AP-42 Section [illegible]
Reference [illegible]
Report Ref 2

SEC

SMITH ENGINEERING COMPANY
SMITH ENVIRONMENTAL CORPORATION
VOC, Air Toxics & Odor Control Systems for Industry

REPLY TO:
☐ CA
■ PA
☐ IL
☐ TX

July 26, 1996

FILE COPY

U.S. EPA
Office of Air Quality Planning and Standards
Emission Standards Division (MD-13)
Research Triangle Park, NC 27711

Attention: Ms. Penny E. Lassiter
Environmental Engineer

Ladies and Gentlemen:

Subject: Regenerative Thermal Oxidizer (RTO) Pricing

Thank you for the opportunity to meet with you last week and discuss activities for VOC controls in pulp & paper plants. Enclosed is BACT cost analysis for RTO systems that we prepared for Laxmi Kesari of the EPA in Washington, DC. Laxmi was interested in this data for the wood industry where he was involved in enforcement of VOC emission regulations.

The RTO system that SMITH recently installed at the kraft mill in Maine was a 20,000 SCFM RTO system that also included a scrubber. Currently, we are actively working on five proposals for other pulp & paper mills. This appears to be an industry that is actively pursuing VOC control equipment.

We hope that this information is helpful to you. We will keep you updated as we work on projects in this industry and please feel free to call us if we can be of assistance.

Sincerely,

Terry A. Crabtree
Eastern Regional Sales Manager

TAC:AC

cc: Mr. Sam Jacobsson, SMITH, Ontario, CA

Enclosures

TABLE 1A
BACT COST ANALYSIS - RTO SYSTEMS
TOTAL CAPITAL INVESTMENT
($.00 OMITTED)

RTO System:	SCFM No. Of Canisters Materials of Construction			20,000 3 CSteel/Cor-Ten	 Stainless	40,000 3 CSteel/Cor-Ten	 Stainless	80,000 5 CSteel/Cor-Ten	 Stainless	110,000 7 CSteel/Cor-Ten	 Stainless
Direct Costs	Purchased Equipment		A	500,600	555,000	710,000	790,000	1,065,000	1,185,000	1,420,000	1,675,000
	Instrumentation/Controls	[0.15 A]		51,000	51,000	54,800	54,800	59,000	59,000	63,000	63,000
	Ductwork/Fire Protection			---	---	---	---	---	---	---	---
	PM Removal			0	0	0	0	0	0	0	0
	Freight			36,000	36,000	50,000	50,000	66,000	66,000	83,000	83,000
	Sales Tax	0.015 A		7,500	8,300	10,700	11,900	16,000	17,800	21,300	25,100
	Total Equipment Costs		TEC*	595,100	650,300	825,500	906,700	1,206,000	1,327,800	1,587,300	1,846,100
	Installation										
	Foundations/Supports	[0.08 TEC]		60,300	60,300	80,100	80,100	87,000	87,000	93,500	93,500
	Erection	[0.14 TEC]		53,500	53,500	73,500	73,500	106,800	106,800	160,200	160,200
	Electrical	[0.07 TEC]		93,500	93,500	100,100	100,100	107,000	107,000	120,200	120,200
	Piping	[0.03 TEC]		14,700	14,700	20,100	20,100	26,700	26,700	33,400	33,400
	Painting	[0.01 TEC]		0	0	0	0	0	0	0	0
	Insulation	[0.02 TEC]		38,800	38,800	53,400	53,400	80,100	80,100	106,800	106,800
	Spare Parts	[0.05 TEC]		30,000	30,000	30,000	30,000	35,000	35,000	40,000	40,000
	Unlisted Equipment	[0.10 TEC]		0	0	0	0	0	0	0	0
	Contingency	[0.06 TEC]		0	0	0	0	0	0	0	0
	Total Installation Cost		TDI*	290,800	290,800	357,200	357,200	442,600	442,600	554,100	554,100
Total Direct Costs (TEC + TDI)			TDC*	885,900	941,100	1,182,700	1,263,900	1,648,600	1,770,400	2,141,400	2,400,200
Indirect Costs	Pre-Appropriation Expense	0.03 TEC		---	---	---	---	---	---	---	---
	Consulting Engineering	0.08 TEC		---	---	---	---	---	---	---	---
	Project Management	0.05 TEC		---	---	---	---	---	---	---	---
	Construction/Field Expense	0.05 TEC		31,700	31,700	38,800	38,800	45,400	45,400	53,400	---
	Commissioning/Start-Up	[0.025 TEC]		21,400	21,400	21,400	21,400	28,100	28,100	34,700	53
	Emissions Testing			---	---	---	---	---	---	---	34,...
Total Indirect Costs			TIC*	53,100	53,100	60,200	60,200	73,500	73,500	88,100	88,100
Summary	Total Direct Costs		TDC*	885,900	941,100	1,182,700	1,263,900	1,648,600	1,790,400	2,141,400	2,400,200
	Total Indirect Costs		TIC*	53,100	53,100	60,200	60,200	73,500	73,500	88,100	88,100
	Total Installed Equipment Costs (TDC + TIC)		TCI*	939,000	994,200	1,242,900	1,324,100	1,722,100	1,843,900	2,229,500	2,488,300

NOTES:

1) For cost items in [ ], $ cost shown is based on SMITH's project costs, not formula indicated. 2) "*" indicates $ total based on SMITH's project costs, with items excluded as shown. 3) "-----" indicates data not available, or by others. 4) Data rounded to nearest $100.

TABLE 1A COMMENTS:

1. $ Cost figures given represent SMITH's scope and project costs for an installed RTO project on a fixed price contract.

2. Project scope/costs as given are for complete RTO system designed for automatic unattended operation.

3. "Instrumentation/controls" cost does not include variable frequency drive for ID fan (if required).

4. "Installation" costs assume use of open shop labor.

5. Comments on "—" items, and items shown as $0:

- Direct Costs:

  - "Ductwork/Fire Protection"
    Specific to application/process/site - generalized estimate not meaningful

  - "Painting"
    Included in "Purchased Equipment" cost

  - "Unlisted Equipment"
    All equipment required for complete RTO system are included in costs given

  - "Contingency"
    Costs as given represent SMITH's contract price.

- Indirect Costs

  - "Pre-Appropriation Expense"
  - "Consulting Engineering"
  - "Project Management"
    Not in SMITH's project scope (but see Table 1B where these figures are included)
  - Emissions Testing
    Specific to project - generalized estimate not meaningful

6. See Table 2A for detail on RTO system SCFM equipment sizing and process detail.

7. Materials of Construction for RTO alternates for each SCFM equipment sizing:

RTO Component	MATERIAL	
	"C Steel/Cor-Ten"	"Stainless"
Ductwork		
- Inlet	MS	SS
- Purge	CT	SS
- Burnout Return	CT	CT
- Outlet	MS	MS
Media Beams	CT	SS
HX		
- Hoppers	CT	SS
- Canisters	MS	MS
Combustion Chamber	MS	MS

MS = Mild (Carbon) Steel   CT = Cor-Ten   SS = Stainless (304)

Suitability:

- "C Steel/Cor-Ten"

  Relatively low moisture content processes (e.g., presses, OSB dryers w/o WESP). Processes containing no corrosives.

- "Stainless"

  Relatively high moisture content processes (e.g. with WESP upstream of RTO, veneer dryers). Processes containing corrosives.

... ENGINEERING COMPANY
Ontario, California
Joseph J. Seiwert, Jr.
March 3, 1995

TABLE 1B
BACT COST ANALYSIS - RTO SYSTEMS
TOTAL CAPITAL INVESTMENT
($.00 OMITTED)

RTO System:	SCFM			20,000		40,000		80,000		110,000	
	No. Of Canisters			3		3		5		7	
	Materials of Construction			CSteel/Cor-Ten	Stainless	CSteel/Cor-Ten	Stainless	CSteel/Cor-Ten	Stainless	CSteel/Cor-Ten	Stainless
Direct Costs	Purchased Equipment		A	500,600	555,000	710,000	790,000	1,065,000	1,185,000	1,420,000	1,675,000
	Instrumentation/Controls	[0.15 A]		51,000	51,000	54,800	54,800	59,000	59,000	63,000	63,000
	Ductwork/Fire Protection			---	---	---	---	---	---	---	---
	PM Removal			0	0	0	0	0	0	0	0
	Freight			36,000	36,000	50,000	50,000	66,000	66,000	83,000	83,000
	Sales Tax	0.015 A		7,500	8,300	10,700	11,900	16,000	17,800	21,300	25,100
	Total Equipment Costs		TEC*	595,100	650,300	825,500	906,700	1,206,000	1,327,800	1,587,300	1,846,[illegible]
	Installation										
	Foundations/Supports	[0.08 TEC]		60,300	60,300	80,100	80,100	87,000	87,000	93,500	93,500
	Erection	[0.14 TEC]		53,500	53,500	73,500	73,500	106,800	106,800	160,200	160,200
	Electrical	[0.07 TEC]		93,500	93,500	100,100	100,100	107,000	107,000	120,200	120,200
	Piping	[0.03 TEC]		14,700	14,700	20,100	20,100	26,700	26,700	33,400	33,400
	Painting	[0.01 TEC]		0	0	0	0	0	0	0	0
	Insulation	[0.02 TEC]		38,800	38,800	53,400	53,400	80,100	80,100	106,800	106,800
	Spare Parts	[0.05 TEC]		30,000	30,000	30,000	30,000	35,000	35,000	40,000	40,000
	Unlisted Equipment	[0.10 TEC]		0	0	0	0	0	0	0	0
	Contingency	[0.06 TEC]		0	0	0	0	0	0	0	0
	Total Installation Cost		TDI*	290,800	290,800	357,200	357,200	442,600	442,600	554,100	554,100
Total Direct Costs (TEC + TDI)			TDC*	885,900	941,100	1,182,700	1,263,900	1,648,600	1,770,400	2,141,400	2,400,200
Indirect Costs	Pre-Appropriation Expense	0.03 TEC		17,900	19,500	24,800	27,200	36,200	39,800	47,600	55,400
	Consulting Engineering	0.08 TEC		47,600	52,000	66,000	72,500	96,500	106,200	127,000	147,700
	Project Management	0.05 TEC		29,800	32,500	41,300	45,300	60,300	66,400	79,400	92,3[illegible]
	Construction/Field Expense	0.05 TEC		31,700	31,700	38,800	38,800	45,400	45,400	53,400	53[illegible]
	Commissioning/Start-Up	[0.025 TEC]		21,400	21,400	21,400	21,400	28,100	28,100	34,700	34,7[illegible]
	Emissions Testing			---	---	---	---	---	---	---	---
Total Indirect Costs			TIC*	148,400	157,100	192,300	205,200	266,500	285,900	342,100	383,500
Summary	Total Direct Costs		TDC*	885,900	941,100	1,182,700	1,263,900	1,648,600	1,790,400	2,141,400	2,400,200
	Total Indirect Costs		TIC*	148,400	157,100	192,300	205,200	266,500	285,900	342,100	383,500
	Total Installed Equipment Costs (TDC + TIC) - -		TCI*	1,034,300	1,098,200	1,375,000	1,469,100	1,915,100	2,056,300	2,483,500	2,783,700

NOTES;
1) For cost items in [ ], $ cost shown is based on SMITH's project costs, not formula indicated. 2) "*" indicates $ total based on SMITH's project costs, with items excluded as shown. 3) "-----" indicates data not available, or by others. 4) Data rounded to nearest $100.

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TABLE 1B COMMENTS:

1. $ Cost figures given represent SMITH's scope and project costs for an installed RTO project on a fixed price contract.

2. Project scope/costs as given are for complete RTO system designed for automatic unattended operation.

3. "Instrumentation/controls" cost does not include variable frequency drive for ID fan (if required).

4. "Installation" costs assume use of open shop labor.

5. Comments on "—" items, and items shown as $0:

- Direct Costs:
  - "Ductwork/Fire Protection"
    Specific to application/process/site - generalized estimate not meaningful
  - "Painting"
    Included in "Purchased Equipment" cost
  - "Unlisted Equipment"
    All equipment required for complete RTO system are included in costs given
  - "Contingency"
    Costs as given represent SMITH's contract price.
- Indirect Costs
  - "Pre-Appropriation Expense"
  - "Consulting Engineering"
  - "Project Management"
    Included based on indicated formula (% of TEC).
  - Emissions Testing
    Specific to project - generalized estimate not meaningful

6. See Table 2B for detail on RTO system SCFM equipment sizing and process detail.

7. Materials of Construction for RTO alternates for each SCFM equipment sizing:

RTO Component	MATERIAL	
	"C Steel/Cor-Ten"	"Stainless"
Ductwork		
- Inlet	MS	SS
- Purge	CT	SS
- Burnout Return	CT	CT
- Outlet	MS	MS
Media Beams	CT	SS
HX		
- Hoppers	CT	SS
- Canisters	MS	MS
Combustion Chamber	MS	MS

MS = Mild (Carbon) Steel CT = Cor-Ten SS = Stainless (304)

Suitability:

- "C Steel/Cor-Ten"

  Relatively low moisture content processes (e.g., presses, OSB dryers w/o WESP). Processes containing no corrosives.

