SECTION 4

PROCESS INFORMATION

Attachment 4-9
Thermal Desorber Mass and Energy Balance

MIXED WASTE FACILITY
RCRA/TSCA PERMIT APPLICATION

PERMA-FIX NORTHWEST RICHLAND, INC.

RICHLAND, WASHINGTON

THERMAL DESORBER SOLIDS TREATMENT LINE (200s):

	NET SHREDDED WASTE TO THERMAL DESORBER	BURNER FLUEGAS TO EVAPORATOR HEATER	SOLIDS TO COOLER	COOLED SOLIDS TO STABILIZATION	PROCESS VAPOR TO CONDENSER	VAPOR CONDENSATE	FILTER SOLIDS AND MEDIA	PROCESS VAPOR TO REHEAT	PROCESS VAPOR TO BAGHOUSE	BAGHOUSE RESIDUE TO STABILIZATION	PROCESS VAPOR TO VOC/Hg REMOVAL	VOC/Hg SPENT CARBON TO STABILIZATION	PROCESS VAPOR TO BLOWER	PROCESS VAPOR BLOWER EXIT	ORGANIC / AQUEOUS CONDENSATE	ORGANIC LIQUIDS TO COLLECTION	ORGANIC -CONTAMINATED AQUEOUS LIQUIDS	TOTAL SOLIDS TO STABILIZATION	COMPACTED DRUMS	COMPACTED DRUMS AND OVERSIZE METAL	VOC/Hg REMOVAL OFFGAS TO VENT
Stream No.	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
Temperature (°F)	70	1354.368	1200	200	1200	50	70	50	80	75	75	75	75	80	0	0	50	0	70	70	70
Pressure (psia)	14.32	14.35	14.28	14.32	14.28	14.24	14.32	14.24	14.21	14.03	14.03	0.00	13.92	14.35	0.00	0.00	0.00	0.00	14.32	14.32	14.32
Total Mass Flow (lb/hr)	552.4	3295.7	498.9	498.9	103.5	165.2	9.1	71.5	71.5	2.9	68.5	197.0	68.5	68.5	156.1	47.4	108.7	1030.0	452.0	493.4	50.5
Gases, Total (lb-mole/hr)	0	116.17	0	0	3.799	0.000	0.000	2.007	2.007	0	2.007	0.206	2.007	2.007	0.000	0.000	0.000	0.000	0.000	0.000	1.797
CO2	0	4.35	0	0	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO	0	0.00	0	0	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
H2O	0	8.70	0	0	1.976	0.000	0.000	0.025	0.025	0	0.025	0.000	0.025	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.023
H2	0	0.00	0	0	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N2	0	88.34	0	0	1.701	0.000	0.000	1.701	1.701	0	1.701	0.000	1.701	1.701	0.000	0.000	0.000	0.000	0.000	0.000	1.701
O2	0	14.78	0	0	0.072	0.000	0.000	0.072	0.072	0	0.072	0.000	0.072	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.072
Ar	0	0.00	0	0	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
H2S	0	0.00	0	0	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SO2	0	0.00	0	0	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CH4	0	0.00	0	0	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LHC	0	0.00	0	0	0.033	0.000	0.000	0.207	0.207	0	0.207	0.205	0.207	0.207	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HHC	0	0.00	0	0	0.016	0.000	0.000	0.002	0.002	0	0.002	0.002	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
(lb/hr)	0	3295.7	0	0	90.722	0.000	0.000	68.516	68.516	0	68.516	17.905	68.516	68.516	0.000	0.000	0.000	0.000	0.000	0.000	50.421
(ACFM)	0	2627	0	0	79	0	0	13	14	0	14	0	14	14	0	0	0	0	0	0	12
(SCFM)	0	749	0	0	24	0	0	13	13	0	13	1	13	13	0	0	0	0	0	0	12
Liquids, Total (lb/hr)	8.01	0.00	0.00	0.00	0.00	159.04	3.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	156.01	47.37	108.63	16.57	16.57	16.57	0.00
Water	2.87	0.00	0.00	0.00	0.00	111.30	2.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.43	0.00	108.43	10.75	10.75	10.75	0.00
LHC	2.84	0.00	0.00	0.00	0.00	15.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.53	15.53	0.00	3.32	3.32	3.32	0.00
HHC	2.30	0.00	0.00	0.00	0.00	32.21	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.05	31.84	0.20	2.50	2.50	2.50	0.00
(gpm)	0.018	0.000	0.000	0.000	0.000	0.319	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.313	0.096	0.217	0.035	0.035	0.035	0.000

THERMAL DESORBER SOLIDS TREATMENT LINE (200s):

