

## APPENDIX B

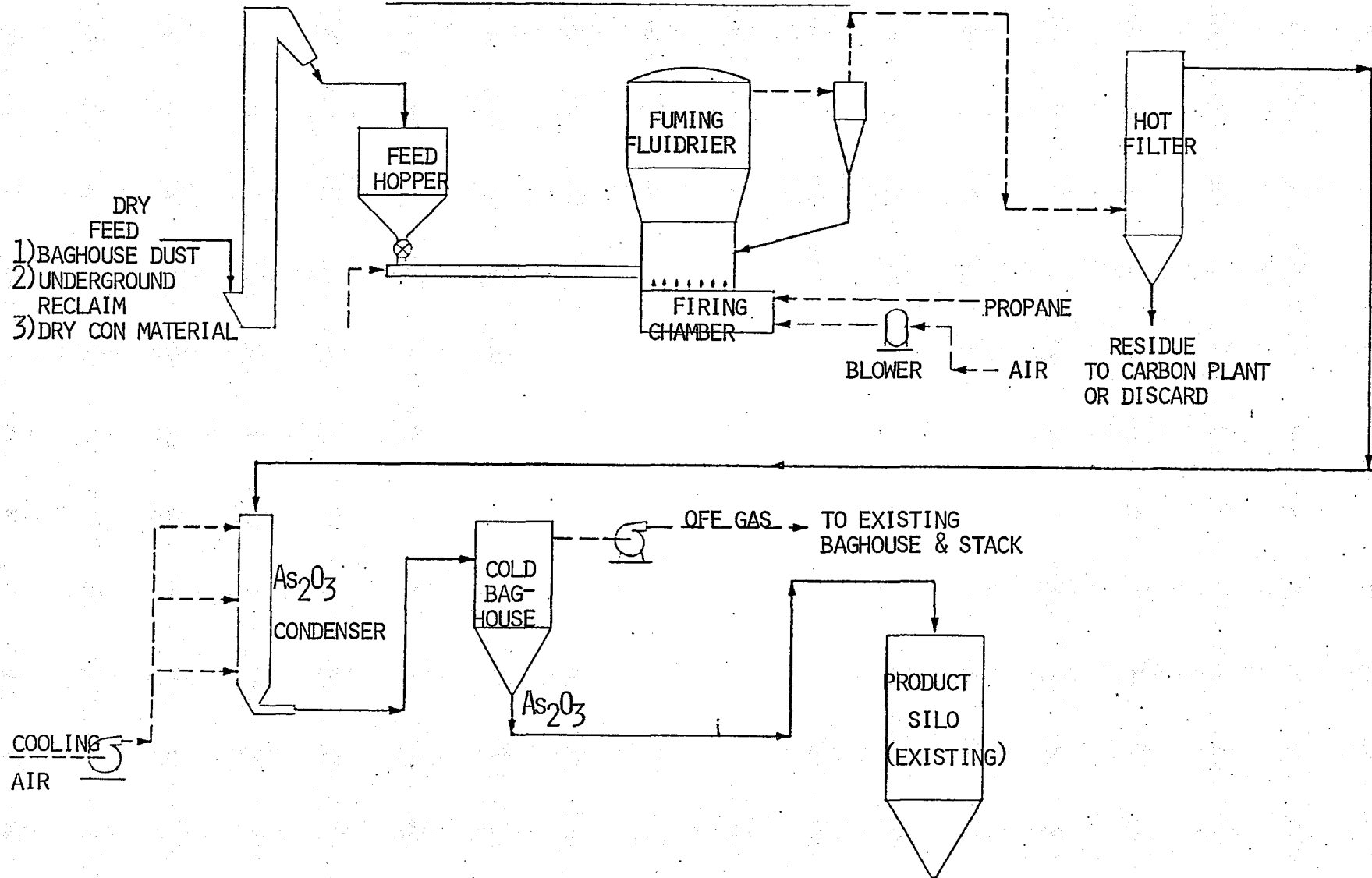
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### Fuming Circuit