- "Stainless"

  Relatively high moisture content processes (e.g. with WESP upstream of RTO, veneer dryers). Processes containing corrosives.

Ontario, California
Joseph J. Seiwert, Jr.
March 3, 1995

Sheet 1 of

TABLE 2A
BACT COST ANALYSIS - RTO SYSTEMS
ANNUAL OPERATING COSTS
($.00 OMITTED)

RTO System:	SCFM No. Of Canisters Materials Of Construction				20,000 3 C Steel/CorTen	 Stainless	40,000 3 C Steel/CorTen	 Stainless	80,000 5 C Steel/CorTen	 Stainless	110,000 7 C Steel/CorTen	 Stainless
Direct Costs	Labor											
	Operating	$15	525 hr		7,900	7,900	7,900	7,900	7,900	7,900	7,900	7,900
	Maintenance	[0.05	TEC]		30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
	Supervision	0.15	Op Labor		1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
	Maintenance Materials	[0.05	TEC]		11,900	13,000	16,500	18,100	24,100	26,600	31,700	36,900
	Ceramic Replacement	[0.25/5	A]		10,500	10,500	19,500	19,500	32,400	32,400	45,400	[illegible]
	Catalyst Replacement				0	0	0	0	0	0	0	
	Media Replacement				0	0	0	0	0	0	0	0
	Utilities											
	Electricity	$0.04	KWH		26,800	26,800	58,700	58,700	116,200	116,200	123,800	123,800
	Fuel	$3.21	MMBTU		27,500	27,500	55,000	55,000	112,800	112,800	189,800	189,800
	Water	$10	1000 gal.		0	0	0	0	0	0	0	0
	Wastewater Disposal	$10	1000 gal.		0	0	0	0	0	0	0	0
	Solid Waste Disposal	$15	cy		400	400	700	700	1,000	1,000	1,400	1,400
	Steam	$6	M lb		0	0	0	0	0	0	0	0
	Annual Testing				---	---	---	---	---	---	---	---
	Instrument Certification				---	---	---	---	---	---	---	---
	Training	$15	100 hr		1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Total Direct Costs				DC*	117,700	118,800	191,000	192,600	327,100	329,600	432,700	437,900
Indirect Costs	Overhead	0.6	Labor		---	---	---	---	---	---	---	---
	General/Administrative	0.02	TCI*		---	---	---	---	---	---	---	---
	Property Tax	0.01	TCI*		---	---	---	---	---	---	---	
	Insurance	0.01	TCI*		---	---	---	---	---	---	---	
	Capital Recovery 10 yrs 7% (CRF)	0.1424	TCI*		---	---	---	---	---	---	---	---
Total Indirect Costs				IC*	---	---	---	---	---	---	---	---
Summary	Total Direct Costs			DC*	117,700	118,800	191,000	192,600	327,100	329,600	432,700	437,900
	Total Indirect Costs			IC*	---	---	---	---	---	---	---	---
	Total Annual Operating Costs (DC+IC)	--										

NOTES:
1) For cost items in [ ], $ cost shown is based on SMITH's project costs, not formula indicated. 2) "*" indicates $ total based on SMITH's project costs, with items excluded as shown. 3) "-----" indicates data not available, or by others. 4) Data rounded to nearest $100.

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TABLE 2A COMMENTS:

1. Direct Costs - Comments

- "Labor-Maintenance"
  Equivalent to 2000 hrs/yr at $15/hr. SMITH considers this conservative.

- "Maintenance Materials"
  Equivalent to 2% of TEC (not 5%). SMITH considers this realistic.

- "Ceramic Replacement"
  Based on 5 year life (20%/yr replacement). Replacement cost for media $18/ft^3.

- "Utilities"
  - "Electricity" - See Item 3 below
  - "Fuel" - See Item 3 below
  - "Solid Waste Disposal"
    Based on disposal of 20% of media/yr, at $15 per cubic yard disposal cost.

- "Annual Testing"
  Specific to application - no data available.

- "Instrument Certification"
  Specific to application - no data available

2. Indirect Costs - Comments

Only direct costs are given in Table 2A. See Table 2B which includes indirect costs calculated by formulas given.

3. Process Data and Utilities Usage

Data are summarized as follows:

ITEM		RTO SCFM 20,000	RTO SCFM 40,000	RTO SCFM 80,000	RTO SCFM 110,000
• Process					
-SCFM		20,000	40,000	80,000	110,000
-°F		350	330	335	245
-H_2O_v	%v	44	26	29	25
-VOC	lb/hr	52	81	153	133
-Inlet Static	"w.c.	0.0	0.0	0.0	0.0
-Site Elevation	'ASL	500	500	500	500
-Operation:					
hrs/yr		8568	8568	8568	8568
weeks/yr		51	51	51	51
• RTO Operational Data					
-°F Operating		1500	1500	1500	1500
-Fuel MMBTUH net, including equipment heat losses		1.0	2.0	4.1	6.9
- Electrical Power					
-ΔP "w.c.					
-Beds		9.0	11.5	11.5	9.5
-RTO		4.0	4.0	4.0	4.0
-Total		13.0	15.5	15.5	13.5
-HP All Motors					
-BHP		105	230	455	485
-Connected HP		205	385	705	705
-KWH		78.2	171.4	339.0	361.3

SMITH ENGINEERING COMPANY
Ontario, California
Joseph J. Seiwert, Jr.
March 3, 1995

Sheet 1o

TABLE 2B
BACT COST ANALYSIS - RTO SYSTEMS
ANNUAL OPERATING COSTS
($.00 OMITTED)

RTO System:	SCFM / No. Of Canisters / Materials Of Construction				20,000 / 3 / C Steel/CorTen	20,000 / 3 / Stainless	40,000 / 3 / C Steel/CorTen	40,000 / 3 / Stainless	80,000 / 5 / C Steel/CorTen	80,000 / 5 / Stainless	110,000 / 7 / C Steel/CorTen	110,000 / 7 / Stainle[ss]
Direct Costs	Labor											
	Operating	$15	525 hr		7,900	7,900	7,900	7,900	7,900	7,900	7,900	7,90
	Maintenance	[0.05	TEC]		30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,00
	Supervision	0.15	Op Labor		1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,20
	Maintenance Materials	[0.05	TEC]		11,900	13,000	16,500	18,100	24,100	26,600	31,700	36,90
	Ceramic Replacement	[0.25/5	A]		10,500	10,500	19,500	19,500	32,400	32,400	45,400	[illegible]
	Catalyst Replacement				0	0	0	0	0	0	0	[illegible]
	Media Replacement				0	0	0	0	0	0	0	0
	Utilities											
	Electricity	$0.04	KWH		26,800	26,800	58,700	58,700	116,200	116,200	123,800	123,80
	Fuel	$3.21	MMBTU		27,500	27,500	55,000	55,000	112,800	112,800	189,800	189,80
	Water	$10	1000 gal.		0	0	0	0	0	0	0	0
	Wastewater Disposal	$10	1000 gal.		0	0	0	0	0	0	0	0
	Solid Waste Disposal	$15	cy		400	400	700	700	1,000	1,000	1,400	1,40
	Steam	$6	M lb		0	0	0	0	0	0	0	0
	Annual Testing				---	---	---	---	---	---	---	---
	Instrument Certification				---	---	---	---	---	---	---	---
	Training	$15	100 hr		1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,50
Total Direct Costs				DC*	117,700	118,800	191,000	192,600	327,100	329,600	432,700	437,90
Indirect Costs	Overhead	0.6	Labor		23,500	23,500	23,500	23,500	23,500	23,500	23,500	23,5[illegible]
	General/Administrative	0.02	TCI*		20,700	22,000	27,500	29,400	38,300	41,100	49,700	55,70
	Property Tax	0.01	TCI*		10,300	11,000	13,800	14,700	19,200	20,600	24,800	2[illegible]
	Insurance	0.01	TCI*		10,300	11,000	13,800	14,700	19,200	20,600	24,800	2[illegible]
	Capital Recovery 10 yrs 7% (CRF)	0.1424	TCI*		147,300	156,400	195,800	209,200	272,700	292,800	353,700	396,40
Total Indirect Costs				IC*	212,100	223,900	274,400	291,500	372,900	398,600	476,500	531,20
Summary	Total Direct Costs			DC*	117,700	118,800	191,000	192,600	327,100	329,600	432,700	437,90
	Total Indirect Costs			IC*	212,100	223,900	274,400	291,500	372,900	398,600	476,500	531,20
	Total Annual Operating Costs (DC+IC)	--			329,800	342,700	465,400	484,100	700,000	728,200	909,200	969,10

NOTES:
1) For cost items in [ ], $ cost shown is based on SMITH's project costs, not formula indicated. 2) "*" indicates $ total based on SMITH's project costs, with items excluded as shown. 3) "-----" indicates data not available, or by others. 4) Data rounded to nearest $100.

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TABLE 2B COMMENTS:

1. Direct Costs - Comments

- "Labor-Maintenance"
  Equivalent to 2000 hrs/yr at $15/hr. SMITH considers this conservative.

- "Maintenance Materials"
  Equivalent to 2% of TEC (not 5%). SMITH considers this realistic.

- "Ceramic Replacement"
  Based on 5 year life (20%/yr replacement). Replacement cost for media $18/ft^3.

- "Utilities"
  - "Electricity" - See Item 3 below
  - "Fuel" - See Item 3 below
  - "Solid Waste Disposal"
    Based on disposal of 20% of media/yr, at $15 per cubic yard disposal cost.

- "Annual Testing"
  Specific to application - no data available.

- "Instrument Certification"
  Specific to application - no data available

2. Indirect Costs - Comments

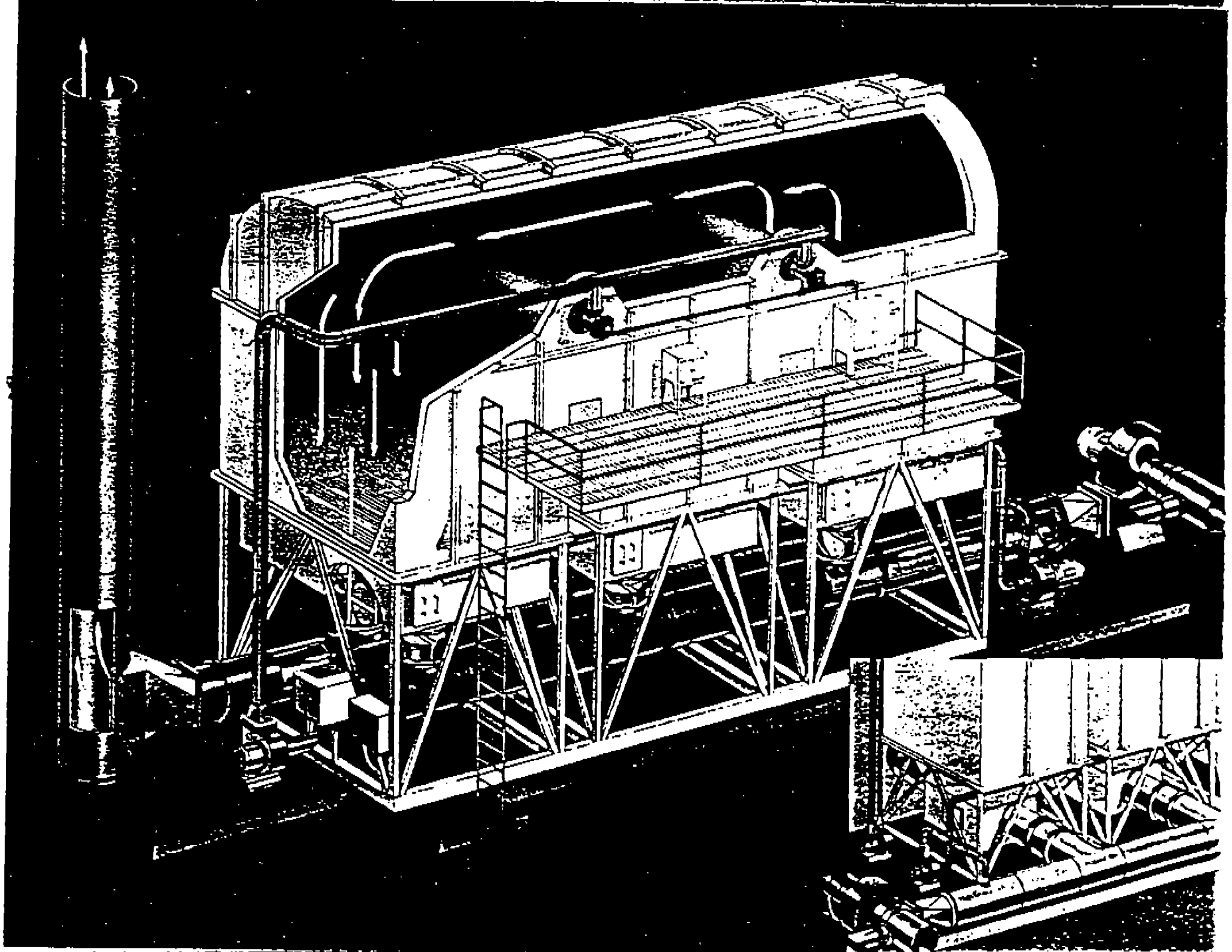
Indirect costs are calculated by formulas given.