Stream No.	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
	NET SHREDDED WASTE TO THERMAL DESORBER	BURNER FLUEGAS TO EVAPORATOR HEATER	SOLIDS TO COOLER	COOLED SOLIDS TO STABILIZATION	PROCESS VAPOR TO CONDENSER	VAPOR CONDENSATE	FILTER SOLIDS AND MEDIA	PROCESS VAPOR TO REHEAT	PROCESS VAPOR TO BAGHOUSE	BAGHOUSE RESIDUE TO STABILIZATION	PROCESS VAPOR TO VOC/Hg REMOVAL	VOC/Hg SPENT CARBON TO STABILIZATION	PROCESS VAPOR TO BLOWER	PROCESS VAPOR BLOWER EXIT	ORGANIC / AQUEOUS CONDENSATE	ORGANIC LIQUIDS TO COLLECTION	ORGANIC -CONTAMINATED AQUEOUS LIQUIDS	TOTAL SOLIDS TO STABILIZATION	COMPACTED DRUMS	COMPACTED DRUMS AND OVERSIZE METAL	VOC/Hg REMOVAL OFFGAS TO VENT
Solids, Total (lb/hr)	544.4	0.0	498.9	498.9	12.8	6.2	6.1	3.0	3.0	2.9	0.0	179.0	0.0	2.98E-02	0.1	0.0	0.1	1013.4	435.4	476.9	0.1
Soil/Ash/Inert Solids	98.5	0.0	96.1	96.1	2.5	1.2	1.2	0.9	0.9	0.9	0.0	0.0	0.0	9.31E-03	0.0	0.0	0.0	98.4	0.8	0.8	0.0
Moisture	32.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Light HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solid Organics	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.0	0.0	0.0	8.24E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Combustibles	82.9	0.0	80.8	80.8	2.1	1.0	1.0	0.8	0.8	0.8	0.0	0.0	0.0	8.24E-03	0.0	0.0	0.0	81.8	0.0	0.0	0.0
Vermiculite	207.2	0.0	202.0	202.0	5.2	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.00E+00	0.0	0.0	0.0	204.6	0.0	0.0	0.0
Clay Solid Absorbant	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00E+00	0.1	0.0	0.1	0.0	0.0	0.0	0.0
Cans/Bottles/Metals	98.0	0.0	95.5	95.5	2.4	1.2	1.2	0.2	0.2	0.2	0.0	0.0	0.0	2.19E-03	0.0	0.0	0.0	573.1	434.5	476.0	0.0
Spent Carbon	25.2	0.0	24.6	24.6	0.6	0.3	0.3	0.2	0.2	0.2	0.0	179.0	0.0	1.78E-03	0.0	0.0	0.0	55.5	0.0	0.0	0.0
Filter Media	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Enthalpy (BTU/hr)	0	1,131,625	154,566	17,782	41,666	-750	0	-346	0	0	0	0	0	0	0	0	0	0	0	0	0
Solids	0.0	0.0	154566.2	17782.0	3963.2	-35.1	0.0	-35.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Liquids	0.0	0.0	0.0	0.0	0.0	-714.8	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gases	0.0	1131625.3	0.0	0.0	37702.8	0.0	0.0	-311.0	0	0	0	0	0	0	0	0	0	0	0	0	0

LIQUID WASTE TREATMENT PROCESSING LINE (300s):

	BULK FLAMMABLE LIQUIDS INPUT	LIQUIDS REQUIRING NEUTRALIZATION/ DEACTIVATION	MIXED LIQUID TO COLLECTION	ORGANIC LIQUIDS TO COLLECTION	EMPTY DRUMS TO COMPACTION	AQUEOUS LIQUIDS TO NEUTRALIZE	SOLID TRASH FROM CONTAINER DRAINING	AQUEOUS TO TRACE ORGANICS REMOVAL	SPENT CARBON TO REPACK/STORE	AQUEOUS LIQUID TO COLLECTION TANKS	ORGANIC LIQUIDS TO FEED TANKS
Stream No.	**300**	**301**	**302**	**303**	**304**	**305**	**306**	**307**	**308**	**309**	**310**
Temperature (°F)	70	70	70	70	70	70	70	70	70	70	70
Pressure (psia)	14.32	14.32	14.32	14.32	14.32	14.32	14.32	14.32	0.00	0.00	14.32
Total Mass Flow (lb/hr)	0.0	384.68	384.7	115.47	70.72	200.00	31.23	494.58	29.85	489.61	117.25
Liquids, Total (lb/hr)	0.00	298.98	298.98	115.23	16.57	199.59	0.00	494.18	4.97	489.20	117.02
Water	0.00	182.71	182.71	10.21	10.75	194.06	0.00	488.65	0.00	488.65	10.21
LHC	0.00	66.44	66.44	59.96	3.32	3.16	0.00	3.16	2.84	0.32	59.96
HHC	0.00	49.83	49.83	45.06	2.50	2.37	0.00	2.37	2.13	0.24	46.84
(gpm)	0.000	0.643	0.643	0.272	0.035	0.401	0.000	0.989	0.012	0.977	0.275
Solids, Total (lb/hr)	0.00	85.70	85.70	0.23	54.16	0.40	31.23	0.40	24.87	0.40	0.23
Soil/Ash/Inert Solids	0.00	16.61	16.61	0.12	0.83	0.20	15.52	0.20	0.00	0.20	0.12
Moisture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Light HC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heavy HC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solid Organics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Combustibles	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
Vermiculite	0.00	0.00	0.00	0.00	0.01	0.00	0.12	0.00	0.00	0.00	0.00
Clay Solid Absorbant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cans/Bottles/Metals	0.00	69.09	69.09	0.12	53.31	0.20	15.52	0.20	0.00	0.20	0.12
Spent Carbon	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	24.87	0.00	0.00
Filter Media	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

