	(\$172,000)	\$150,000
LK-3	270	1,000	scrubber	ESP	34	7,514	221	\$3,650,000	\$146,000	\$401,000	(\$205,000)	\$342,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-33b.

TABLE 6-33b (ENGLISH). COSTS TO REPLACE SCRUBBERS WITH ESP'S TO CONTROL PM TO 0.010 GR/DSCF FOR MODEL LIME KILNS^a

Model lime kilns	Lime rate, ton/d	Equivalent ADTP/d	Baseline APCD	Control option APCD	Gas flowrate-- ESP exit, acfm @8% O ₂	ESP plate area, ft ² (b)	SCA, ft ² /1,000 acfm	TCI, \$ (c)	A, I & T, \$/yr (d)	Capital recovery, \$/yr (e)	DAC & overhead cost savings, \$/yr (f)	ITAC, \$/yr (g)
LK-1	100	350	scrubber	ESP	22,000	24,699	1,123	\$1,110,000	\$44,400	\$122,000	(\$149,000)	\$17,400
LK-2	200	750	scrubber	ESP	42,500	47,714	1,123	\$2,150,000	\$86,000	\$236,000	(\$172,000)	\$150,000
LK-3	300	1,100	scrubber	ESP	72,200	81,058	1,123	\$3,650,000	\$146,000	\$401,000	(\$205,000)	\$342,000

(a) All costs in \$1991

(b) ESP plate area = model gas flowrate x SCA/1,000 acfm

(c) TCI = ESP plate area x (\$45/ft² plate area)

(d) Administrative, insurance, and taxes (A, I & T) = 0.04 x TCI

(e) Capital recovery = 0.1098 CRF x TCI (based on 15-yr ESP life and 7% interest)

(f) Direct annual cost (DAC) and overhead cost savings = (ESP DAC + ESP overhead costs) - (scrubber DAC + scrubber overhead costs)

(g) Incremental total annual cost (ITAC) = DAC and overhead cost savings + A, I & T + capital recovery

TABLE 6-34a (METRIC). MODEL LIME KILN/SCRUBBER DESIGN PARAMETERS^a

Design parameters	Model Lime Kilns		
	LK-1	LK-2	LK-3
Baseline APCD	scrubber	scrubber	scrubber
Lime production rate, Mg CaO/d	90	180	270
Equivalent ADMP/d	320	680	1,000
Gas flowrate--APCD inlet, m3/sec	10	20	34
Pressure drop, mm Hg	39	39	39
Operating days per year			
Equipment	351	351	351
Labor	365	365	365
Operating hours per year			
Equipment	8,424	8,424	8,424
Labor	8,760	8,760	8,760

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-34b.

TABLE 6-34b (ENGLISH). MODEL LIME KILN/SCRUBBER DESIGN PARAMETERS

Design parameters	Model Lime Kilns		
	LK-1	LK-2	LK-3
Baseline APCD	scrubber	scrubber	scrubber
Lime production rate, ton CaO/d	100	200	300
Equivalent ADTP/d	350	750	1,100
Gas flowrate--APCD inlet, acfm	22,000	42,500	72,200
Pressure drop, in. H ₂ O	21	21	21
Operating days per year			
Equipment	351	351	351
Labor	365	365	365
Operating hours per year			
Equipment	8,424	8,424	8,424
Labor	8,760	8,760	8,760

TABLE 6-35. ANNUAL COSTS FOR EXISTING LIME KILN SCRUBBERS^a

Costs	Model Lime Kilns		
	LK-1	LK-2	LK-3
Direct Annual Costs (DAC)			
Operating labor (b)			
Operator	\$37,200	\$37,200	\$37,200
Supervisor	\$5,580	\$5,580	\$5,580
Maintenance (c)			
Labor	\$27,400	\$27,400	\$27,400
Material	\$27,400	\$27,400	\$27,400
Utilities (d)			
Electricity	\$42,000	\$81,200	\$138,000
Water	\$22,200	\$43,000	\$73,000
Wastewater treatment (e)	\$0	\$0	\$0
Total DAC	\$162,000	\$222,000	\$309,000
Indirect Annual Costs (IAC)			
Overhead (f)	\$58,500	\$58,500	\$58,500
Total Annual Costs	\$221,000	\$281,000	\$368,000

