Heat Mass Balance - FS2000

Typical Clinical Waste		
Massflow	2000.00	kg/h
C	50.00	mass%
H	6.57	mass%
O	21.31	mass%
N	0.45	mass%
S	0.17	mass%
CL	1.50	mass%
ASH	10.00	mass%
H2O	10.00	mass%
TOTAL	100.00	mass%
GCV	22.80	MJ/kg

Sens Heat	14.31	kJ/s
GCV Heat	12168.29	kJ/s

HEAT LOSS		
Lining	121.73	kW

PRIMARY COMBUSTION CHAMBER

ASH		
Bottom Ash	190.28	kg/h
	49.5	kW

COMBUSTION AIR		
O2	6574.96	kg/h
N2	21655.87	kg/h
H20	163.51	kg/h
TOTAL	28394.34	kg/h

70%

AUXILIARY FUEL		
C	86.50	kg/h
H	13.20	kg/h
S	0.30	kg/h
TOTAL	100.00	kg/h

30%

30%

70%

HEAT LOSS		
Lining	198.61	kW

SECONDARY COMBUSTION CHAMBER

KG/HR@1120oC
=33.24Am3/sec

MINIMUM VALUE REQUIRED FOR 2 SECONDS = 75.42m3

DESIGN VOLUME = 80 M3
GAS RETENTION TIME = 2.17s @ 90% VOLUME UTILISATION

CHAMBER OFF GAS		
CO2	4051.44	kg/h
N2	21594.19	kg/h
O2	2870.00	kg/h
SO2	7.52	kg/h
HCl	2.9	kg/h
H2O	1771.19	kg/h
ASH	9.72	kg/h
TOTAL	30306.96	kg/h

DILUTION AIR		
O2	1,820.65	kg/h
N2	5,997.26	kg/h
H20	28.44	kg/h
TOTAL	7,846.35	kg/h

HEAT LOSS		
Lining	53.56	kW

HOT GAS TRANSFER DUCT

Steam	9113.35	kW

STEAM	
13451 kg/hr from feed water @ 80°C	

WASTE HEAT RECOVERY BOILER

ASH		
Dust	0.0972	kg/h

Sorbent Injection		
NaHCO3	40.00	kg/h
PAC	4.00	kg/h
O2	81.21	kg/h
N2	267.52	kg/h
H2O	1.27	kg/h
Total	394	kg/h

Flue Loss	4023.17	kW

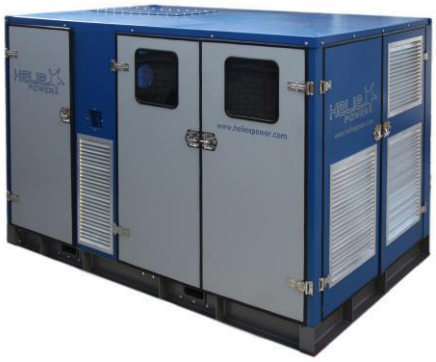
EXHAUST GAS		
CO2	4061.84	kg/h
N2	27858.97	kg/h
O2	4771.86	kg/h
SO2	0.16	kg/h
HCl	0.079	kg/h
H2O	1805.20	kg/h
TOTAL	38498.11	kg/h

APC FILTER

FILTER FLY ASH		
NaCl	4.68	kg/h
Na2SO4	16.71	kg/h
Na2CO3	8.35	kg/h
C	4.00	kg/h
ASH	9.62	kg/h
TOTAL	43.36	kg/h

Technical Data – Heliex GenSet

Steam Expander Generator Set HP204 500kW & 630kW



Description

The HP204 steam expander generator set is a fully integrated system which converts energy in the form of wet steam into clean electrical power.

Features

- Rugged screw expander technology
- Standalone packaged unit
- Industry standard key components
- Fully automated
- Soft start

Package design may vary.

Performance	HP204 – 500	HP204 – 630
Gross power output	Up to 500 kWe	Up to 630kWe
Auxiliary power input	Up to 2.5 kWe	Up to 2.5 kWe

Operating parameters		
Electrical	400V, 50Hz, 3ph+N	480v, 60Hz, 3ph+N *Option*
Ambient temperature	-10°C to +45°C	
Ambient humidity	<95% (non-condensing)	
Installation	Indoor or Outdoor	
Sound pressure level	<87dBA at 1 metre	
Steam mass flow rate range	Up to 15000kg/h	
Max. steam inlet temperature	221°C (saturated steam)	
Max. steam inlet pressure	23.5 Bar A	
Max. inlet-outlet ΔP	20 Bar	
Steam inlet dryness fraction	<97%	

Dimensions and foundations	
Dimensions	3610 X 1850 X 2230 mm (LWH)
Mass	Up to 9,000 kg
Lifting and handling	Standard forklift pockets 225 x 125 mm, 1400 mm between centres
Site foundation	Level load bearing surface 4000 X 2500 mm

Plant services and interconnections	
Steam inlet	DN100, PN25
Steam outlet	PN25 flange and depending on customer steam flow either DN150,200,250 or 300
Compressed air supply	7 bar g (Instrument air to ISO 8573.1 Class 2:3:1)
Electrical output	400V, 3 ph+N, continuous rating to suit generator protection device
Electrical input	400V, 3 ph+N
Remote monitoring	Internet bridge (via internet cable or optional wireless GPRS / UMTS Modem). BMS or SCADA systems - MODbus over RS232, RS485, USB, Ethernet.