"What we used in the AMWTP was 7 ft/sec for liquids with viscosities close to water. For liquids with viscosities significantly higher than water (ie. heavy organics), maybe 3 ft/sec. For gases, it depends on temperature. For room temperature gases go with 30 ft/sec, for hot gases (~1,200F) go with 55 ft/sec and for really hot gases (~2,200F) go with 70 ft/sec." JSV 7/29/04

Solids leaving Thermal Desorber assumed to have a density of 70 lbs/ft^3.

Activated carbon density = 30 lbs/ft^3.

Metal trash assumed to have a density of 120 lbs/ft^3.

Stream Number	Stream Description	Fluid	Transport Method	Volumetric Flow Rate	Flowrate units	Design Velocity (ft/sec)	Pipe ID Required (in)
100	GROSS SOLID WASTE TO DUMP STATION	solid	Drums by Forklift	6.15	drums/hr	---	---
101	DRAINED ORGANIC LIQUIDS	liquid	Liquid Tote by Forklift	13.79	gph	---	---
102	METALS FROM DUMP STATION	solids	Totebin by Forklift	3.52	ft^3/hr	---	---
103	OVERSIZE METAL OBJECTS	solids	Totebin by Forklift	0.35	ft^3/hr	---	---
104	DRUMS TO COMPACTION	solids	Totebin by Forklift	6.15	drums/hr	---	---
105	DRAINED AQUEOUS LIQUIDS	liquid	Liquid Tote by Forklift	35.30	gph	---	---
106	NET SOLID WASTE TO SHREDDING	solids	Totebin by Forklift	38.4	ft^3/hr	---	---
107	SHREDDED WASTE TO REPACK	solids	Totebin by Forklift	38.4	ft^3/hr	---	---
108	NET SHREDDED WASTE TO SOLIDS FEEDING	solids	Totebin by Forklift	38.4	ft^3/hr	---	---
200	NET SHREDDED WASTE TO THERMAL DESORBER	solids	Solids Feed Auger	38.4			
201	BURNER FLUEGAS TO EVAPORATOR HEATER	gas	Hi Temp Duct	2627.2	ACFM	55	12.08
202	SOLIDS TO COOLER	solids	Hi Temp Chute	7.13	ft^3/hr		
203	COOLED SOLIDS TO STABILIZATION	solids	Hi Temp Totebin by Forklift	7.13	ft^3/hr	---	---
204	PROCESS VAPOR TO CONDENSER	gas	Hi Temp Duct	79.0	ACFM	55	2.10
205	VAPOR CONDENSATE	liquid	pipe	0.319	gpm	7	0.137
206	FILTER SOLIDS AND MEDIA	solids	Totebin by Forklift	0.130	ft^3/hr	---	---
207	PROCESS VAPOR TO REHEAT	gas	pipe	12.85	ACFM	30	1.14
208	PROCESS VAPOR TO BAGHOUSE	gas	pipe	13.64	ACFM	30	1.18
209	BAGHOUSE RESIDUE TO STABILIZATION	solids	Totebin by Forklift	0.0421	ft^3/hr	---	---
210	PROCESS VAPOR TO VOC/Hg REMOVAL	gas	pipe	13.69	ACFM	30	1.18
211	VOC/Hg SPENT CARBON TO STABILIZATION	solids	Totebin by Forklift	6.565	ft^3/hr	---	---
212	PROCESS VAPOR TO BLOWER	gas	pipe	13.80	ACFM	30	1.19
213	PROCESS VAPOR BLOWER EXIT	gas	pipe	13.51	ACFM	30	1.17
214	ORGANIC / AQUEOUS CONDENSATE	liquid	pipe	0.313	gpm	7	0.135
215	ORGANIC LIQUIDS TO COLLECTION	liquid	pipe	0.096	gpm	7	0.075
216	ORGANIC -CONTAMINATED AQUEOUS LIQUIDS	liquid	pipe	0.217	gpm	7	0.113
217	TOTAL SOLIDS TO STABILIZATION	solids	Totebin by Forklift	14.7	ft^3/hr	---	---
218	COMPACTED DRUMS	solids	Totebin by Forklift	3.8	ft^3/hr	---	---
219	COMPACTED DRUMS AND OVERSIZE METAL	solids	Totebin by Forklift	4.1	ft^3/hr	---	---
220	VOC/Hg REMOVAL OFFGAS TO VENT	gas	pipe	11.90	ACFM	30	1.10
310	ORGANIC LIQUIDS TO FEED TANKS	liquid	pipe	0.275	gpm	7	0.127

Vapor Condenser

Max Heat Removal Load (BTU/hr) =	192,488.00
Cooling Water Inlet Temperature (°F)	25
Counter-current flow regime	
Scrub Temp leaving the cooler (°F) =	35
Heat Capacity of water (BTU/lb-°F) =	1.0

Cooling Water Flow (lb/hr)	Cooling Water Exit Temp (°F)
1000	217.5
1500	153.3
1200	185.4
1300	173.1
1400	162.5
1350	**167.6**

A cooling water flow of 1350 lb/hr = 161.8 gph, which requires a pipe ID of 0.397" for a design velocity of 7 ft/sec

Solids Cooler

Max Heat Removal Load (BTU/hr) =	163,851
Cooling Water Inlet Temperature (°F)	45.0
Solids Exit Temperature (°F) =	200
Solids Inlet Temperature (°F) =	1200

Counter-current Flow Regime, use 45 °F cooling water.