3. Process Data and Utilities Usage

Data are summarized as follows:

ITEM		RTO SCFM			
		20,000	40,000	80,000	110,000
• Process					
-SCFM		20,000	40,000	80,000	110,000
-°F		350	330	335	245
-H_2O,	%v	44	26	29	25
-VOC	lb/hr	52	81	153	133
-Inlet Static	"w.c.	0.0	0.0	0.0	0.0
-Site Elevation	'ASL	500	500	500	500
-Operation:					
hrs/yr		8568	8568	8568	8568
weeks/yr		51	51	51	51
• RTO Operational Data					
-°F Operating		1500	1500	1500	1500
-Fuel MMBTUH net, including equipment heat losses		1.0	2.0	4.1	6.9
- Electrical Power					
-ΔP "w.c.					
-Beds		9.0	11.5	11.5	9.5
-RTO		4.0	4.0	4.0	4.0
-Total		13.0	15.5	15.5	13.5
-HP All Motors					
-BHP		105	230	455	485
-Connected HP		205	385	705	705
-KWH		78.2	171.4	339.0	361.3

Equipment Uptime at Reduced Costs



Smith Regenerative Thermal Oxidizers

S — *SMITH regenerative thermal oxidizer (RTO) systems are custom-designed to thermally conve pollutant-laden process exhaust streams into a harmless combination of CO_2 and water. SMI RTOs are an ideal solution for controlling VOC (volatile organic compounds), air toxics, and o*

M — *Meets or exceeds compliance. SMITH RTOs achieve destruction/removal efficiency (DRE) requirements as high as 99+%. Designs for controlling CO and NOx emissions are available.*

A — *Affordable. SMITH RTOs are designed with innovative features to reduce capital, freight, installation, operating and maintenance costs.*

R — *Reliable. SMITH uses an ongoing Failure Mode Effects Analysis (FMEA) program to design systems to minimize unscheduled shutdowns. You optimize production.*

T — *Turnkey. SMITH will provide total project responsibility from emissions evaluations, assistanc in permit process through design, fabrication, installation, start up and performance testing a permanent total enclosures (PTE). Your needs are met through single-source responsibility.*

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Maximize Uptime & Reduce Operating Costs.

Capital Costs

RTO size is governed by your process air flow. SMITH performs air volume reduction studies to reduce RTO size and costs. SMITH RTOs are available in a compact design for flows up to 40,000 scfm. Supply and exhaust ducts are located underneath the RTO to reduce the system footprint, maximize shop assembly of components, and cut down freight and installation costs. RTO designs for large flows (up to 200,000 scfm) are also available. Forced-draft designs reduce fan costs (fan operates at cool RTO inlet).

Operating Costs

Save up to 95% of the energy required to oxidize pollutants (VOCs) with a SMITH RTO. Ceramic heat exchange media (random or structured packing) recovers and reuses waste heat from combustion to reduce up to 95% of natural gas usage. Additional energy released from oxidized VOCs can result in virtually zero fuel usage. System pressure drop is optimized for fan power cost savings. For applications using the SMITH SMART System (fuel gas injection at process inlet), operating burners are completely shut down to further reduce operating costs by 20-25%. NOx emissions are also reduced.

Maintenance Costs

Save down-time costs through immediate service. Call our toll-free 24-hour hot line (1-800-764-8496) to reach on-call service technicians within minutes. Immediate diagnostics begin when access to your oxidizer PLC controls is done via modem. Remote troubleshooting can eliminate service call costs. SMITH stocks a large inventory of oxidizer parts for immediate shipment to you. Don't stop production to wait for a low-cost part.

Learning Curve Costs

Since 1925, SMITH has built high-temperature combustion systems. The advent of air pollution (VOC) laws in the 1960s prompted SMITH to focus its 40 years of combustion experience on developing oxidation technology to destroy VOCs. SMITH has oxidizer experience with industrial applications ranging from simple VOC exhaust streams to those containing silicones, nitrogen, phosphorous and sulfur compounds, condensates, halogens and organic particulates. SMITH provides ancillary equipment upstream and down stream of RTOs such as concentrators, baghouses, prefilter, ESPs, boilers, and scrubbers.

SMITH has over 70 years of turnkey project management experience.

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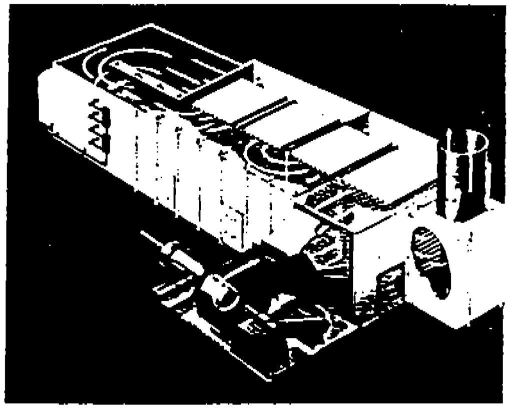
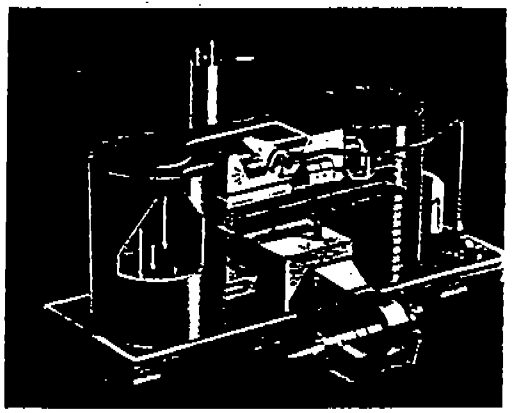
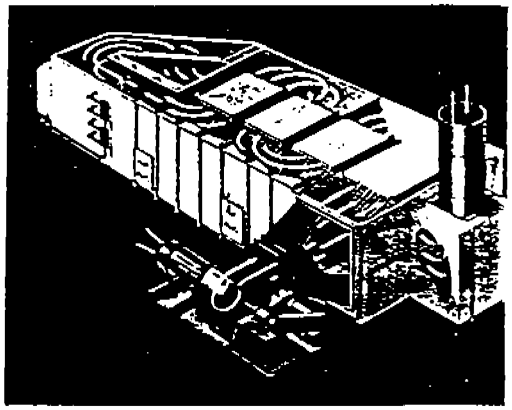


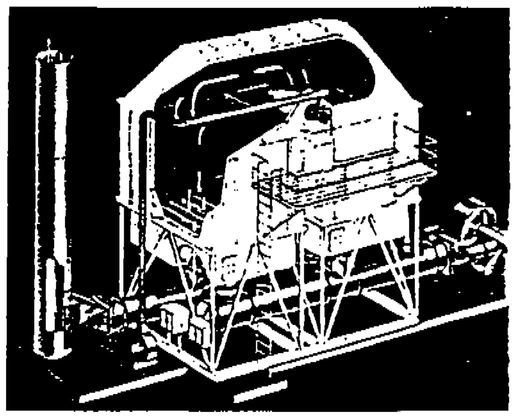
SMITH Thermal Recuperative Ox



SMITH Compac:



SMITH Catalytic Ox



SMITH Regenerative Catalytic Ox

ENVIRONMENTAL NEWS

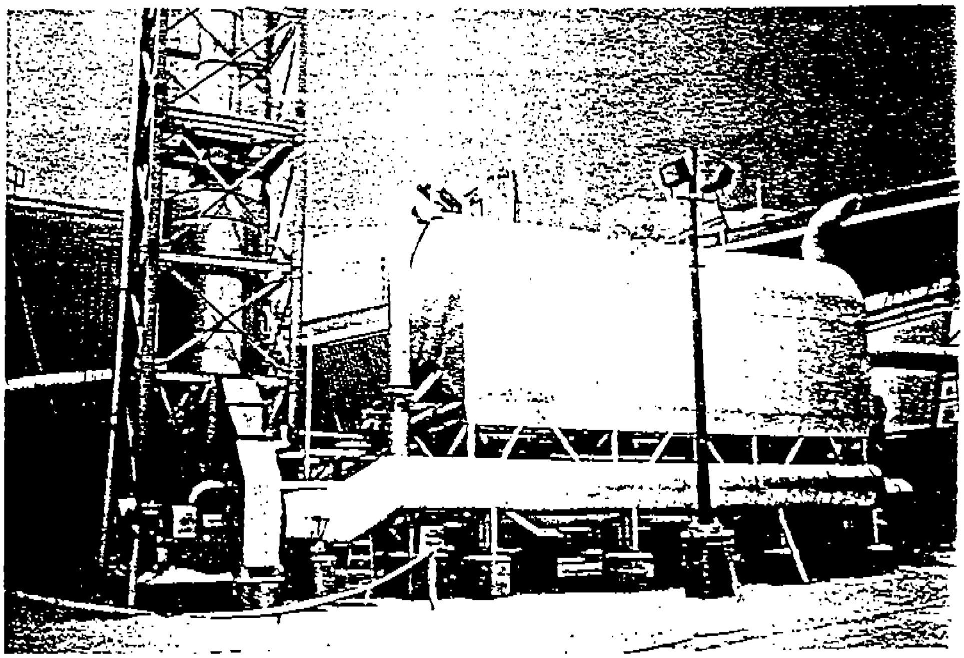
MARCH 1996 ENVIRONMENTAL NEWS FOR PULP & PAPER INDUSTRY VOL. 1, ISSU

PULP MILL INSTALLS FIRST REGENERATIVE THERMAL OXIDIZER (RTO) FOR TRS CONTROL

A northeastern kraft pulp and paper mill was faced with controlling totally reduced sulfur (TRS) compounds from its pulp operations.

The mill conducted an extensive investigation of several control technologies for HVLC (high volume, low concentration) NCG (noncondensible gas) emission containing TRS as well as HAPs (hazardous air pollutants) and VOCS (volatile organic compounds).

The mill selected a SMITH regenerative thermal oxidizer (RTO) coupled with an SO_2 scrubbing system as the most cost-effective solution to satisfy regulatory requirements.



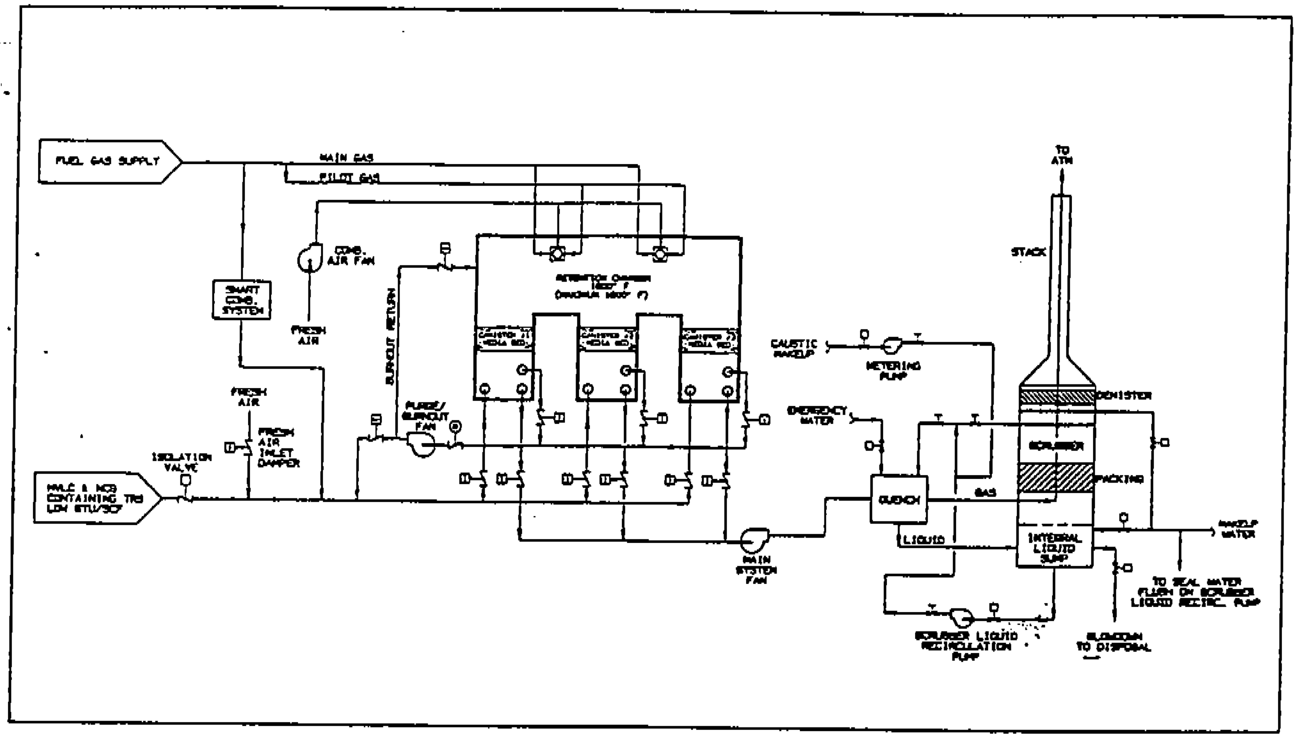
SMITH RTO/SO_2 scrubber system handles 20,000 ACFM of various emissions