- 1) Flowsheet
- 2) Mass and Energy balances for 3 cases
- 3) Gas composition and volumes for 3 cases
- 4) Equipment list & cost

# APPENDIX - B

## FIGURE B1 - FUMING CIRCUIT FLOWSHEET



### Case I

		Mass Rate		Heat effects K cal.		Total K cal in 000's
		Kg/Hr	Kg moles per Hour	Per Kg	Per Kg mole	
<u>Input</u>						
Dry Con pond material	@ 25°C	450.00	-	-	-	-
Baghouse dust	@ 25°C	450.00	-	-	-	-
Combustion air	@ 25°C	-	22.46	-	-	-
Propane		14.2	0.32	11,100	-	157.6
Total input						157.6
<u>Output</u>						
Residue	@ 400°C	194.8	-	75.0	-	14.6
As <sub>4</sub> O <sub>6</sub> vapours:						
:heat of volatolization		705.2	1.78	77.1	-	54.4
:sensible heat @ 400°C		-	-	22.5	-	15.9
Combustion products @ 400°C	CO <sub>2</sub>	-	0.97	-	3939	3.8
	H <sub>2</sub> O	-	1.29	-	3152	4.1
	O <sub>2</sub>	-	3.10	-	2779	8.6
	N <sub>2</sub>	-	17.74	-	2658	47.2
Heat losses		-	-	-	-	9.0
Total output						157.6

Table B 2 - Condenser Mass and Energy Balance

CASE I

	Mass Rate		Heat effects K cal.		Total K cal in 000's
	Kg/Hr	Kg moles per Hour	Per Kg	Per Keg mole	
<u>Input:</u>					
Sensible heat of fuming Fce off gases at 375°C : CO <sub>2</sub>	-	0.97	-	3354	3.3
H <sub>2</sub> O	-	1.29	-	2712	3.5
O <sub>2</sub>	-	3.10	-	2389	7.4
N <sub>2</sub>	-	17.74	-	2293	40.7
As <sub>4</sub> O <sub>6</sub>	705.2	1.78	21.0	-	14.8
heat of condensation of As <sub>4</sub> O <sub>6</sub> vapours	-	-	77.1		54.4
cooling air at 25° C	-	<u>101.50</u>	-	-	<u>0</u>
Total input		126.38			124.1
<u>Output:</u>					
Sensible heat of gases leaving condenser at 150°C : CO <sub>2</sub>	-	0.97	-	1192	1.2
H <sub>2</sub> O	-	1.29	-	1016	1.3
O <sub>2</sub>	-	24.42	-	893	21.8
N <sub>2</sub>	-	97.92	-	872	85.4
sensible heat of As <sub>2</sub> O <sub>3</sub> at 150°C	705.2	-	16.25	-	11.5
heat losses	-	-	-	-	<u>2.9</u>
Total output	-	124.60	-	-	124.1

Table B 3 - Fuming Furnace Mass &amp; Energy Balance

CASE 2

	Mass Rate		Heat effects K cal.		Total K cal in 000's
	<u>Kg/Hr</u>	<u>Kg moles per Hour</u>	<u>Per Kg</u>	<u>Per Keg mole</u>	
<u>Input</u>					
Baghouse dust at 25°C	450.0	-	-	-	-
Combustion air	-	12.00	-	-	-
Propane	7.6	<u>0.17</u>	11,100	-	<u>84.4</u>
Total input	-	12.17	-	-	84.4
<u>Output</u>					
Residue at 400°C	45	-	75.0	-	3.4
As <sub>4</sub> O <sub>6</sub> vapours : heat of volatalization	405	1.02	77.1	-	31.2
: sensible heat at 400°C	-	-	22.5	-	9.1
Combustion products at 400°C					
CO <sub>2</sub>	-	0.52	-	3939	2.0
H <sub>2</sub> O	-	0.69	-	3152	2.2
O <sub>2</sub>	-	1.66	-	2779	4.6
N <sub>2</sub>	-	9.48	-	2658	25.2
Heat Losses	-	<u>-</u>	-	-	<u>6.7</u>
Total output		13.37			84.4