Cooling Water Flow (lb/hr)	Cooling Water Exit Temp (°F)	
1300	171.0	
1400	162.0	
1200	**181.5**	**Looks Good! = 143.8 gph**
1100	194.0	

Input Data:

Kiln Firing Rate:	1.00E+06	BTU/hr	max firing rate 1.5E6 btu/hr
Heat Zone length:	18.5	ft	
Kiln ID	24	in	
Shroud OD	46	in	
Shroud Length	18.5	ft	
Shroud Skin Temp	300	deg F	

Light Organics (n-Hexane)

Formula	C6H14
MW (lb/lbmole)	86.1766
Cp (BTU/lbmol -R)	70.36
Hvap (BTU/lbmol)	13572.8145

Data from JSV visit in May, 2004

<u>Heat Transfer from outside of shroud</u>

Q=hA(Tw-Tam)		F
(Tw-Tam)	250	ft^2
A=Pi*D*L	222.791279	BTU/hr-ft^2_F
$h=(h_c+h_r)$	2.51	
		B TU/hr
Qshroud	140004.4112	

Heat to Fluegas

Tavg	700	
DeltaT	1300	BTU/lb
HHV of CH4	21502	lb/lbmol
btu/lbmol for CH4 =	344032	
lbmol/hr CH4 =	2.907	

XS Air = 100.00%

Stoiciometric cals	Stoiciometric	Times Stoichiometric	2	a	b	c	BTU/ lbmol-F Cp	BTU/ lbmol =mCpDeltaT
air required	27.701	55.402						
comb products (lbmol/hr)								
CO2	2.907	2.907		10.34	0.00274	-195500	11.859	44811.9
H2O	5.813	5.813		8.22	0.00015	1E-06	8.9816	67877.87
N2	21.88372012	43.76744		6.5	0.001	0	7.2	409663.2
O2	0	5.817		8.27	0.00026	-187700	8.06754	61009.54
								583362.6
	BTU/hyr							
Qflugas	583362.552							

Heat Balance on Thermal Desorber (BTU/hr)

			Max Firing Rate	
Qin	1.00E+06		1.50E+06	BTU/hr
Qout		%		
Qshroud	140004.4112	14.0%	210007	BTU/hr
Qflugas	583362.552	58.3%	875044	BTU/hr
Qtokiln	2.77E+05	27.7%	414950	BTU/hr
	1.00E+06		1.50E+06	BTU/hr