This RTO and scrubber system for emissions control[1] represents the first of its kind for the pulp and paper industry. Started up in early January of 1996, the system is performing at levels of excellent control efficiencies for HAPs, VOCs, and TRS emissions. The table below shows the efficiency level at which the system was designed and its actual performance:

RTO/SCRUBBER EMISSIONS PERFORMANCE

	DESIGN	ACTUAL
TNMHC	98% DRE	98.5% - 99.2% DRE
TRS	98% DRE	99.7% - 99.9% DRE <0.5ppm v/outlet
SO_2	97%	<0.1 #/hr. outlet

[1] INDUSTRA, INC., Greenville, SC acted as prime contractor for supply and installation of the HVLC NCG TRS abatement system.



Process flow diagram of SO_2 scrubber and regenerative thermal oxidizer (RTO) system.

The RTO and scrubber system is handling approximately 20,000 ACFM of combined emissions from various pulp mill sources.

Special design considerations and materials of construction were incorporated into both the RTO and scrubber equipment.

Together with the high energy recoveries associated with RTO equipment, the system incorporates SMITH's SMART combustion system, providing for "flameless" thermal oxidation.

Operation to date has shown minimal fuel usage as the RTO is operating in essentially a "self-sustaining" mode, using the heat content of the emissions for system operation.

SMITH will continue to benchmark and monitor system performance to report in future newsletters.

For more information on this technology for control of HVLC NCG TRS emissions, or to be added to our newsletter mailing list, please call SMITH at (800) 959-5732.

Please contact SMITH for additional details at any of the following offices:

- ✓ **California** (909) 923-3331
- ✓ **Dallas** (214) 380-4385
- ✓ **Chicago** (708) 635-0400
- ✓ **Philadelphia** (610) 356-5652
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WOOD INDUSTRY PROJECTS

STARTUP DATE	CUSTOMER	PLANT SITE	PLANT APPLICATION	PROCESS EMISSIONS	PARTICULATE CONTROL DEVICE	ABATEMENT EQUIPMENT	DESIGN FLOW PER RTO
May 1, 1991	MASONITE	Ukiah, CA	Hardboard	a. Press/Kiln	Not Required	(1) 5-Can RTO	80,000 scfm
Jan 24, 1994	LOUISIANA-PACIFIC	Hanceville, AL	OSB	a. Five Rotary Dryers b. One Stack Press	Multiclones Not Required	(2) 7-Can RTOs (1) 7-Can RTO	120,000 scfm 120,000 scfm
Nov 28, 1993	LOUISIANA-PACIFIC	Urania, LA	MDF	a. Two Flash Tube Dryers b. One Continuous Press	Product Cyclones Only Not Required	(2) 7-Can RTOs (1) 7-Can RTO	120,000 scfm 90,000 scfm
Oct 17, 1994	POTLATCH (UNIT 1)	Grand Rapids, MN	OSB	a. Two Rotary Dryers	Multiclones & One Wet-ESP	(1) 5-Can RTO	68,000 scfm
Jan 23, 1995	LOUISIANA-PACIFIC	Clayton, AL	MDF	a. Four Flash Tube Dryers	Product Cyclones Only	(3) 7-Can RTOs	120,000 scfm
Feb 20, 1995	LOUISIANA-PACIFIC	Athens, GA	OSB	a. Five Rotary Dryers b. One Stack Press	Multiclones Not Required	(2) 7-Can RTOs (1) 7-Can RTO	120,000 scfm 120,000 scfm
Feb 20, 1995	LOUISIANA-PACIFIC	Urania, LA	OSB	a. Two Rotary Dryers	Multiclones	(1) 7-Can RTO	120,000 scfm
Feb 13, 1995	J.M. HUBER	Crystal Hill, VA	OSB	a. Four Rotary Dryers b. One Stack Press	Two Wet-ESPs Not Required	(2) 5-Can RTOs Heat Cell/Dryers	96,000 scfm 160,000 scfm
May 19, 1995	MEC - TEMPLE INLAND	Hope, AR	Particleboard	a. One Rotary Dryer	One Wet-ESP	(1) 5-Can RTO	68,250 scfm
May 19, 1995	POTLATCH (UNIT 2)	Grand Rapids, MN	OSB	a. Two Rotary Dryers	Multiclones & One Wet-ESP	(1) 5-Can RTO	68,000 scfm
Jun 6, 1995	J.M. HUBER	Commerce, GA	OSB	a. Two Rotary Dryers	Multiclones & One Wet-ESP	(1) 5-Can RTO	96,000 scfm
Jan 24, 1995	LOUISIANA-PACIFIC	Arcata, CA	Particleboard	a. One Stack Press	Not Required	Engineering Study	N/A
Sep 15, 1995	LOUISIANA-PACIFIC	Roxboro, NC	OSB	a. Five Rotary Dryers b. One Stack Press	Multiclones Not Required	(2) 7-Can RTOs (1) 7-Can RTO	135,000 scfm 120,000 scfm
Sep 15, 1995	LOUISIANA-PACIFIC	Manitoba, Canada	OSB	a. Four Rotary Dryers b. One Stack Press	Two Scrubbers Not Required	(2) 7-Can RTOs (1) 7-Can RTO	90,100 scfm 109,400 scfm
Jun 5, 1995	WILLAMETTE	Albany, OR	PB	a. Two Stack Presses	Not Required	Engineering Study	N/A
Nov 13, 1995	INT'L PAPER	Jay, ME	P&P	a. Pulping Process	Not Required	(1) 3-Can RTO (1) Scrubber	18,000 scfm
Sep 23, 1995	LOUISIANA-PACIFIC	Oroville, CA	MDF	a. One Stack Press	Not Required	PTE Installed	65,000 scfm
May 10, 1996	LOUISIANA-PACIFIC	Montrose, CO	OSB	a. Press/One Dryer	One Wet-ESP	(1) 7-Can RTO	129,250 scfm
Mar 10, 1996	TEMPLE INLAND	Hope, AR	PB	a. One Stack Press	Not Required	(1) 3-Can RTO	50,500 scfm

NOTES:

1. Total 29 commercial scale RTOs with a total of approximately 3,140,600 SCFM
2. L-P Arcata, CA involves engineering study to exhaust press emissions to dryers.
3. Willamette - Albany, OR involves engineering of two PTEs.

SIMULTANEOUSLY SATISFYING CAAA TITLE V, MACT, RACT, AND HVLC GAS CONTROL DESIGN REQUIREMENTS IN DEVELOPING AN AIR EMISSIONS INVENTORY FOR A LARGE INTEGRATED MILL

December 27, 1994

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J. S. Gogolos, P.E. Senior Project Engineer Parsons Engineering Science, Inc. Boston, Massachusetts, 02199	J. Neptune, P.E. Project Manager International Paper Jay, Maine, 04239 C. Brown Environmental Engineer International Paper Jay, Maine, 04239

ABSTRACT

The International Paper (IP) Androscoggin mill in Jay, Maine is required to install a high volume low concentration (HVLC) noncondensible gas (NCG) system in order to comply with the Town of Jay and the State of Maine Department of Environmental Protection (DEP) regulations requiring the collection and destruction of gases from sources in the mill that emit 5 parts per million (ppm) or more of total reduced sulfur (TRS) compounds by 1996. IP must also meet the following requirements: (1) Title V operating permit with an undetermined deadline, (2) EPA proposed NESHAPS (MACT) with an official deadline for final promulgation of 1997, and (3) state VOC RACT with a compliance deadline of 1995.

The basic information IP needed to understand these requirements and plan for compliance was an inventory of all air emissions at the mill. The inventory had to meet IP needs for assessment of regulatory burdens and compliance, engineering design basis of emission controls, as well as future regulatory reporting.

The TRS/HAP emission sources covered under the applicable regulations were characterized and design criteria for a collection system and control technology are presented. IP has selected a regenerative thermal oxidizer (RTO) for destruction of TRS/HAP gases. The project is under the design phase.

INTRODUCTION

International Paper's (IP) Androscoggin mill is required, under the mill's Air Emission Permit dated January 28, 1992 by the Town of Jay, Maine, to collect and control air emissions containing total reduced sulfur (TRS) gases from its pulp preparation and chemical recovery operations at the mill. Since the mill had already in place a system of collection and control for TRS gases from low volume, high concentration (LVHC) sources (emission points), the primary focus of the permit requirement (and consequently of this project) was the control of TRS emissions from high volume, low concentration (HVLC) sources. The concurrent and related requirements of the 1990 Clean Air Act Amendments, i.e., Title I VOC RACT, Title III Draft MACT Standards, and Title V permitting requirements, put IP at a dilemma as to how to properly define, schedule, and comply with the Town's TRS requirements as well as to enable the mill to meet the VOC RACT and future MACT emission control requirements.

IP decided to characterize, in addition to TRS gases which were the initial and primary focus of the project, all VOC and Hazardous Air Pollutant (HAP) emissions from the pulp preparation, chemical recovery, paper making, and other areas of potential TRS/VOC/HAP interface, so that technical solutions for TRS gas control requirements would be properly analyzed and selected for suitability for VOC/HAP control, if found to be cost-effective. The project is currently under the preliminary engineering phase and is planned for start-up on or before January 1996.

This paper presents a summary of air emissions inventory and regulatory requirements for control of TRS, VOC, and HAP emissions from the IP's Androscoggin mill, with an analysis of control schemes for meeting VOC/HAP emissions collection and control requirements. Parsons Engineering Science, Inc. (Parsons ES) provided environmental and engineering services to prepare a comprehensive emissions inventory, and to assist IP in defining a design basis for the required control equipment. Parsons ES also provided air modeling and permitting support services for the project.

MILL DESCRIPTION

The Androscoggin mill is an integrated kraft pulp and paper mill. Some excess pulp is produced and sold. The mill as a whole has the capacity to produce approximately 1450 metric tons of air dried bleached kraft pulp, and about 228 metric tons of ground wood pulp per day. The existing pulp mill has two continuous digester trains: A-line for cooking softwood chips, and B-line for cooking hardwood chips. The A-line consists of a Kamyr digester, 2-stage brownstock washing, 3-stage screening, decker, and a 3-stage bleach plant $(D \rightarrow C_d E_{o+p} D)$. The B-line consists of a Kamyr digester, 2-stage diffusion washer, 3-stage screening, 4-stage cleaning, decker, and a 3-stage bleach plant $(D \rightarrow C_d E_{o+p} D)$. Bleached stock from A and B-lines is then fed to five paper machines for subsequent processing.

The black liquor is fed to the chemical recovery process which consists of two parallel trains with each train consisting of evaporators and concentrators, chemical recovery boiler, smelt dissolving tank, and lime kiln.

IP operates one waste fuel incinerator, and two power boilers. The recovery boilers and the waste fuel incinerator have steam boilers which are used in conjunction with the power boilers to drive steam turbines and generate electricity.

IP currently controls the TRS gases from low volume, high concentration (LVHC) emission points via incineration in one of the mill's two lime kilns. The HVLC gas emissions are not currently controlled.

REGULATORY REQUIREMENTS

The primary regulations applicable to this project are certain provisions of TRS gas emission requirements of the Town of Jay (hereafter referred to as Town) under the Town Ordinance Chapter 13, and State of Maine Department of Environmental Protection (DEP) Regulation 06-096 Chapter 124. Other regulations which are applicable include the DEP Regulation Chapter 134 relative to Reasonably Available Control Technology (RACT) for major sources that emit volatile organic compounds (VOCs), and the draft MACT rules and standards under the National Emission Standards of Hazardous Air Pollutants (NESHAPs) (Environmental Protection Agency 40 CFR Parts 63 and 430 RIN 2060-AD03 and RIN 2040-AN53).