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Document Ref: 19CM03079-B

Overall Plant Mass Balance

Global Settings

Ambient Temperature	20.00	°C	0.5792%
Excess Air %	77.93%		
Air Humidity %	0.5792%	(40% RH @ 20°C)	

PLANT INPUTS

	kg/hr AR	Free water %	kg/hr DB	kg/hr DAF	kg/hr water	kg/hr Ash	Chksum
Medwaste	**2000.00**	10.00%	1800.00	1600.00	200.00	200.00	2000.00

TOTAL WASTE 2000.00 kg/hr

Diesel Oil 100.00 kg/hr 122.55 litres/h

Maximum of 150 litres/h @ 816 g/l density

	Total Air	Stoich Air	XSAir	chksum	Air /Nm3/s
Medwaste Air	25667.22	14425.46	11241.76	0.00	5.57
Diesel Oil Air	2563.61	1440.80	1122.81	0.00	0.56
Total Air	28230.83	15866.26	12364.58	0.00	6.13
Air humidity	163.51	91.90	71.62	0.00	

Total Liquid Water 200.00 *Wste Air* 5.57 *Nm3/s*

Total Incombustibles 200.00

GROSS INPUTS **30494.35** kg/hr

PLANT OUTPUTS

	CO2	H2O	O2	N2	SO2	TOTALS
Medwaste Flue	3734.47	1289.72	2608.52	19627.60	6.92237	27267.22
Diesel Oil Flue	316.97	117.96	261.48	1966.59	0.59935	2663.61
Totals	4051.44	1407.68	2870.00	21594.19	7.52	29930.83
Dry Gas H @ T(D78)	5927982.05		3644455.82	29692932.11		

Free Water OUT	---------->				200.00
Humidity OUT	---------->				163.51
Ash OUT	---------->				200.00

GROSS OUTPUT **30494.35** kg/hr *Gas Massflow/s* **8.415** kg/s

C1 Water fract **0.058** m/m

GROSS GASEOUS **30294.35** kg/hr

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Overall Plant Heat Balance

THIS VERSION USES THE GAS HEAT CONTENT CALCULATED FROM THE ROGERS & MAYHEW AIR Cp AND WATER VAPOUR Cp TABLES. DRY GAS CALCULATION INDIVIDUAL N2, O2 AND CO2 IN FLUE GASES
ALL INPUT ENERGIES ARE REFERENCE TO 0°C, SEE R&M ENTHALPY SHEET, SO EVERY INPUT AT 20°C HAS AN ENERGY ASSOCIATED WITH IT. EITHER SENSIBLE HEAT (MASS X SPECIFIC HEAT X TEMPERATURE) OR AS CHEMICAL POTENTIAL ENERGY SHOWN AS "GCV HEAT" MOISTURE ENTHALPY INCLUDES Hfg

Global Settings

Diesel Oil Temp	20.00	°C
Air Input Temperature	20.00	°C
Output Temperature	1115.0	°C
Ref Temperature	0.00	°C

ENERGY INPUTS

	Cp	Latent	Embodied Heat	GCV Heat
Medwaste	1.61	dry solid	51520.00	43805839.49
Diesel Oil	2.22	liquid	4440.00	4570000.00
Total Air	1.01	gas	570262.87	
Water Vapour	from eqn ---------->		406777.82	
		Totals	1053104.69	48375839.49

ENERGY OUTPUTS

	kg/hr	Embodied Heat	
Dry Gas	28523.16	39265369.98	*KJ/hr*
Water Vapour	1771.19	8823004.909	*KJ/hr*
Ash	200.00	187320.00	*KJ/hr*
Case Losses	2.38%	1153249.29	*KJ/hr*
TOTAL		49428944.18	*KJ/hr*

ENERGY IN	49428944.18	*KJ/hr*
ENERGY OUT	49428944.18	*KJ/hr*
ENERGY BALANCE	0.00	*KJ/hr*

13730 kW

Goal seek to ZERO on gas D23 or on XSA D8 or on Temp D72)

Cksums 0.00

Mass, Molar and Volumetric Outputs

	CO2	H2O	O2	N2	SO2	Totals	
Mass Outputs	4051.442	1771.191	2870.001	21594.192	7.522	**30294.348**	***kg/hr***
Mass Fractions		0.058					
Molar mass	44.010	18.016	32.000	28.020	64.070	[redacted]	*kg*
kilogram mol outputs	92.057	98.312	89.688	770.671	0.117	1050.845	*kmol/hr*
STP Volume	2062.084	2202.191	2009.001	17263.023	2.630	**23538.928**	*Nm3/hr*
Actual Vol @ Tsec	10484.147	11196.486	10214.260	87769.510	13.370	**119677.774**	*Am3/hr*
v/v% Wet	**8.760%**	**9.356%**	**8.535%**	**73.338%**	**0.011%**	**100.000%**	
v/v% Dry	**9.664%**		**9.416%**	**80.908%**	**0.012%**	**100.000%**	