Horizontal pipe natural convection heat losses

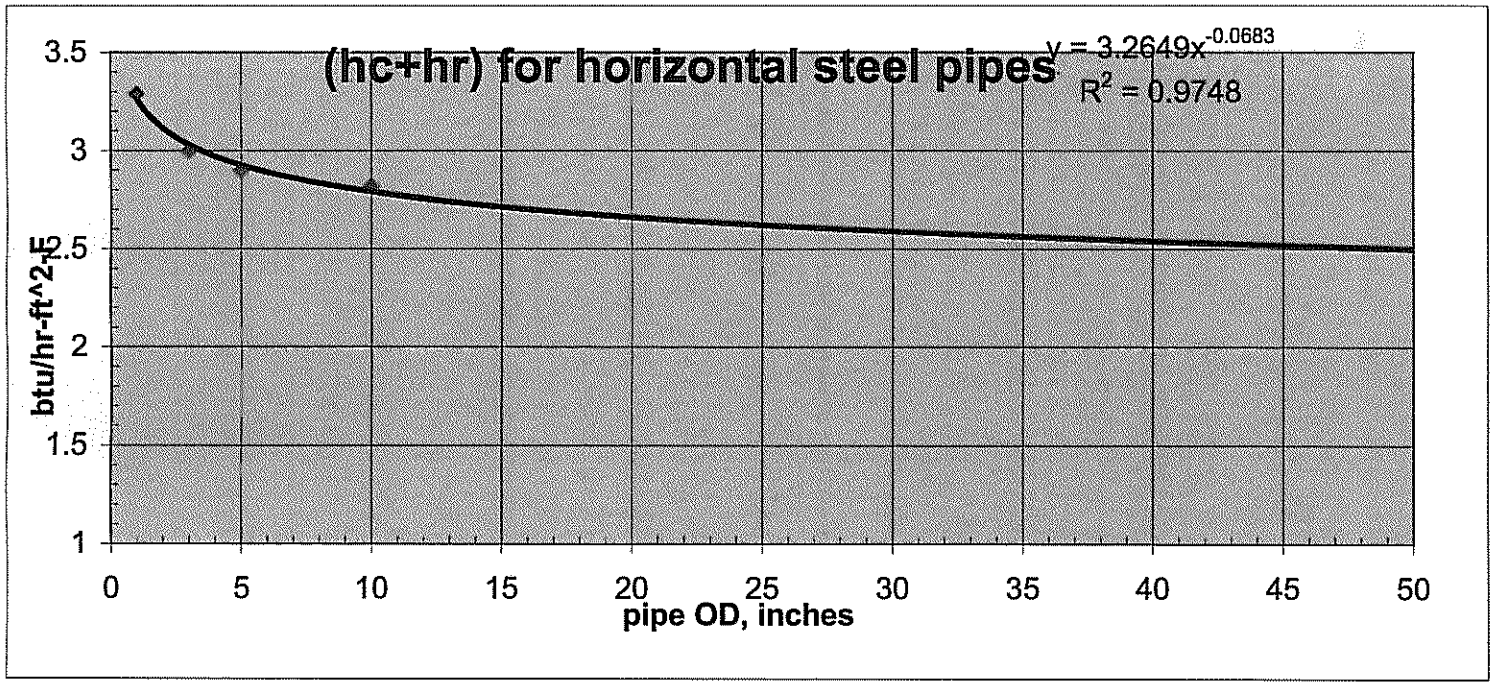
Ref: Perrys 5th, p 10-11, table 10-2

Horizontal bare steel pipe in a room at 80 F.

Delta T Skin - ambient = 250F

h units are btu/hr-ft^2-F from pipe to ambient, combined natural convection and radiation.

Nominal pipe diameter (in)	(h_c+h_r)
1	3.29
3	3
5	2.9
10	2.82



Reference: PEcoS MLLW Functional Diagram (Rev 2) 6-14-04

Assumptions:

Light Hydrocarbons represented by n-Hexane	
Heavy Hy represented by 1,3,dichlorobenzene	
Solids elutriation from kiln (Wt % of solid feed in)	2.5%
N2 glovebox exhaoust (lb/hr)	40.00
Thermal Desorber Inleakage Air (lb/hr)	10.00
Thermal Desorber Solids Exit Temp (F)	1200
Energy Available for solids and vapor at Max firing rate (Btu/hr)	414,950
Ambient Temperature (deg F)	70
Percent Labpack Liquids decanted:	90%
XS Air ratio in Thermal Desorber Burners (times	2.0
Particulate Removal Efficiency in Vapor Conden	50%
Gas Reheater Delta T (F)=	30
Atmospheric Pressure (psia) =	14.5
Thermal Desorber Pressure Drop (in WC) =	2
Condenser Pressure Drop (in WC) =	3
Reheater Pressure Drop (in WC) =	1
Baghouse Pressure Drop (in WC) =	3
Baghouse Temperature Drop (F)	5
Baghouse Particulate Removal Efficiency =	90%
Condensate Solids Filtration Efficiency =	95%
Wet Solids Moisture Content =	50%
Organics/Aqueous Separation Efficiency=	95%
Carbon Organics Absorbtion Efficiency=	98%

Conversion:

Ideal Gas Const	10.73
in w.g./psia	27.673
deg F to R	459.67
deg C to K	273.15
sec/min	60
min/hr	60
mole % O2 in Air	21
mm Hg/psia	51.7126

Data:

Percent XS air in Thermal Desorber Burners: 100.00%

Physical and Thermal Properties:

VP eqn constants

a	b	c
6.87601	1171.17	224.41
7.0401	1607.05	213.38

test deg F 50
test deg C 10

Species	name	Formula	MW	SpG	BTU/lbmol F @ 980F - c	BTU/lb Hvap	VP (psia)
Light HC	n-Hexane	C6H14	86.1766	0.659	70.36	157.5	1.466
Heavy HC	1,3 dichlorobenzene	C6H4Cl2	147.0036	1.2884	63.5	127.9	0.0136
H2O	water		18.0152	1	9.198	982	0.178
O2			31.9988		8.183		
N2			28.0134		7.3		
Soil					*0.250*	*BTU/lb-deg F*	
Clay					*0.224*	*BTU/lb-deg F*	
Vermicullite					*0.33*	*BTU/lb-degF*	
Solid Organics					*0.4*	*BTU/lb-degF*	
Combustibles					*0.32*	*BTU/lb-degF*	
Cans/Bottles/Metals					*0.16*	*BTU/lb-degF*	
liquid water					*1.0*	*BTU/lb-degF*	

Feed Compositions (wt %)

RCRA MLLW

	Soils	Lab Packs - Aqueous Liquids	Lab Packs - Organic Liquids	Flammable Solids	Absorbed Liquids - Aqueous	Absorbed Liquids - Organics	Organic Sludges / Particulates	Organic Solids
Soil/Ash/Inert Solids	60%	10%	10%	15%			30%	10%
Moisture	25%	40%	5%	10%	49%	2%		
Light HC	4%		17%	1%	1%	29%	32%	2%
Heavy HC	1%		18%	1%	1%	20%	36%	5%
Solid Organics	5%			34%				80%
Combustibles	0%	10%	10%	34%				
Vermiculite	0%	25%	25%					
Clay Solid Absorbant	0%				49%	49%		
Cans/Bottles/Metals	5%	15%	15%	5%			2%	3%