TRS Regulations

TRS gases by definition consist of hydrogen sulfide (H_2S), methyl mercaptan (CH_3SH), dimethyl sulfide (CH_3SCH_3), and dimethyl disulfide ($CH_3S_2CH_3$). The TRS emission control requirements by local and state regulations are similar in contents and requirements, but differ only in the required implementation schedules. The regulations apply to a set defined process areas consisting of digesters, evaporators, recovery furnaces, lime kilns, brown stock washing, and condensate stripping. The TRS requirements are that emissions from emission points from these designated areas must meet a maximum concentration of 5 ppmv, and that H_2S emissions from smelt dissolving systems be limited to 0.016 gm/kg or 0.033 lb/ton of black liquor solids.

VOC RACT Requirements

The Androscoggin mill, by virtue of its location, is in an area designated as an "incomplete data ozone non-attainment area". The VOC RACT requirement under Title I of the CAAA is applicable to the Androscoggin mill, since the mill's annual VOC emissions exceed 36 metric tons (40 tons). However, Section 3 of the Maine DEP Chapter 134 regulation states that facilities subject to Chapter 134 for which EPA proposes Maximum Achievable Control Technology (MACT) by May 31, 1994 do not have to comply with any RACT deadlines except as required by MACT. Since EPA has already promulgated draft MACT rules and since IP plans to collect and control HAP emissions from MACT related emission points, as part of the HVLC gas emission control system, and meet the MACT requirements. DEP has confirmed that VOC RACT rules and deadlines do not apply to the mill.

Insignificant Activities

Maine DEP regulation 06-096, Chapter 115, "Air Emission License Regulations" defines the insignificant activities that do not contribute towards the calculation of total emissions for permitting purposes. Insignificant activities include "emissions with any single hazardous air pollutant less than 45.5 kilograms (100 pounds) per year, or less than the de minimis levels established by EPA in CFR Part 63 Subpart B, whichever is less, or any combination of such HAPs of less than 45.5 kilograms (100 pounds) per year". Parsons ES used this definition of "insignificant activities" as a criteria to evaluate emission point categorization (source definition).

National Emission Standards for HAPs (Proposed MACT Rules)

National Emission Standards for Hazardous Air Pollutants (NESHAPs) have been proposed (draft) for the Pulp and Paper Industry Source Category under authority of Section 112 (d) of the Clean Air Act as amended in 1990. The standards are included in 40 CFR Part 63 Subpart S, and are applicable to the pulping component, bleaching component, and process wastewater component associated with the production of chemical pulp from wood, including kraft, soda, sulfite, or semi-chemical processes. For the purpose of the 40 CFR Part 63, the definition of a Source Category is comprised of Pulping, Bleaching and Wastewater Components (prior to any treatment) at a mill, or in combination.

Hazardous Air Pollutants (HAPs) are the 189 compounds which are included in the Clean Air Act Title III list of HAPs and which are to be regulated under the proposed MACT Rules. The proposed rules establish HAP reduction levels and control technologies. They also specify process areas within the Source Category where the proposed rules are not applicable, and establish maximum allowable emission levels. Individual emission points that emit less then the maximum allowable levels are exempt from collection and control purposes.

For the Pulping component, the following emission points would not be regulated at all:

1) Categorical exemption of emissions from deckers and screens
2) Emissions from any enclosed emission unit which maintains either:
   - a gas flow of less than 5 sfpm (0.18 scfm), or
   - total HAP emission rate of less than 0.23 kg/hr (0.5 lb/hr), or
   - total HAP emission rate of less than 0.00091 kg (0.002 lb) per 0.91 metric tons (1 ton) of ADP
3) Emissions from any unit where total HAP load into the unit from both pulp liquor and wastewater streams is less than 0.045 kg (0.1 lb) per 1000 kg of ADP

The rules require enclosure and venting of all emission points, and provision of control device for a minimum of 98 % HAP destruction efficiency. Incineration technology appears to be the presumptive MACT for these emissions.

For the Bleaching component, emission points which emit less than 5 sℓpm (0.18 scfm) gas flow rate, or 0.23 kg/hr (0.5 lb/hr) or 0.001 kg (0.002 lb) per ADTP of HAPs, are exempt from controls. Otherwise, all regulated emission points are required to have enclosures, and vent into a control device that would achieve minimum of 99 % reduction of HAPs.

For the Wastewater component, the following emission points/streams would not be regulated:

1) Bleaching caustic and acid sewers
2) Wastewater streams with a flow of less than 0.01 ℓpm or which have less 500 mg/ℓ (ppmw) of HAP concentration

The Rules for the wastewater component in general include: (a) enclosures for open sewers, trenches, pump sumps, impoundments, open manholes, tanks, etc., and (b) control requirements of the emissions similar to those of the Pulping Component (98 % reduction of HAPs). Fugitive emissions from wastewater sources and tankage equipment is to be less than 500 ppmv above background.

Regulatory Applicability Determination Procedure

The applicability of each of the above applicable regulations to each emission point was evaluated in terms of two basic criteria, as follows:

a) Is the particular emission point or unit located in a process area or Source Category which is covered by the applicable regulation(s)?

b) Is the maximum emission rate from an emission point which is located in an applicable process area or Source Category greater than the maximum allowable emission levels under the applicable regulation(s)?

If the answers to both of the above questions are yes, then the emission point is required to be collected and/or controlled under the applicable regulation. Otherwise, the emission point was considered to be exempt from the collection and control requirements of the applicable regulations.

EMISSIONS INVENTORY EFFORT

General Approach

The approach to the identification and characterization of the emission points can be summarized as follows:

a) Mill-wide field verification of the location and physical characteristics of all emission points and units. The initial inventory list included "process vents" as well as a partial list of vents associated with occupational ventilation, emergency and safety vents, as well as vents from non-process areas, and fugitive sources.

b) Based on engineering evaluation of the initial vent listing, the inventory list was sorted into several designations, and a list of candidate sources for the HVLC/MACT collection and destruction system was developed which consisted of "process" process vents and fugitive emission points. The list was evaluated to document those emission points which were of minor or insignificant in nature, based on emission estimates prepared by application of fundamental engineering principles, or published emission factors.

c) The process emission points were evaluated and characterized in terms of volumetric gas flow rates and TRS, VOC, and HAP discharges. Each emission point was confirmed in terms of its applicability of each of the TRS and MACT regulations in regards to their collection and control requirements.

d) IP subsequently reduced the number of emission points on the list by working with the mill's Source Reduction Task Team to determine which emission points could have their emissions reduced or eliminated. This effort resulted in a significant reduction in the overall number of emission points requiring collection and destruction. The list was then divided into two lists: (a) a list of emission points requiring collection and treatment by January 1996, and (b) a list of emission points to be collected and controlled by 1998.

In preparing emissions estimates for the process areas, existing emission factors for TRS, VOC, and HAP emissions were utilized from past, on-site (Androscoggin mill) tests, tests conducted at other IP bleached kraft mills, and source testing programs conducted at other mills by the National Council on Air and Stream Improvement (NCASI). In some cases, engineering principles for calculating emission point characteristics were also used. Screening tests were conducted and the data was utilized to calculate emission factors where there were no appropriate emission factors.

EMISSION POINTS SELECTED FOR COLLECTION AND CONTROL

Based on the two lists of emission points developed by IP's Source Reduction Task Team, the project was divided into two phases. Phase I is the installation and operation of a collection and destruction system for all HVLC gas emission points containing 5 ppmv or greater of TRS by January 1996 to satisfy the TRS requirements of the Town of Jay and the Maine DEP. Phase II is the installation and operation of a collection and destruction system for all MACT gas emission points containing 0.5 pounds per hour (lb/hr) or greater of methanol.

The list of HVLC gas emission points containing 5 ppmv or greater of TRS which are included in Phase I are shown in Table I. The list of MACT gas emission points containing 0.23 kg/hr (0.5 lb/hr) or greater of methanol which are included in Phase II are shown in Table II.

DESIGN CRITERIA FOR HVLC GAS COLLECTION SYSTEM

The Phase I HVLC gas collection system will collect gases from the designated emission points in the A and B pulp mills and the power plant. These systems are independent, each having a dedicated fan. The three collection headers will be combined into a single duct that will transport the HVLC gases to the control technology system at a slight positive pressure. Air flow from the various emission points will be restricted via dampers, orifice plates, and valves in order to properly balance the system. The estimated volumetric flow rate of the Phase I combined HVLC gas emission points is 850,000 sfpm (30,000 scfm) at a temperature of 65°C (150°F). A process flow diagram of the Phase I HVLC gas collection system is shown in Figure 1.

In order to minimize the overall HVLC gas volumetric flow rate and the sizing of the associated collection system, IP's Source Reduction Task Team examined design flows at various point and fugitive sources and minimized air infiltration via repairing faulty seals and gaskets on vessels, improving the sealing of existing hoods on the brownstock washers, providing more efficient hoods on the secondary knotters, and installing lids on sampling pots. For a number of sources, the amount of venting is dependent only on the changing conditions within the vessel such as a rising liquid level or increased temperature. In many instances, vessels are interdependent on the process so that an increasing liquid level at one location is balanced by a decreasing level at another. The HVLC gas collection system design basis was conservative in that it assumed maximum vessel fill rates at peak operating temperatures at all sources.

Since many of the HVLC gas sources have normal temperatures in the range of 80-90°C and are saturated with water vapor, condensation formation due to the exposed vent piping network was a consideration. The vent piping layout will be designed to provide adequate slope for drainage, low point drains, and mist eliminators to minimize condensate in the gas collection system. Insulation and heat tracing will be provided as required to maintain safety and operating reliability.

The TRS compounds are noxious and have a very low threshold of odor detectability, resulting in the need for additional H_2S monitors to be installed along with adequate ventilation to ensure operator safety in the event of an upset condition.

The HVLC gas collection system will be designed to operate such that the concentration of the TRS and VOC components will be below the lower explosion limit (LEL). LEL and oxygen monitoring instrumentation will be interlocked to the HVLC gas collection system to automatically vent the gases if the LEL is exceeded.

STRATEGIES FOR CONTROL TECHNOLOGY SELECTION

Due to the very tight compliance schedule, the control technologies evaluated focused on "end-of-pipe" abatement rather than process modifications at the sources. This was due to the fact that any process modifications would have to be evaluated as to their potential impact to pulp production, quality of the final paper products, and potential changes to customer specifications. The time required for this critical evaluation did not coincide with the compliance schedule.

The control technology alternatives evaluated focused on available thermal destruction technologies. For a particular technology or device to be considered, it had to provide a minimum thermal destruction efficiency of 99%, 0.5 seconds of residence time, and operate at a temperature of 815°C (1,500°F). Based on this criteria, five thermal destruction technologies were evaluated for the destruction of TRS, VOC, and HAP compounds associated with the HVLC gases. The five technologies included:

- an enclosed flare
- direct-flame thermal oxidizer with a quench chamber
- recuperative thermal oxidizer
- catalytic oxidizer
- regenerative thermal oxidizer

The evaluation assumed that the existing power boilers were not suitable as an alternative.

The basic difference between the direct-flame, recuperative, and regenerative thermal oxidation systems is the ability of each to recover heat energy. Direct-flame thermal oxidizers allow no energy recovery. Recuperative thermal oxidation systems use heat exchangers which recycle hot flue gases leaving the thermal oxidizer to preheat the incoming gas stream, thus providing heat recovery efficiencies between 40 and 70%. Regenerative thermal oxidizers have heat recovery efficiencies as high as 95% without the use of heat exchangers.

The selection criteria included: (1) capital cost, (2) annual operating cost, (3) thermal destruction efficiency, (4) system reliability, (5) operating simplicity and flexibility, and (6) fuel consumption. A summary of the comparative capital and operating costs of these thermal destruction technologies for a 850,000 sfpm (30,000 scfm) system are presented in Table III. The enclosed flare was not included in the cost comparison because of its high fuel consumption, marginal destruction capability, and incompatibility with a downstream scrubber system.

As shown in the comparison in Table 3, the regenerative thermal oxidizer (RTO) is the most cost effective alternative for the thermal destruction of HVLC gases for this application. The RTO will provide operating flexibility with a 4 to 1 turndown ratio, and will be of modular design, thereby allowing future expansion and retrofit of its volumetric capacity.