Table B4 - Condenser Mass and Energy Balances

Case 2

		<u>Mass Rate</u>		<u>Heat effects</u> K cal.		<u>Total</u> K cal in 000's
		<u>Kg/Hr</u>	<u>Kg moles</u> per <u>Hour</u>	<u>Per Kg</u>	<u>Per</u> <u>Keg mole</u>	
<u>Input</u>						
Sensible heat of fuming furnace						
off gases @ 375°C:	CO <sub>2</sub>	-	0.52	-	3354	1.7
	H <sub>2</sub> O	-	0.69	-	2712	1.9
	O <sub>2</sub>	-	1.66	-	2389	4.0
	N <sub>2</sub>	-	9.48	-	2293	21.7
	As <sub>4</sub> O <sub>2</sub>	405	1.02	21.0	-	8.5
Heat of condensation of As <sub>4</sub> O <sub>6</sub> vapours	-	-	-	77.1	-	31.2
Cooling air @ 25°C	-	-	55.2	-	-	-
			<u>68.57</u>			<u>69.0</u>
Total input						
<u>Output</u>						
Sensible heat of gases leaving						
condenser at 150°C:	CO <sub>2</sub>	-	0.52	-	1192	0.6
	H <sub>2</sub> O	-	0.69	-	1016	0.7
	O <sub>2</sub>	-	13.25	-	893	11.8
	N <sub>2</sub>	-	53.10	-	872	46.3
Sensible heat of As <sub>2</sub> O <sub>3</sub> @ 150°C	405	-	-	16.25	-	6.6
Heat losses	-	-	-	-	-	<u>3.0</u>
			<u>67.56</u>			<u>69.0</u>

Table B5 - Fuming Furnace Mass & Energy BalanceCase 3

	Mass Rate		Heat effects K cal.		Total K cal in 000's
	Kg/Hr	Kg moles per Hour	Per Kg	Per Keg mole	
<u>Input</u>					
Baghouse dust @ 25°C	450.0	-	-	-	-
Reclaimed underground material	333.0				
Combustion air @ 25°C	-	21.00	-	-	-
Propane	13.0	<u>0.30</u>	11,100	-	<u>144.3</u>
Total input	-	21.3	-	-	144.3
<u>Output</u>					
Residue at 400°C	78.3	-	75.0	-	5.9
As <sub>4</sub> O <sub>6</sub> vapours:					
: heat of volatilization	704.7	1.78	77.1	-	54.3
: sensible heat @ 400°C	-	-	22.5	-	15.9
Combustion products @ 400°C					
CO <sub>2</sub>	-	0.90	-	3939	3.5
H <sub>2</sub> O	-	1.20	-	3152	3.8
O <sub>2</sub>	-	2.90	-	2779	8.1
N <sub>2</sub>	-	16.60	-	2658	44.1
Heat losses	-	<u>-</u>	-	-	<u>8.7</u>
Total output		23.38			144.3

Table B 6 - Condenser Mass &amp; Energy Balance

CASE 3

	Mass Rate		Heat effects K cal.		
	Kg/Hr	Kg moles per Hour	Per Kg	Per Kg mole	Total K cal in 000's
<u>Input</u>					
Sensible heat in fuming furnace off gases at 375°C:					
CO <sub>2</sub>	-	0.90	-	3354	3.0
H <sub>2</sub> O	-	1.20	-	2712	3.3
O <sub>2</sub>	-	2.90	-	2389	6.9
N <sub>2</sub>	-	16.60	-	2293	38.1
As <sub>4</sub> O <sub>6</sub>	704.7	1.78	21.0	-	14.8
heat of condensation of As <sub>4</sub> O <sub>6</sub> vapours	-	-	77.1	-	54.3
cooling air at 25°C	-	96.00	-	-	-
Total input					120.4
<u>Output</u>					
Sensible heat of gases leaving condenser at 150°C:					
CO <sub>2</sub>	-	0.90	-	1192	1.1
H <sub>2</sub> O	-	1.20	-	1016	1.2
O <sub>2</sub>	-	23.06	-	893	20.6
N <sub>2</sub>	-	92.44	-	872	80.6
sensible heat of As <sub>2</sub> O <sub>3</sub> at 150°C	704.7	-	16.25	-	11.5
heat losses	-	-	-	-	5.4
Total output					120.4