Input Streams:

Waste Feedrate (lb/hr)	625.4	1624.7	1504.6	802.4	442.1	676.1	610.3	900.9
Soil/Ash/Inert Solids	375.2	162.5	150.5	120.4	0.0	0.0	183.1	90.1
moisture	156.3	649.9	75.2	80.2	216.7	13.5	0.0	0.0
Light HC	25.0	0.0	255.8	8.0	4.4	196.1	195.3	18.0
Heavy HC	6.3	0.0	270.8	8.0	4.4	135.2	219.7	45.0
Solid Organics	31.3	0.0	0.0	272.8	0.0	0.0	0.0	720.7
Combustibles	0.0	162.5	150.5	272.8	0.0	0.0	0.0	0.0
Vermiculite	0.0	406.2	376.2	0.0	0.0	0.0	0.0	0.0
Clay Solid Absorbant	0.0	0.0	0.0	0.0	216.7	331.3	0.0	0.0
Cans/Bottles/Metals	31.3	243.7	225.7	40.1	0.0	0.0	12.2	27.0
	625.4	1624.7	1504.6	802.4	442.1	676.1	610.3	900.9
Misc. Inputs (lb/hr):								
N2 purges	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Air Inleakage	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Output Streams:

Misc Outputs (lb/hr):								
Decanted Aqueous Liquids:	0.0	584.9	67.7	0.0	0.0	0.0	0.0	0.0
Decanted Organic Liquids:	0.0	0.0	474.0	0.0	0.0	0.0	0.0	0.0

Thermal Desorber Calcs:								
Vapor exit pressure (psia)	14.428	14.428	14.428	14.428	14.428	14.428	14.428	14.428
Thermal Desorber Vapor OG (lbmol/hr)								
N2	1.701	1.701	1.701	1.701	1.701	1.701	1.701	1.701
H2O	8.678	3.607	0.418	4.454	12.026	0.751	0.000	0.000
O2	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072
L:HC	0.290	0.000	0.297	0.093	0.051	2.275	2.266	0.209
HHC	0.043	0.000	0.184	0.055	0.030	0.920	1.495	0.306
Particulates (lb/hr)	10.162	18.278	16.927	16.651	5.416	8.282	4.578	20.270
Vapor flowrate (ACFM)	221.9	110.7	55.0	131.2	285.6	117.7	113.9	47.1
Kiln Solids (lb/hr)								
Soil/Ash/Inert Solids	365.8	158.4	146.7	117.4	0.0	0.0	178.5	87.8
Solid Organics	30.5	0.0	0.0	266.0	0.0	0.0	0.0	702.7
Combustibles	0.0	158.4	146.7	266.0	0.0	0.0	0.0	0.0
Vermiculite	0.0	396.0	366.7	0.0	0.0	0.0	0.0	0.0
Clay Solid Absorbant	0.0	0.0	0.0	0.0	211.2	323.0	0.0	0.0
Cans/Bottles/Metals	31.3	243.7	225.7	40.1	0.0	0.0	12.2	27.0
	427.6	956.5	885.8	689.5	211.2	323.0	190.7	817.5

Kiln Energy Balance (BTU/hr)								
Qvaporization								
Moisture	153,525	63,818	7,388	78,800	212,752	13,278	0	0
LHV	3,940	0	40,255	1,264	696	30,880	30,762	2,838
HHC	800	0	34,609	1,026	566	17,294	28,103	5,761
Heat to raise solids Temp								
Soil/Ash/Inert Solids	103,348	44,750	41,442	33,154	0	0	50,434	24,813
Solid Organics	13,780	0	0	120,237	0	0	0	317,611
Combustibles	0	57,281	53,046	96,190	0	0	0	0
Vermiculite	0	147,676	136,760	0	0	0	0	0
Clay Solid Absorbant	0	0	0	0	53,468	81,758	0	0
Cans/Bottles/Metals	5,653	44,062	40,805	7,254	0	0	2,207	4,886
Heat to raise vapor Temp								
N2	14,034	14,034	14,034	14,034	14,034	14,034	14,034	14,034
H2O	90,199	37,494	4,340	46,297	124,996	7,801	0	0
O2	670	670	670	670	670	670	670	670
L:HC	23,078	0	23,599	7,403	4,079	180,891	180,195	16,623
HHC	3,052	0	13,220	3,917	2,158	66,002	107,252	21,987
Particulates (lb/hr)	2,871	5,164	4,782	4,704	1,530	2,340	1,293	5,726
Total heat for dryin feed (BTU/hr)	**414,949**	**414,950**	**414,950**	**414,950**	**414,950**	**414,949**	**414,950**	**414,950**
BTU/lb of feed to TD	663.5	255.4	275.8	517.1	938.5	613.7	679.9	460.6
Manual Iteration Parameters								
New Feed rate guess (lb/hr)	625.356	1624.703	1504.605	802.447	442.147	676.089	610.349	900.872
Qbalance	0	0	0	0	0	0	0	0