DESIGN CRITERIA FOR SELECTED CONTROL TECHNOLOGY

Regenerative thermal oxidizers (RTO) utilize ceramic beds as the heat transfer media. As part of a cyclic process, the incoming gas stream passes through a hot bed of ceramic material which simultaneously heats the incoming gas and cools the bed. From this bed, the gas enters the combustion chamber, where it is oxidized. Treated gas leaving the combustion chamber passes over a second bed, which is heated by the cleaned gas, and simultaneously cools the air stream. At regular intervals, the process flow is reversed. As the process stream passes over the freshly heated bed, it is heated. The RTO system will include dual ceramic particulate filters ahead of the RTO to allow collection and burnoff of particulates when necessary, and a packed tower scrubber after the RTO for control of SO_2 emissions. A process flow diagram of the RTO system is shown in Figure 2.

The RTO system will be designed for 99% thermal destruction of TRS, VOC, and HAP compounds, a minimum of 0.5 second of residence time, an operating temperature of 871°C (1,600°F), and a thermal efficiency of 95%. The RTO will be sized to handle a design maximum inlet HVLC gas flow rate of 1.13×10^{6} aℓpm (40,000 acfm), at 65.5°C (150°F) saturated with water vapor, and containing 3.2×10^{9} Joules per hour (3×10^{6} Btu/hr) heat content. Propane gas will be utilized as start-up and auxiliary fuel.

The packed tower scrubber will be designed to remove 97% of the SO_2 emissions using a sodium hydroxide (NaOH) solution as the scrubbing medium.

LICENSING/PERMITTING APPROACH

A major regulatory hurdle to overcome was obtaining the necessary regulatory approvals to construct and operate the proposed Regenerative Thermal Oxidizer (RTO), since the RTO will be a source of air emissions and, as such, is subject to applicable State of Maine and Town of Jay licensing and permitting programs. Specifically, it was necessary to satisfy requirements of Chapter 115 (Emission License Regulations) of the Maine Department of Environmental Protection (DEP) Bureau of Air Quality Control as well as Town of Jay requirements contained in Chapter 13 (Air Pollution) of the Jay Environmental Control and Improvement Ordinance.

Both sets of regulations contain requirements for air quality modeling analyses to ensure that applicable ambient air quality standards and air quality increments will be preserved. Given the complex terrain setting of the Androscoggin Mill, the existence of many significant emission sources at the mill and at nearby off-site facilities, the need to satisfy restrictive Maine Ambient Air Quality Standards (MAAQS) and the narrow margin of compliance which had been predicted in some previous modeling analyses, modeling related considerations played a central role in forging the basic licensing/permitting approach. Following discussions with representatives of DEP, the Town of Jay, and the US Environmental Protection Agency concerning a wide range of possible licensing/permitting approaches, the following strategy was selected and pursued. It was decided to minimize the potential regulatory burden for the project by ensuring that the potential to emit of the selected control system would fall below defined significant emission rates which would subject the project to Prevention of Significant Deterioration (PSD) requirements.

The advantage of this approach was that the project was freed from a wide range of analytical and monitoring requirements as well as more extensive review requirements which would likely have jeopardized critical scheduling constraints for the project. The approach also subjected the project to less onerous analysis requirements and less restrictive limits with regard to allowable impacts in protected Class I areas.

The basic modeling approach was similarly designed to provide the clearest and fastest path to the desired regulatory approvals. The basic modeling approach was predicated upon demonstrating through approved air quality modeling procedures that the proposed RTO would have predicted impacts which were always less than significant impact levels established for criteria air pollutants. A demonstration of insignificant predicted impacts for the proposed RTO largely avoided the need for additional modeling analyses. In particular, the project was freed from the requirement for extensive modeling analyses which would have needed to include other mill emision sources and numerous off-site sources at other facilities to demonstrate compliance with ambient air quality standards and air quality increments.

The basic modeling analyses were conducted using approved air quality dispersion models (ISC2 and RTDM) with a recent 5-year meteorological data base assembled from on-site and off-site data sources. Impacts of the proposed RTO were predicted at a field of over 1300 receptors covering Class II areas surrounding the mill as well as four Class I areas in Maine, New Hampshire, and New Brunswick. Modeling analyses were conducted in accordance with applicable guidance and requirements provided by and negotiated with the DEP and Town.

Since the volume of gases to be treated by the RTO had not been finalized at the time when the application was submitted, the modeling considered two basic operating cases to span the range of expected maximum volumetric flow rates during normal operation 0.99×10^6 to 1.13×10^6 aℓpm (35,000 to 40,000 acfm). Additional cases were also explicitly modeled to account for lower volumetric flow rates 283,000 aℓpm (10,000 acfm) expected during some short-term start-up scenarios.

The modeling successfully demonstrated insignificant predicted impacts from the RTO. However, the DEP and Town imposed a few additional analytical requirements due to the results of prior modeling analyses for sources in the Jay area. These prior analyses had predicted narrow margins of compliance with short-term SO_2 MAAQS and short-term increments for TSP in a few well-defined geographical areas. In order to satisfy these additional requirements, some additional analyses were submitted. These included a review of prior modeling results to demonstrate that an adequate margin with respect to short-term SO_2 ambient standards did, in fact, exist when predicted impacts associated with earlier proposed, but never permitted, emission increases were removed from model results. In addition, supplemental analyses of the proposed RTO were submitted to demonstrate that: (1) predicted short-term impacts of TSP at a few receptors of concern were sufficiently small that the increment would not be jeopardized; and (2) predicted short-term SO_2 impacts of the proposed RTO were still insignificant when modeled using an earlier 5-year meteorological data base. The modeling was conducted and submitted in time to support the license and permit applications for the proposed RTO.

SUMMARY

1. The HVLC gases are characterized for TRS, VOC, and HAP compounds. Emission sources prioritized for two phase collection and control strategy.

2. A regenerative thermal oxidizer technology was selected for cost-effective control.

3. The project will satisfy TRS, VOC RACT, and MACT requirements.

4. PSD permitting was avoided as part of the permitting strategy.

LITERATURE CITATIONS

1. Parsons Engineering Science, Engineering Report, "Emissions Inventory for HVLC/MACT Project for International Paper Androscoggin Mill", February 1994.

2. State of Maine, Department of Environmental Protection, Bureau of Air Quality Control, Regulation 06-096, Chapter 124, "Total Reduced Sulfur Control from Kraft Pulp Mills", p. 1-10.

3. Town of Jay, Ordinance Chapter 13-503, "Total Reduced Sulfur Emissions from Existing Kraft Pulp Mills", p. 30-31.

4. Environmental Protection Agency, Title 40, Code of Federal Regulations (CFR), Parts 63 and 430, "Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards: Pulp, Paper, and Paperboard Category; National Emission Standards for Hazardous Air Pollutants for Source Category: Pulp and Paper Production", p. 1-227, 1993.

ACKNOWLEDGMENTS

The authors thank IP Jay, Maine mill staff for their assistance in conducting the emissions inventory effort during the HVLC/MACT Interface Project.

TABLE I

HVLC SOURCE LIST

PHASE I

A PULP MILL SOURCES	(ACFM)
Brown Stock Washer and Secondary Knotter	11000
No. 1 Seal Tank	1500
No. 2 Seal Tank	1500
Oxidation Sump	300
Knot Drainer	500
Floor Drain Collection Tank	870
Screen Chest	1100
Oxygen Delignification	3500
B PULP MILL SOURCES	
Rotary Drainer	500
Diffuser	3000
Diffuser Filtrate Tank	400
Screen Chest	870
Knot Tank	150
Parshall Flume Vent	700
Unscreened Stock Tank	300
POWER PLANT SOURCES	
No. 1 Boiler Mix Tank	300
No. 2 Boiler Mix Tank	300
W. Precipitator Mix Tank	300
E. Precipitator Mix Tank	300
E. Economizer Mix Tank	300
52% Black Liquor Tank	250
63% Black Liquor Tank	250
Total	28190

TABLE II

MACT RULES LIST

PHASE II

EMISSION POINTS LIST	(ACFM)
Green Environmental Stack	23000
Weak Liquor No. 3	150
Weak Liquor No. 4	150
68% Black Liquor Tank	250
Strong Black Liquor Tank	250
Black Liquor Tank on Hill	250
New Foul Condensate Collection Tank	250
FUGITIVES LIST	
B Mill Dilution Supply Chest	250
A White Water Tank	250
Total	24800

TABLE III
SUMMARY OF COMPARATIVE COSTS FOR THERMAL DESTRUCTION TECHNOLOGIES

Thermal Destruction Technology	Destruction Efficiency (%)	Thermal Efficiency (%)	Relative Capital Cost	Electrical Cost ($/hr)	Fuel Cost ($/hr)	Total Cost ($/hr)	Advantages	Limitations
Direct-flame Thermal Oxidation	95-99	0	1 0	1.32	179 20	180 52	• Relatively easy to operate	• High fuel consumption • Poor thermal efficiency
Recuperative Thermal Oxidation	95-99	65	1 2	1.88	58.80	60 66	• Achieve high destruction efficiencies	• Potential fouling of heat exchanger • Cannot operate at high temps
Catalytic Oxidation	90-98	65	0 9	2.57	27.20	29.77	• Operates at low temps	• Potential catalyst poisoning from HOCs and particulates • High maintenance cost due to periodic catalyst replacement
Regenerative Thermal Oxidation	95-99	95	1 0	3.90	2.84	6 74	• Low operating cost at low and high LELs • Can operate at high temps • 4:1 Turndown • System can be easily expanded • Particulates can be burned off beds	• Requires large area

NOTES:

1 Comparative capital and operating costs for system sized to handle inlet of 30,000 scfm, 70 degF, and 100 lb/hr VOC loading.
2. Electric cost is based on $0.03/kW
3 Fuel cost is based on propane at $4 00/MMBtu.

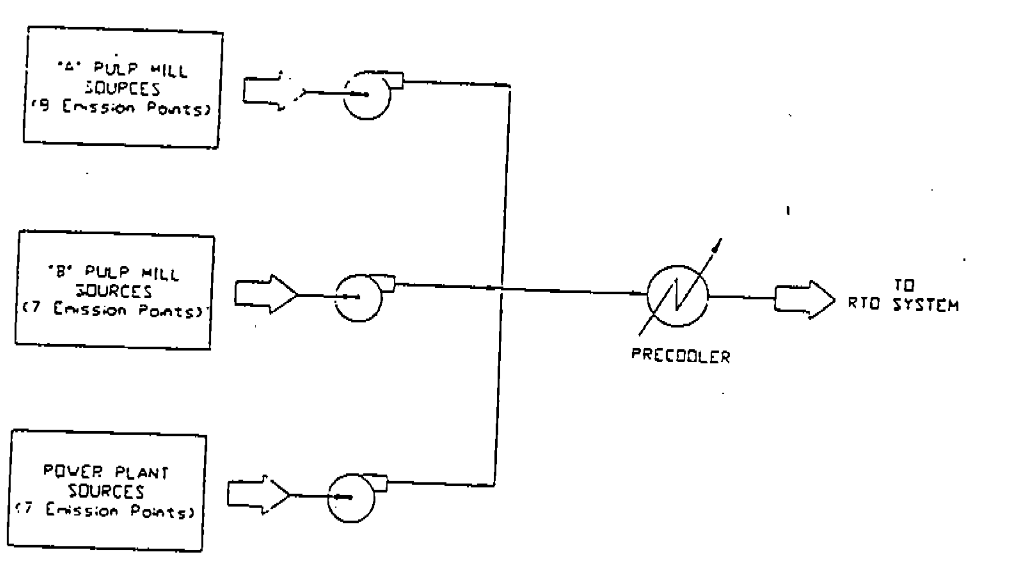


FIGURE 1.
PHASE I
HVLC GAS COLLECTION SYSTEM
PROCESS FLOW DIAGRAM

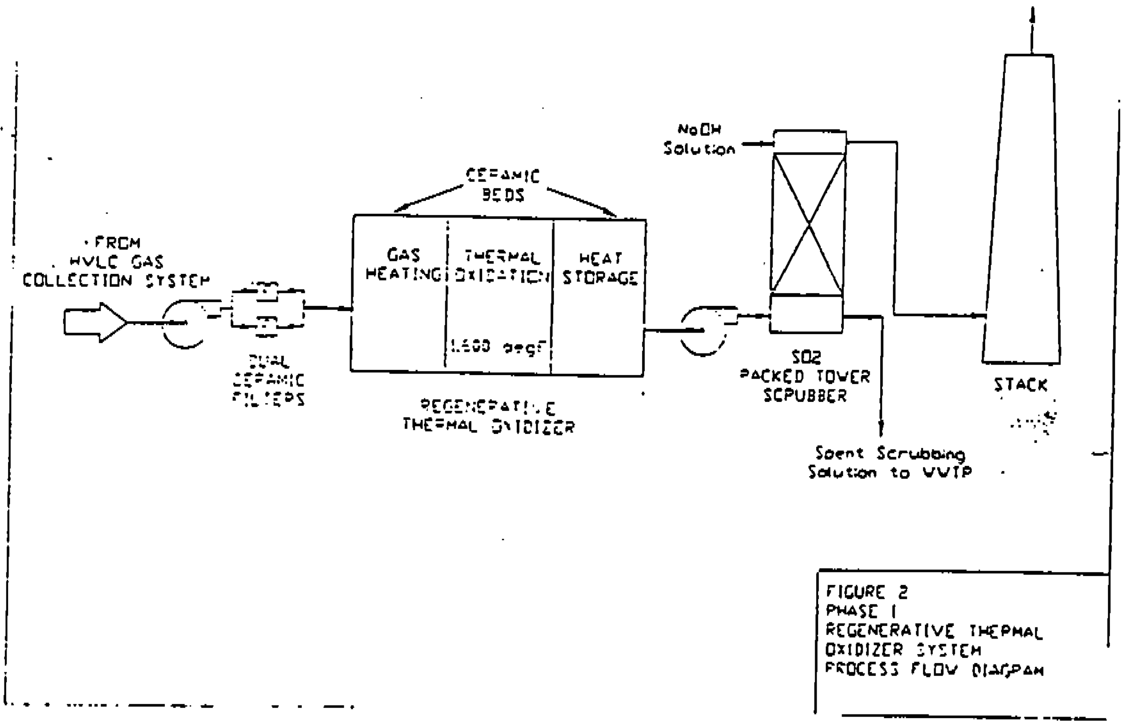
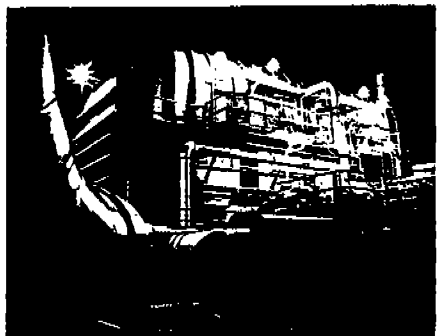