- (a) All costs in \$1991
- (b) Operator labor = 6 hr/d x 365 d/yr x \$17/hr
Supervisor labor = 15% of operator labor
- (c) Maintenance labor = 3 hr/d x 365 d/yr x \$25/hr
Maintenance materials = 100% of maintenance labor
- (d) Electricity = 0.00018 x model inlet gas flowrate x pressure drop x 8,424 hr/yr x \$0.06/kWh
Water = 0.06 x model inlet gas flowrate x 8,424 hr/yr x \$0.20/1,000 gal
- (e) Recycled to mud washer
- (f) Overhead = 0.6 x (labor + maintenance)

TABLE 6-36a (METRIC). MODEL LIME KILN/ESP DESIGN PARAMETERS^a

Design parameters	Model Lime Kilns		
	LK-1	LK-2	LK-3
Control option APCD	ESP	ESP	ESP
Lime production rate, Mg CaO/d	90	180	270
Equivalent ADMP/d	320	680	1,000
Gas flowrate--ESP exit, m3/sec	10	20	34
ESP plate area, m2			
PM controls--0.15 g/dscm	909	1,818	3,090
PM controls--0.023 g/dscm	2,210	4,420	7,514
SCA, m2/(m3/sec)			
PM controls--0.15 g/dscm	91	91	91
PM controls--0.023 g/dscm	221	221	221
Pressure drop, mm Hg	2	2	2
Operating days per year			
Equipment	351	351	351
Labor	365	365	365
Operating hours per year			
Equipment	8,424	8,424	8,424
Labor	8,760	8,760	8,760

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-36b.

TABLE 6-36b (ENGLISH). MODEL LIME KILN/ESP DESIGN PARAMETERS

Design parameters	Model Lime Kilns		
	LK-1	LK-2	LK-3
Control option APCD	ESP	ESP	ESP
Lime production rate, ton CaO/d	100	200	300
Equivalent ADTP/d	350	750	1,100
Gas flowrate--ESP exit, acfm	22,000	42,500	72,200
ESP plate area (A), ft ²			
PM controls--0.067 gr/dscf	10,157	19,621	33,332
PM controls--0.01 gr/dscf	24,699	47,714	81,058
SCA, ft ² /1,000 acfm			
PM controls--0.067 gr/dscf	462	462	462
PM controls--0.01 gr/dscf	1,123	1,123	1,123
Pressure drop, in. H ₂ O	1	1	1
Operating days per year			
Equipment	351	351	351
Labor	365	365	365
Operating hours per year			
Equipment	8,424	8,424	8,424
Labor	8,760	8,760	8,760

TABLE 6-37. ANNUAL COSTS FOR NEW LIME KILN ESP'S CONTROLLING PM TO 0.15 G/DSCM (0.067 GR/DSCF)^a

Costs	Model Lime Kilns		
	LK-1	LK-2	LK-3
Total Capital Investment (TCI) (b):	\$457,000	\$883,000	\$1,500,000
Direct Annual Costs (DAC):			
Operating labor (c):			
Operator	\$13,100	\$13,100	\$13,100
Supervisor	\$1,970	\$1,970	\$1,970
Coordinator	\$4,320	\$4,320	\$4,320
Maintenance (d):			
Labor	\$838	\$1,620	\$2,750
Material	\$2,740	\$5,300	\$9,000
Electricity (e):			
Electricity-fan	\$2,000	\$3,870	\$6,570
Electricity-operating	\$10,000	\$19,200	\$32,700
Waste disposal:	\$0	\$0	\$0
Total DAC:	\$35,000	\$49,400	\$70,400
Indirect Annual Costs (IAC):			
Overhead (f):	\$13,800	\$15,800	\$18,700
Admin., taxes and insurance (g):	\$18,300	\$35,300	\$60,000
Capital recovery (h):	\$50,200	\$97,000	\$165,000
Total IAC:	\$82,300	\$148,000	\$244,000
Total Annual Costs:	\$117,000	\$197,000	\$314,000

- (a) All costs in \$1991
(b) TCI = ESP plate area x \$45/ft² plate area
(c) Operator labor = 3 hr/day x 365 d/yr x \$12/hr
Supervisor labor = 15% of operator labor
Coordinator labor = 33% of operator labor
(d) Maintenance labor = 0.0825 x ESP plate area
Maintenance material = 0.01 x (0.6 x TCI)
(e) Electricity-fan = 0.00018 x model gas flowrate x pressure drop x 8,424 hr/yr x \$0.06/kWh
Electricity-operating = 0.00194 x ESP plate area x 8,424 hr/yr x \$0.06/kWh
(f) Overhead = 0.6 x (labor + maintenance)
(g) Administrative, taxes, and insurance = 0.04 x TCI
(h) Capital recovery = 0.1098 x TCI (based on 15-yr ESP life and 7% interest)