Solids Cooler Calculations:								
Solids Mass Flow (lb/hr)	427.6	956.5	885.8	689.5	211.2	323.0	190.7	817.5
Solids Inlet Temp (F)	1200	1200	1200	1200	1200	1200	1200	1200
Solids Outlet Temp(F)	100	100	100	100	100	100	100	100
Cooler Heat Removal Duty (BTU/hr)	119,521	285,970	264,831	250,016	52,048	79,588	51,243	338,091
Cooling Water Inlet Temp (F)	60	60	60	60	60	60	60	60
Cooling Water Outlet Temp (F)	190	190	190	190	190	190	190	190
Cooling Water Flow (lb/hr)	919	2,200	2,037	1,923	400	612	394	2,601
" (gpm)	1.84	4.39	4.07	3.84	0.80	1.22	0.79	5.19

Vapor Condensation Calcs:								
Vapor Inlet Temp (F)	1200	1200	1200	1200	1200	1200	1200	1200
Vapor Exit Temp (F)	50	50	50	50	50	50	50	50
" (deg C)	10	10	10	10	10	10	10	10
Vapor Exit Pressure (psia)	14.319	14.319	14.319	14.319	14.319	14.319	14.319	14.319
Vapor Pressure H2O (psia)	0.178	0.178	0.178	0.178	0.178	0.178	0.178	0.178
Vapor Pressure LHC (psia)	1.466	1.466	1.466	1.466	1.466	1.466	1.466	1.466
Vapor Pressure HHC (psia)	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136
Mole Fraction of Condensibles in gas								
H2O	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0000	0.0000
LHC	0.1024	0.0000	0.1024	0.1024	0.1024	0.1024	0.1024	0.1024
HHC	0.0009	0.0000	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
Exit Vapor Composition (lb mol/hr)								
O2	0.0725	0.0725	0.0725	0.0725	0.0725	0.0725	0.0725	0.0725
N2	1.7013	1.7013	1.7013	1.7013	1.7013	1.7013	1.7013	1.7013
H2O	0.0250	0.0223	0.0250	0.0235	0.0230	0.0250	0.0000	0.0000
LHC	0.2054	0.0000	0.2054	0.0931	0.0513	0.2054	0.2025	0.2025
HHC	0.0019	0.0000	0.0019	0.0018	0.0018	0.0019	0.0019	0.0019
Particulates (lb/hr)	5.08	9.14	8.46	8.33	2.71	4.14	2.29	10.13
total lbmol/hr	2.0060	1.7961	2.0060	1.8922	1.8498	2.0060	1.9782	1.9782
total lb/hr	**73.487**	**59.519**	**76.870**	**67.015**	**57.780**	**72.548**	**69.996**	**77.842**
Vapor Flowrate (ACFM)	12.77	11.43	12.77	12.04	11.77	12.77	12.59	12.59

Condensate Composition (lb/hr)								
H2O	155.889	64.586	7.073	79.821	216.237	13.072	0.000	0.000
LHC	7.315	0.000	7.879	0.000	0.000	178.366	177.858	0.563
HHC	5.974	0.000	26.804	7.761	4.164	134.939	219.450	44.768
Particulates	5.081	9.139	8.463	8.325	2.708	4.141	2.289	10.135
total lb/hr	**174.259**	**73.724**	**50.219**	**95.907**	**223.110**	**330.518**	**399.597**	**55.466**
gpm	0.338	0.129	0.083	0.175	0.440	0.652	0.793	0.091
Condenser Heat Duty (BTU/hr)								
vapor sensible heat								
O2	682	682	682	682	682	682	682	682
N2	14,282	14,282	14,282	14,282	14,282	14,282	14,282	14,282
H2O	91,795	38,158	4,417	47,116	127,208	7,939	0	0
LHC	23,487	0	24,016	7,534	4,151	184,093	183,384	16,917
HHC	3,106	0	13,454	3,986	2,196	67,170	109,150	22,376
Particulates	2,922	5,255	4,866	4,787	1,557	2,381	1,316	5,828
Total Sensible heat load (BTU/hr)	136,274	58,377	61,718	78,388	150,077	276,548	308,815	60,085
vapor condensation								
H2O	153,083	63,423	6,946	78,384	212,345	12,837	0	0
LHC	1,152	0	1,241	0	0	28,093	28,013	89
HHC	764	0	3,428	993	533	17,259	28,068	5,726
Total Condensation heat load (BTU/hr)	154,999	63,423	11,615	79,376	212,878	58,188	56,080	5,815
al Condenser Heat Removal Load (BTU/hr)	**291,274**	**121,800**	**73,333**	**157,764**	**362,955**	**334,736**	**364,895**	**65,899**