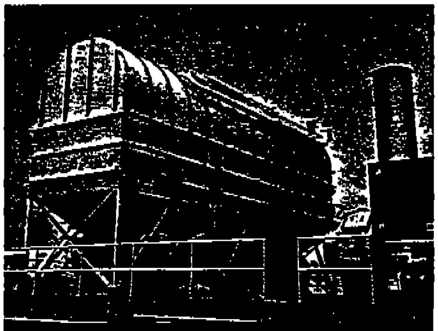
FIGURE 2
PHASE I
REGENERATIVE THERMAL
OXIDIZER SYSTEM
PROCESS FLOW DIAGRAM

INDUSTRIES THAT USE SMITH OXIDIZER SYSTEMS.

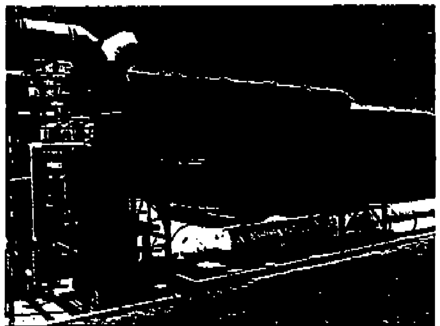
- Converting: flexographic, rotogravure, heat set web offset, coating, laminating
- Chemical process industries: pharmaceutical, chemical, flavor/fragrance
- Paint finishing applications: automotive, appliance, architectural products, furniture
- Plastics: automotive
- Coating/metallizing
- Metal decorating: can making, coil coating
- Textile: wall coverings
- Composites: semi-conductors, printed circuit boards, fiberglass impregnation
- Bakery
- Food processing
- And many more



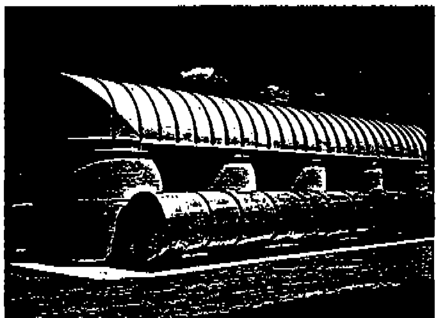
38,000 SCFM regenerative oxidizer with 95% primary heat exchanger. Application: Polystyrene Reprocessing



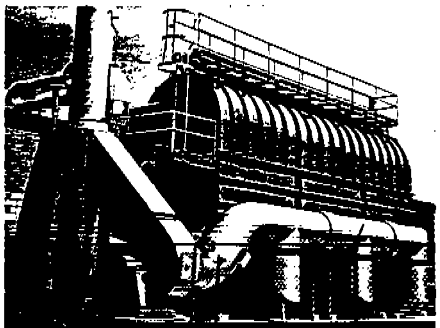
26,000 SCFM regenerative oxidizer with 90% primary heat exchanger. Application: 8-Color Press



120,000 SCFM regenerative oxidizer with 90% primary heat exchanger and 50,000 lbs/hrs waste heat boiler. Application: Rotogravure Printing



145,000 SCFM five-canister regenerative oxidizer with 85% primary heat exchanger. Application: Paper & Film Coating



18,000 SCFM regenerative oxidizer with 95% primary heat exchanger. Application: Wicket Ovens

SEC

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FAX: (215) 356-0286

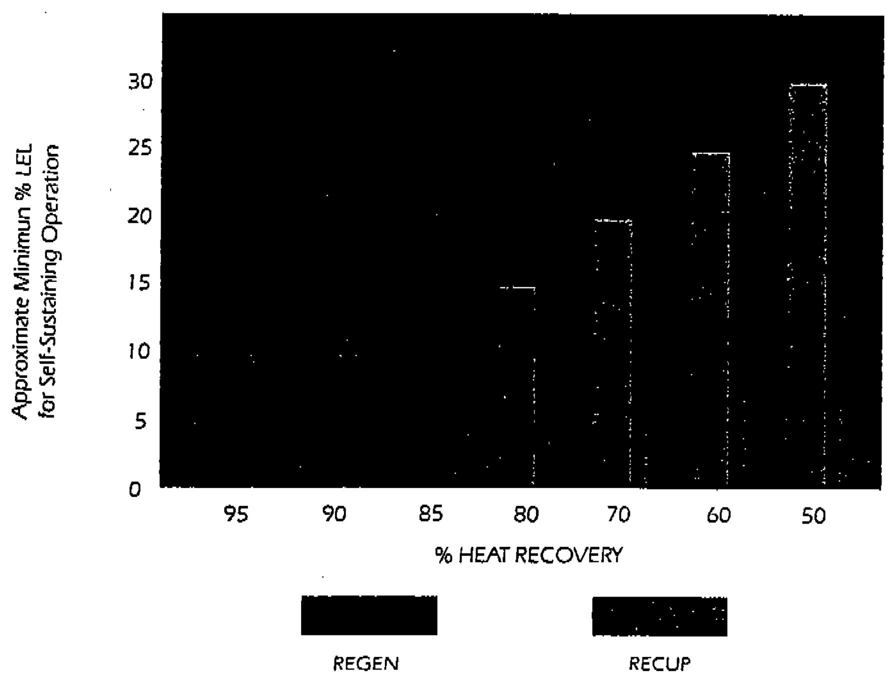
MIDWESTERN REGIONAL OFFICE
P.O. Box 661
Geneva, IL 60134-0661
PHONE: (708) 232-0400
FAX: (708) 232-0428

LICENSEES:
Europe

BUY ONLY THE HEAT RECOVERY YOU NEED.

The quantity of heat available from solvents in your process exhaust is a very important consideration when you select how much primary heat recovery is needed for optimum fuel efficiency. Since Smith offers both regenerative and recuperative systems, we can provide the optimum amount of primary heat recovery to minimize your operating costs under a wide range of process conditions. Depending on the solvent loading, choices can range from no primary heat exchanger to a maximum 95% thermal efficiency. We will help you select the most cost-effective heat recovery system for your process.

Heat Exchanger Selection Criteria



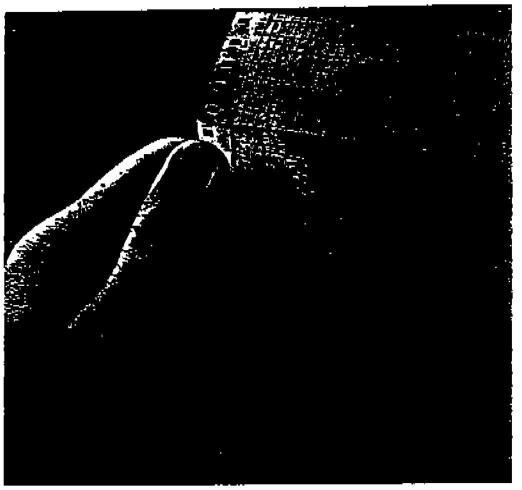
THE IDEAL SOLUTION.

Smith regenerative oxidizer systems are the ideal solution when:

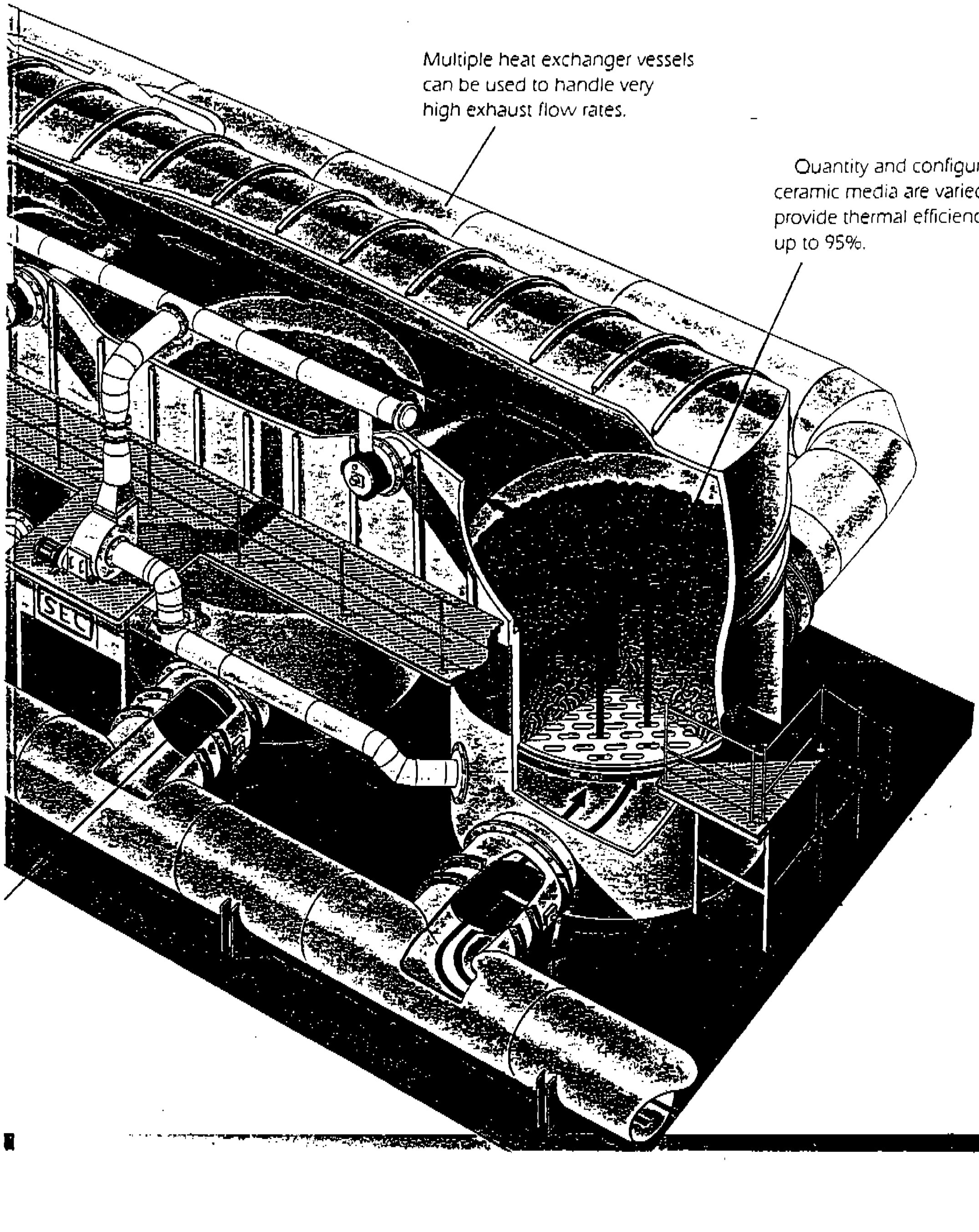
- You need more than 80% thermal efficiency
- Process exhaust flows cannot be reduced
- VOC concentrations are low and air flows are high – up to 400,000 SCFM, or higher
- Your process exhaust contains halogenated hydrocarbons and other corrosive VOCs
- You have high VOC loading and some energy can be "exported" from the oxidizer for steam generation, thermal fluid heating, absorption chilling, etc.