Secdr. Flow Am3/s	**33.24**	Am3/s
2s volume	**73.88**	m3
Actual Secondary V	**80.00**	m3
Actual Residence	**2.17**	s

Utilisation factor 90.00% 0.000 *Cksum*

Gas Absorption Coeff 0.000181158

PREDICT
ANALYS

Boiler Attemperation using Ambient Air

			Attemperation Air with Humidity				
Secondary Out T°C	1115.0	°C	*O2*	*N2*	*H2O*		
Boiler Entry T °C	925.0	°C	20.878%	78.542%	0.579%	100.000%	*v/v*
			6.681	22.008	0.104	28.793	*mole*
Dilution Gases Input	7846.4	kg/hr	23.204%	76.434%	0.362%	100.000%	*m/m*

	CO2	H2O	O2	N2	SO2	Totals	
Mass outputs	**4051.442**	**1771.191**	**2870.001**	**21594.192**	**7.522**	**30294.348**	***kg/hr***
Air Dilution	0.000	28.436	1820.653	5997.263	0.000	7846.352	*kg/hr*
Totals with Dilution	**4051.442**	**1799.627**	**4690.654**	**27591.456**	**7.522**	**38140.700**	***kg/hr***
kg mol outputs	92.057	99.890	146.583	984.706	0.117	1323.354	*kmol/hr*
NTP Volume	2062.084	2237.546	3283.458	22057.409	2.630	**29643.127**	*Nm3/hr*
	CO2	H2O	O2	N2	SO2	Totals	
m/m% Wet	***10.62%***	***4.72%***	***12.30%***	***72.34%***	***0.02%***	**100.000%**	
v/v% Wet	**6.956%**	**7.548%**	**11.077%**	**74.410%**	**0.009%**	**100.000%**	
v/v% Dry	**7.524%**		**11.981%**	**80.485%**	**0.010%**	**100.000%**	

Dry Gas (Diluted)	36341.07	*kg/hr*	Mass Checksum	0.000
Moisture (Diluted)	1799.63	*kg/hr*		
Enthalpy Dilution Dry	152349.61			
Enthalpy Dilution Wet	65407.33			

	CO2	O2	N2
Enthalpy Dry Gases	4771888.77	4840241.146	30717608.39
Enthalpy Dry Total	40329738.31		

FLUE GA
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163		*Enthalpy water*	7976393.51							
164		*TOTAL Enthalpy*	48306131.83							
165										
166		*Avaliable Enthalpy*	48306131.83							
167		*Difference*	0.00	Goal seek to zero on dilution input D142						
168										
169					**Stack °C**	**200.00**	**°C**			
170		***Flow Nm3/s***	**8.23**		**Am3/s Stack**	**14.267**	**Am3/h Stack**	**51359.70**		
171										
172										
173										
174		**SNCR Duct Length**								
175										
176		*Temp Post Dilution*	**925.00**	°C		*Duct Residence t sec*	**0.50**	s		
177		*Gas Volume @T*	**36.13**	Am3/s		*Volume requirement*	18.07	m3		
178						*Duct diameter*	1.55	m		
179						*Duct length*	10.00	m		
180						*Duct volume*	18.87	m3		
181						*Surface*	48.69	m2		
182										
183										
184										
185		**Boiler Steam Estimate**								
186										
187		***Gas Side***				***Steam Side***				
188		*Boiler Entry T*	**925.0**	°C		*Boiler Losses*	**3.00%**			
189		*Boiler Outlet T*	**250.0**	°C		*Boiler Pressure*	**9.00**	*Bar(a)*		
190						*Feedwater Temperature*	**80.00**	°C		
191		*Boiler Dry Gas Mass*	**36341.1**	*kg/hr*		*Feedwater Enthalpy*	334.90	*kJ/kg*		
192		*Boiler Moisture Mass*	**1799.6**	*kg/hr*		*Steam Enthalpy*	2774.00	*kJ/kg*		
193		*Total Boiler Gas Mass*	**38140.7**	*kg/hr*		*Enthalpy Difference*	2439.10	*kJ/kg*		
194						*Gross Steam Output*	**13450.88**	*kg/hr*		
195						*Steam kW*	**9113.35**	***kW***		
196						*Flue Loss*	**4023.17**	***kW***		
197			*CO2*		*O2*	*N2*				
198		*Enthalpy Dry Gases*	1069972.916		1171812.606	7311720.56				
199		*Enthalpy Dry Tot Out*	9553506.082	*kJ/hr*						
200		*Enthalpy water Out*	4929896.887	*kJ/hr*						
201		*TOTAL Enthalpy Out*	14483402.97	*kJ/hr*						
202										
203		*Recovered Enthalpy*	33822728.86	*kJ/hr*						
204		*Boiler Losses*	1014681.87	*kJ/hr*						
205		*Enthalpy to Steam*	32808046.99	*kJ/hr*						
206										
207										
208										