TABLE 6-38. ANNUAL COSTS FOR NEW LIME KILN ESP'S CONTROLLING PM TO 0.023 G/DSCM (0.010 GR/DSCF)^a

Costs	Model Lime Kilns		
	LK-1	LK-2	LK-3
Total Capital Investment (TCI) (b):	\$1,110,000	\$2,150,000	\$3,650,000
Direct Annual Costs (DAC):			
Operating labor (c):			
Operator	\$13,100	\$13,100	\$13,100
Supervisor	\$1,970	\$1,970	\$1,970
Coordinator	\$4,320	\$4,320	\$4,320
Maintenance (d):			
Labor	\$2,040	\$3,940	\$6,690
Material	\$6,660	\$12,900	\$21,900
Electricity (e):			
Electricity-fan	\$2,000	\$3,870	\$6,570
Electricity-operating	\$24,200	\$46,800	\$79,500
Waste disposal:	\$0	\$0	\$0
Total DAC:	\$54,300	\$86,900	\$134,000
Indirect Annual Costs (IAC):			
Overhead (f):	\$16,900	\$21,700	\$28,800
Admin., taxes and insurance (g):	\$44,400	\$86,000	\$146,000
Capital recovery (h):	\$122,000	\$236,000	\$401,000
Total IAC:	\$183,000	\$344,000	\$576,000
Total Annual Costs:	\$237,000	\$431,000	\$710,000

- (a) All costs in \$1991
(b) $TCI = ESP \text{ plate area} \times \$45/\text{ft}^2 \text{ plate area}$
(c) Operator labor = 3 hr/day x 365 d/yr x \$12/hr
Supervisor labor = 15% of operator labor
Coordinator labor = 33% of operator labor
(d) Maintenance labor = 0.0825 x ESP plate area
Maintenance material = 0.01 x (0.6 x TCI)
(e) Electricity-fan = 0.00018 x model gas flowrate x pressure drop x 8,424 hr/yr x \$0.06/kWh
Electricity-operating = 0.00194 x ESP plate area x 8,424 hr/yr x \$0.06/kWh
(f) Overhead = 0.6 x (labor + maintenance)
(g) Administrative, taxes, and insurance = 0.04 x TCI
(h) Capital recovery = 0.1098 x TCI (based on 15-yr ESP life and 7% interest)

TABLE 6-39a (METRIC). COSTS TO UPGRADE ESP'S TO CONTROL PM TO 0.023 G/DSCM FOR MODEL LIME KILNS^a

Model lime kilns	Lime prod., Mg/d	Equivalent ADMP/d	Gas flowrate-- ESP exit, m3/sec @8% O2	Increase in ESP plate area, m2	Increase in SCA, m2/(m3/sec)	TCI, \$	Electricity, \$/yr	A, I & T, \$/yr	Capital recovery, \$/yr	ITAC, \$/yr
LK-4	90	320	10	1,301	130	\$654,000	\$14,300	\$26,200	\$71,800	\$112,000
LK-5	180	680	20	2,602	130	\$1,260,000	\$27,500	\$50,400	\$138,000	\$216,000
LK-6	270	1,000	34	4,424	130	\$2,150,000	\$46,800	\$86,000	\$236,000	\$369,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-39b.

TABLE 6 - 39b (ENGLISH). COSTS TO UPGRADE ESP'S TO CONTROL PM TO 0.010 GR/DSCF FOR MODEL LIME KILNS^a

Model lime kilns	Lime prod., ton/d	Equivalent ADTP/d	Gas flowrate-- ESP exit, acfm @8% O ₂	Increase in ESP plate area, ft ² (b)	Increase in SCA, ft ² /1000 acfm	TCI, \$ (c)	Electricity, \$/yr (d)	A, I & T, \$/yr (e)	Capital recovery, \$/yr (f)	ITAC, \$/yr (g)
LK-4	100	350	22,000	14,543	661	\$654,000	\$14,300	\$26,200	\$71,800	\$112,000
LK-5	200	750	42,500	28,094	661	\$1,260,000	\$27,500	\$50,400	\$138,000	\$216,000
LK-6	300	1,100	72,200	47,726	661	\$2,150,000	\$46,800	\$86,000	\$236,000	\$369,000