RUGGED FLOW VALVE SYSTEMS YOU CAN COUNT ON.

Smith incorporates hydraulic, electric and pneumatic heavy-duty valves designed for high-VOC destruction efficiency. Our unique flow control valve system (inlet, outlet and purge) controls the air flow into and from the heat exchanger canisters. Tandem operating valves stabilize air flow and prevent surges. When you require exceptionally high-VOC destruction efficiency and/or odor elimination, a valve system providing for zero process-to-process leakage is incorporated.



SMITH consistently achieves over 99% destruction efficiency.



Multiple heat exchanger vessels can be used to handle very high exhaust flow rates.

Quantity and configuration of ceramic media are varied to provide thermal efficiencies of up to 95%.

SMITH SYSTEMS PROVIDE OVER 99% VOC DESTRUCTION EFFICIENCY.

Smith's unique patented purge design and low-leakage valves routinely result in systems providing over 99% VOC destruction efficiency – considered by the EPA the highest ever achieved for regenerative thermal oxidizers! The purge system evacuates the heavier-than-air, VOC-laden air stream from the bottom of the heat exchanger canisters returning this purged air to the system for *complete oxidation*. The purged air is often used as a source of combustion air for the burners, eliminating the need for outside combustion air and extra fuel.

TROUBLE-FREE DESIGN.

Vertical gas flow through the heat exchanger canisters is an important advantage in packed-bed design and operation. It means efficient operation, uniform gas flow, low maintenance and minimum pressure drop — and that translates into savings for you!

WHAT IS A REGENERATIVE THERMAL OXIDIZER?

A regenerative thermal oxidizer is a device that uses heat to burn unwanted pollutants, such as VOCs, air toxics, and odors, at high temperatures of 1,400°F. to over 2,000°F. To save fuel, these units are equipped with ceramic-packed bed-type regenerative heat exchanger canisters to recover valuable heat generated during oxidation to preheat incoming process gases.

HOW DOES IT WORK?

VOC-containing or odorous process exhaust gases enter the system passing vertically through one or more heated ceramic beds (heat exchangers) which preheat the gases to almost final oxidation temperature. These preheated process gases then enter a combustion chamber where they are further heated to final oxidation temperature and held at that temperature to achieve high destruction efficiency. Oxidation also occurs in the ceramic-packed beds.

The now-purified, hot gases exit this chamber through one or more different ceramic beds cooled in an earlier cycle. Heat from the process gases is absorbed by these beds before the gases exit to atmosphere at an outlet temperature only slightly higher than the inlet temperature. In order to ensure high overall VOC destruction efficiency, a remaining ceramic bed is simultaneously being purged of any exhaust still contaminated with inlet VOC emissions or odors. The cycle is repeated alternating between ceramic beds for heating, cooling and purging.

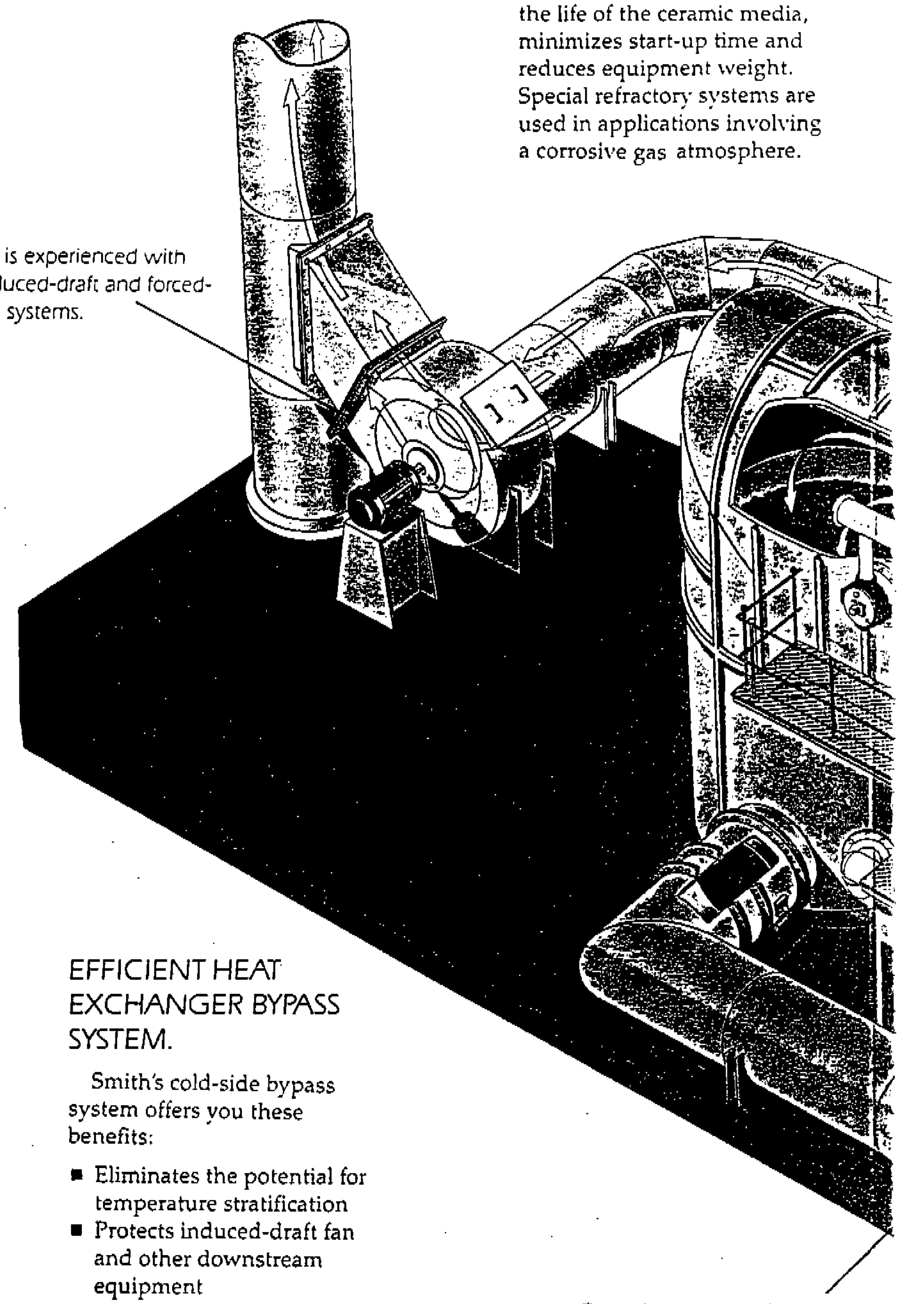
SELF-CLEANING BED SYSTEM.

When organic particulate ("aerosol") is contained in the process exhaust, it may deposit on the packed-bed heat transfer surfaces. A special self-cleaning feature can be incorporated to remove these deposits.

WORKS GREAT WHEN THE HEAT IS ON!

At 1,400°F. to 2,000°F., the refractory system is not important, it's *vital*. Smith has been designing and installing refractory systems since 1925, so you can be sure the technology is there. Special long-life ceramic fiber refractory insulation in the heat exchanger vessels and combustion chamber extends the life of the ceramic media, minimizes start-up time and reduces equipment weight. Special refractory systems are used in applications involving a corrosive gas atmosphere.

Smith is experienced with both induced-draft and forced-draft fan systems.



EFFICIENT HEAT EXCHANGER BYPASS SYSTEM.

Smith's cold-side bypass system offers you these benefits:

- Eliminates the potential for temperature stratification
- Protects induced-draft fan and other downstream equipment
- System responds faster
- Simpler to maintain
- Valves exposed to lower temperatures

Our valves are extra heavy duty with oversized shafts and bearings designed for ready access, easy maintenance.

SMITH. THE QUALIFIED COMPANY FOR VOC EMISSIONS CONTROL.

over 65 years
SINCE • 1925

People — Our Greatest Resource

- Large in-house staff of engineers and technicians, including over 25 degreed engineers
- Over 200 man-years of VOC experience among top ten technical people

Variety of Technology — More Choices For You

- Regenerative thermal oxidizers
- Recuperative thermal oxidizers
- Catalytic oxidizers
- Direct-fired afterburners
- Secondary heat recovery systems
- Air-to-air heat exchangers

Experience — In Business Since 1925

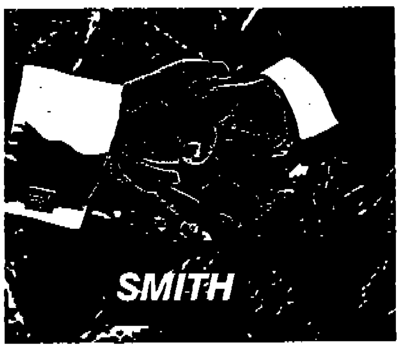
- 65 years of high-temperature experience (1,400° to over 2,000°F.)
- Over 30 years of VOC fume oxidation experience
- Unexcelled process/industry knowledge
- Pioneers and leading experts in capture system technology
- Our *only* business

Performance — We Meet Your Requirements

- An innovator in regenerative thermal oxidation technology
- Highest recorded VOC reduction efficiency confirmed by the EPA
- A history of meeting demanding performance requirements
- Pilot oxidizer to prove process criteria
- Already meets air pollution standards set by EPA for year 2025

Capabilities — A One-Stop Shop

- Process modifications
- Capture system design
- Design engineering
- Fabrication
- Installation/process tie-in/start up
- Testing (design/airflow/performance)
- Service/spare parts/training
- Total project responsibility

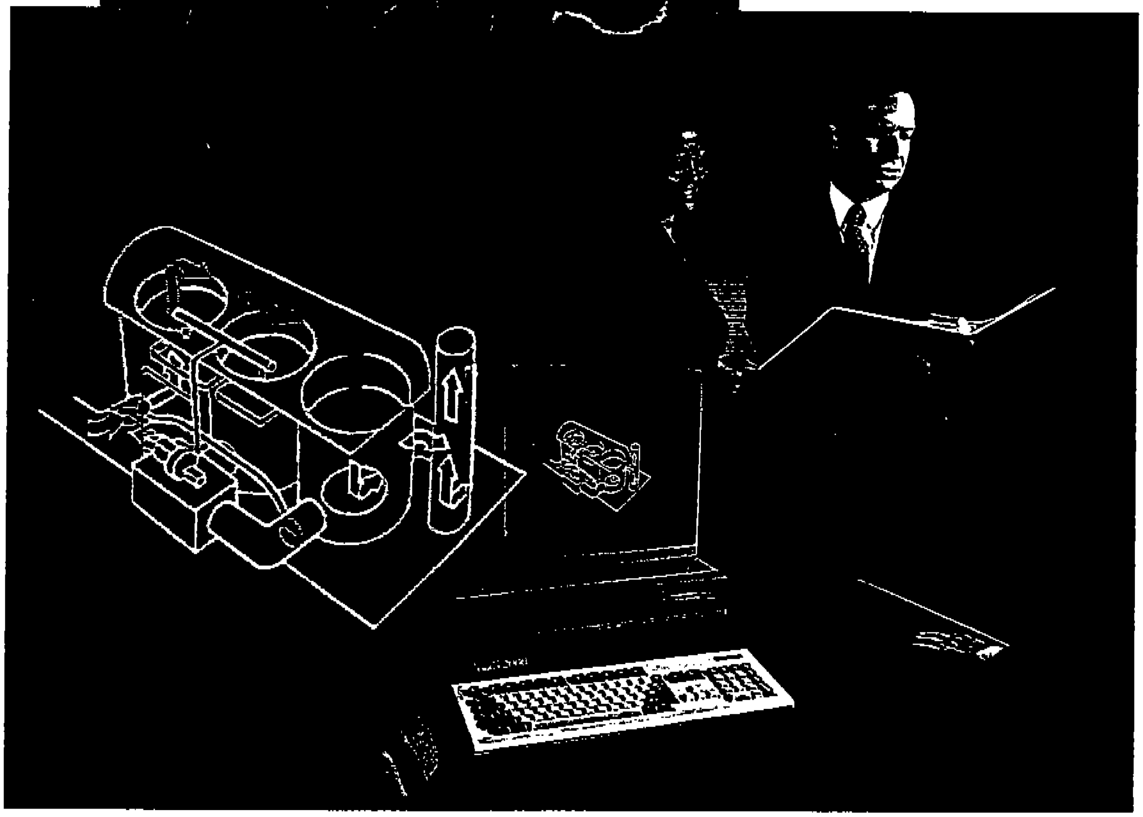


Integrity — A Partner You Can Depend On

- We listen to you and understand your process needs first
- If our system is not right for your application, we tell you
- Each unit meets performance requirements, or we're not finished
- Excellent, responsive field service nationwide

SMITH REGENERATIVE THERMAL OXIDIZERS

FOR VOC EMISSIONS AND ODOR CONTROL



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