Gas Reheater Calcs:								
Gas Inlet Temp (F)	50	50	50	50	50	50	50	50
Gas Outlet Temp (F)	80	80	80	80	80	80	80	80
Gas Outlet Pressure (psia)	14.283	14.283	14.283	14.283	14.283	14.283	14.283	14.283
Gas Composition (lbmol/hr)								
O2	0.0725	0.0725	0.0725	0.0725	0.0725	0.0725	0.0725	0.0725
N2	1.7013	1.7013	1.7013	1.7013	1.7013	1.7013	1.7013	1.7013
H2O	0.0250	0.0223	0.0250	0.0235	0.0230	0.0250	0.0000	0.0000
LHC	0.2054	0.0000	0.2054	0.0931	0.0513	0.2054	0.2025	0.2025
HHC	0.0019	0.0000	0.0019	0.0018	0.0018	0.0019	0.0019	0.0019
Particulates (lb/hr)	5.08	9.14	8.46	8.33	2.71	4.14	2.29	10.13
total lbmol/hr	2.0060	1.7961	2.0060	1.8922	1.8498	2.0060	1.9782	1.9782
total lb/hr	**73.4875**	**59.5194**	**76.8699**	**67.0152**	**57.7796**	**72.5475**	**69.9961**	**77.8421**
Offgas Exit Flowrate (ACFM)	13.55	12.14	13.55	12.79	12.50	13.55	13.37	13.37
Heat Duty (BTU/hr)								
O2	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8
N2	372.6	372.6	372.6	372.6	372.6	372.6	372.6	372.6
H2O	6.9	6.2	6.9	6.5	6.4	6.9	0.0	0.0
LHC	433.5	0.0	433.5	196.6	108.3	433.5	427.5	427.5
HHC	3.6	0.0	3.6	3.4	3.3	3.6	3.6	3.6
Particulates (lb/hr)	38.1	68.5	63.5	62.4	20.3	31.1	17.2	76.0
Reheater Heat Duty (BTU/hr)	**872.5**	**465.1**	**897.9**	**659.3**	**528.7**	**865.5**	**838.6**	**897.5**

Dry Particulate Removal Calcs:								
Inlet Gas Temp (F)	80	80	80	80	80	80	80	80
Outlet Gas Pressure (psia)	14.175	14.175	14.175	14.175	14.175	14.175	14.175	14.175
Outlet gas Temp (F)	75	75	75	75	75	75	75	75
Offgas (lbmol/hr)								
O2	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072
N2	1.701	1.701	1.701	1.701	1.701	1.701	1.701	1.701
H2O	0.025	0.022	0.025	0.024	0.023	0.025	0.000	0.000
LHC	0.205	0.000	0.205	0.093	0.051	0.205	0.203	0.203
HHC	0.002	0.000	0.002	0.002	0.002	0.002	0.002	0.002
Particulates (lb/hr)	0.51	0.91	0.85	0.83	0.27	0.41	0.23	1.01
total lbmol/hr	2.006	1.796	2.006	1.892	1.850	2.006	1.978	1.978
Offgas Flowrate (ACFM)	**13.53**	**12.12**	**13.53**	**12.76**	**12.48**	**13.53**	**13.34**	**13.34**
Baghouse Residues (lb/hr)	**4.57**	**8.23**	**7.62**	**7.49**	**2.44**	**3.73**	**2.06**	**9.12**

Solid/Liquid Separation Calcs:

Condensate In (lbs/hr)								
H2O	155.89	64.59	7.07	79.82	216.24	13.07	0.00	0.00
LHC	7.31	0.00	7.88	0.00	0.00	178.37	177.86	0.56
HHC	5.97	0.00	26.80	7.76	4.16	134.94	219.45	44.77
Particulates	5.08	9.14	8.46	8.33	2.71	4.14	2.29	10.13
total lb/hr	**174.26**	**73.72**	**50.22**	**95.91**	**223.11**	**330.52**	**399.60**	**55.47**
gpm	0.338	0.129	0.083	0.175	0.440	0.652	0.793	0.091
Solids Out to Repackage & Storage (lbs/hr)								
Solids	4.827	8.682	8.040	7.909	2.573	3.934	2.174	9.628
H2O	2.224	4.341	0.681	3.604	1.262	0.079	0.000	0.000
LHC	0.104	0.000	0.759	0.000	0.000	1.075	0.487	0.060
HHC	0.085	0.000	2.581	0.350	0.024	0.813	0.600	4.754
Total lbs/hr:	**7.240**	**13.023**	**12.060**	**11.864**	**3.859**	**5.901**	**3.262**	**14.442**
Condensate Out (lbs/hr)								
H2O	153.67	60.24	6.39	76.22	214.98	12.99	0.00	0.00
LHC	7.21	0.00	7.12	0.00	0.00	177.29	177.37	0.50
HHC	5.89	0.00	24.22	7.41	4.14	134.13	218.85	40.01
Particulates	0.25	0.46	0.42	0.42	0.14	0.21	0.11	0.51
total lb/hr	**167.02**	**60.70**	**38.16**	**84.04**	**219.25**	**324.62**	**396.34**	**41.02**
gpm	0.333	0.120	0.075	0.167	0.438	0.648	0.791	0.081