(a) All costs in \$1991

(b) Increase in ESP plate area = flow rate x (1,123 - 462)/ft²/1,000 acfm

(c) TCI = Increase in ESP plate area x (\$45/ft² plate area)

(d) Electricity = (0.00194 x flow rate x [1,123 - 462])/ft²/1,000 acfm SCA) x 8,424 hr/yr x \$0.06/kWh

(e) Administrative, insurance, and taxes (A, I & T) = 0.04 x TCI

(f) Capital recovery = 0.1098 CRF x TCI (based on 15-yr ESP life and 7% interest)

(g) Incremental total annual cost (ITAC) = Electricity + A, I & T + capital recovery

TABLE 6-40. SUMMARY OF ENHANCED MONITORING COSTS

Enhanced monitoring system	Cost
Opacity monitor	Capital cost: \$34,800 Annual cost: \$21,200/yr
Methanol CEM (FTIR)	Capital cost: \$160,000 Annual cost: \$71,500/yr
HCl CEM	Capital cost: \$126,900 Annual cost: \$77,400/yr
EPA Method 5 PM compliance test (three runs)	Initial compliance test cost: \$8,500 Semiannual testing annual cost: \$17,000/yr
EPA Method 29 PM compliance test (three runs)	Initial compliance test cost: \$12,000 Semiannual testing annual cost: \$24,000/yr
EPA Method 26 or 26A HCl compliance test (three runs) ^a	Initial compliance test cost: \$9,100 ^a \$600 ^b Annual testing annual cost: \$9,100/yr ^a \$600 ^b
Monitoring plan	Cost not available
Confirmation of NDCE recovery furnace with dry ESP system	\$0
Confirmation of BLO control equipment	\$0
Temperature monitor for power boiler or other incineration device ^c	\$0
pH monitoring system ^d	\$5,000
Flow rate measurement system ^{d,e}	\$2,000 - \$25,000
Magnehelic gauge, S-type pitot tube (pressure drop measurement) ^d	Manual read-out system: \$300 Digital read-out system: Cost not available

^aCost assumes EPA Method 26 or 26A HCl testing is performed alone.

^bCost assumes EPA Method 26 or 26A HCl testing is performed in conjunction with EPA Method 5, Method 29, or Method 17 testing.

^cCost of monitoring power boiler or incinerator temperature is assumed to be zero because temperature monitoring is already conducted by mills.

^dAnnual costs were not available for monitoring pH and flow rate of scrubber liquid or for monitoring scrubber pressure drop.

^eCost depends on the device sensitivity and distance from the control room.

TABLE 6-41. OPACITY AND HCL CONTINUOUS EMISSION MONITOR COSTS^a

Parameters	CEM costs	
	Opacity CEM	HCl CEM
Capital costs		
Planning	\$1,200	\$4,600
Select type of equipment	\$4,000	\$10,500
Provide support facilities	\$100	\$13,100
Purchased equipment cost	\$21,500	\$61,500
Install and check CEM's	\$300	\$11,100
Performance specification tests (certification)	\$1,400	\$14,300
Prepare QA/QC plan	\$6,300	\$11,800
Total capital investment	\$34,800	\$126,900
Annual costs		
Operating and maintenance	\$7,000	\$8,500
Annual RATA ^b	\$0	\$10,000
Supplemental RATA	\$0	\$9,500
Quarterly CGA's ^c	\$0	\$3,500
Reporting and recordkeeping	\$5,900	\$11,600
Annual review and update	\$3,600	\$17,200
Administrative, insurance, and property taxes ^d	\$3,300	\$12,000
Capital recovery ^e	\$1,400	\$5,100
Total annual cost	\$21,200	\$77,400

^aAll costs are based on EMTIC's CEM program, except for administrative, insurance, property tax, and capital recovery costs, which are based on procedures from the OAQPS Control Cost Manual.

^bRelative accuracy test audit

^cCylinder gas audits

^dAdministrative, taxes, and insurance = 0.04 x TCI

^eCapital recovery = 0.0944 x TCI (based on 20-yr equipment life and 7% interest)

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