## Appendix B

Table B 7 - Fuming Circuit Gas Composition and Volumes

1) Fuming Furnace Off Gases:			Case 1	Case 2	Case 3
Composition:	Vol %	CO <sub>2</sub>	3.9	3.9	3.9
		H <sub>2</sub> O	5.2	5.2	5.1
		O <sub>2</sub>	12.5	12.4	12.4
		N <sub>2</sub>	71.3	70.9	71.0
		As <sub>4</sub> O <sub>6</sub>	7.1	7.6	7.6
		Total	100.0	100.0	100.0
Volume	kg moles/Hr		24.9	13.4	23.4
	m <sup>3</sup> /Hr @ 400°C		1374	738	1291
	cfm @ 400°C		809	435	760
2) Condenser Outlet					
Composition:	Vol %	CO <sub>2</sub>	0.8	0.8	0.8
		H <sub>2</sub> O	1.0	1.0	1.0
		O <sub>2</sub>	19.6	19.6	19.6
		N <sub>2</sub>	78.6	78.6	78.6
		Total	100.0	100.0	100.0
Volume	kg moles/Hr		124.6	67.6	117.6
	m <sup>3</sup> /Hr @ 150°C		4325	2345	4082
	cfm @ 150°C		2545	1380	2402
3) Condenser Cooling air:					
	kg moles/Hr		101.5	55.2	96.0
	m <sup>3</sup> /Hr @ 15°C		2399.0	1304	2269
	scfm		1412.0	768	1335

Table B8 - Fuming Circuit Equipment List

(Sizes and costs apply to Case 1 &amp; Case 3 only)

Item No.	<u>Description</u>	Cost \$ Can
1)	Bucket Elevator 6" x 4" buckets (smallest available from FMC) 25 feet lift	15,000
2)	Feed hopper: 15 m <sup>3</sup> working volume 2.75 m diamter, 2 m high at straight section, 1.5 m high cone bottom: approx. wt. 2000 kg	4,500
3)	Fluidizer package unit to include: pneumatic feeder for metering the feed, cyclone, "dutch oven" type combustion chamber with burner, air compressor and controls. Fluidizer proper to be of 1.0 meter diameter in the hearth area, refractory lined to 1.2 meter height, 1.2 meter diameter freeboard, 3.5 meter high, the whole unit with external insulation.	130,000
4)	Hot Baghouse, Aerex Corporation type equipped with 24 Pyrotex B bags for continuous operation at 400°C, compartment with outside insulation, top entry for bag replacement and necessary controls and hardware for dust dislodging.	31,000
5)	Condenser - Cylindrical carbon steel vessel schedule 20, 18" pipe, 15 feet long, equipped with an axial inlet for arsenic bearing gases, multiple tangential inlet for cooling air and axial outlet for cooled gas. Approx. wt 900 lbs.	1,500
6)	Cold baghouse - Aerex type equipped with 64 pyrotex GT bags for continuous service at 150°C, carbon steel baghouse compartment with top entry for bag replacement and controls	13,000
7)	Condenser cooling air blower, Sheldon exhausted, Size 9 type X0, for 1600 scfm at 8" W.G., ambient temperature	1,650
8)	Tail gas exhaust fan, for 2,500 AC/m at 150°C, 6" W.G. Sheldon, exhauster, size 11, type X0	2,200
		<hr/> Total estimated equipment cost
		198,850
		say 200,000