

Boiler Design

Heat Recovery Steam Generator (Reference)



Prepared by

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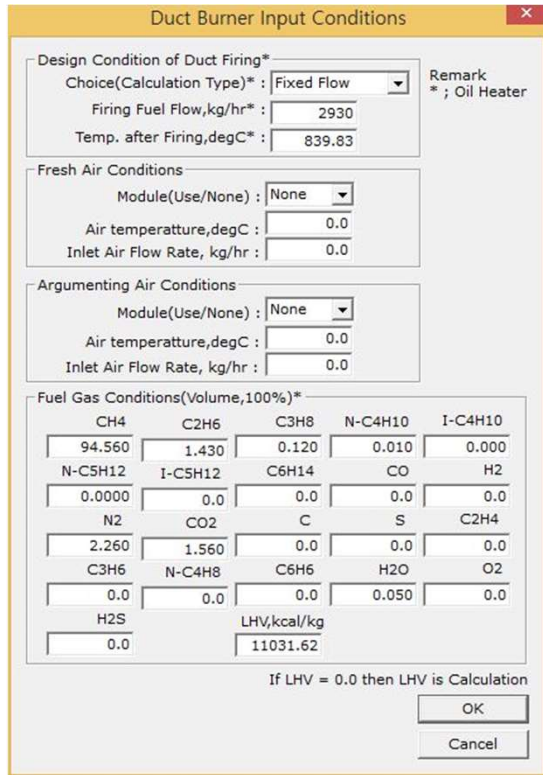
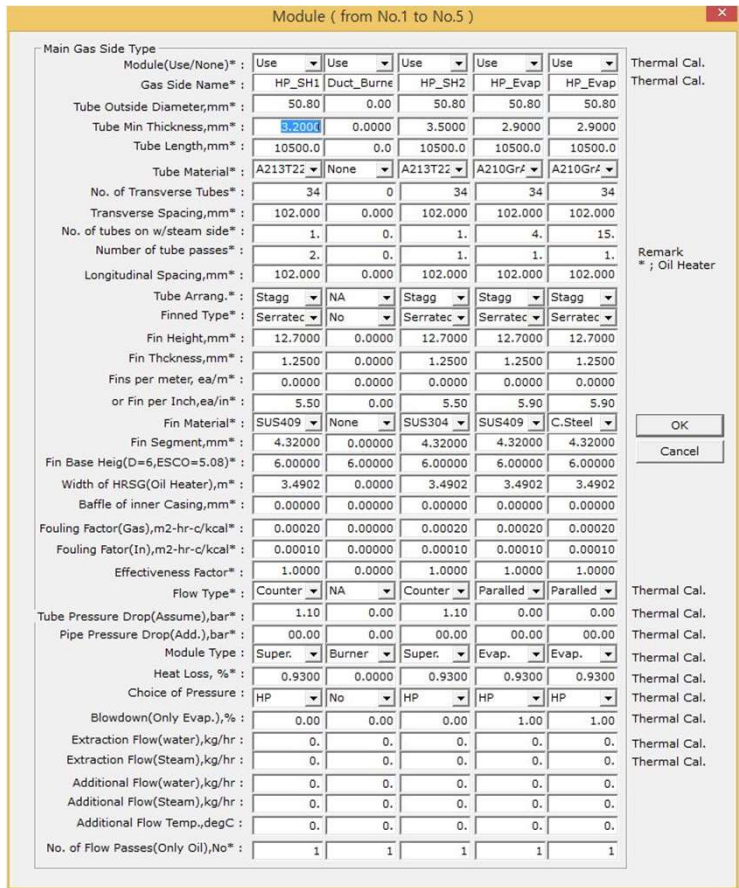
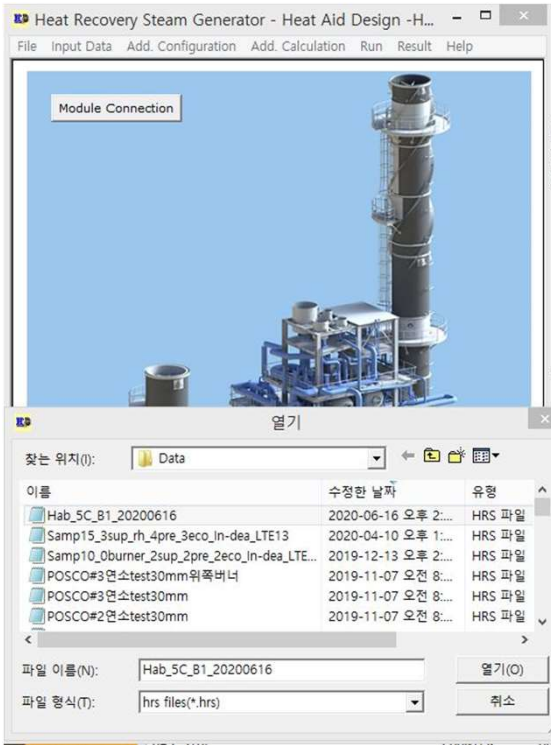


DAEKYUNG ENGINEERING CO., LTD.

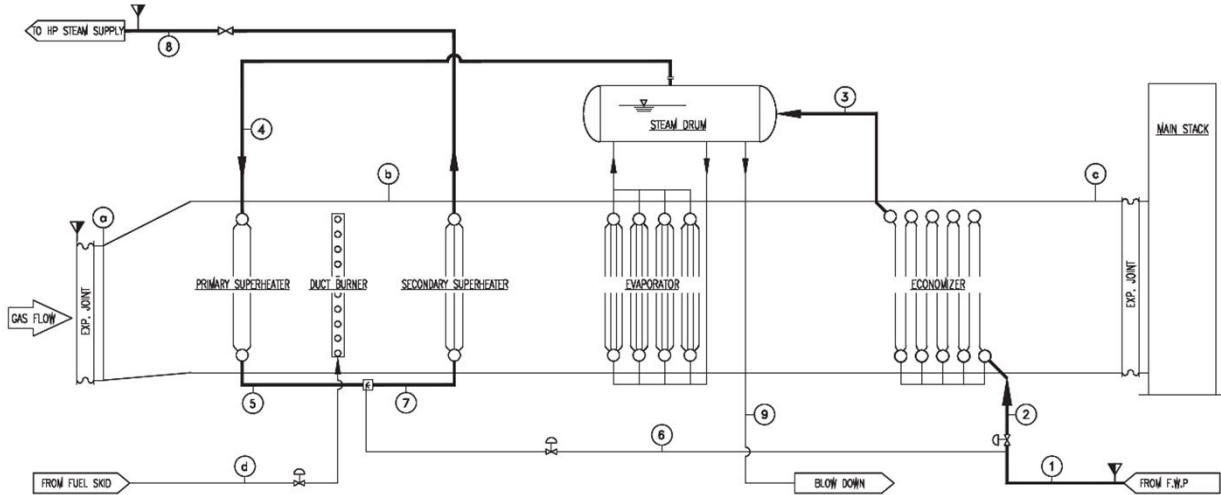
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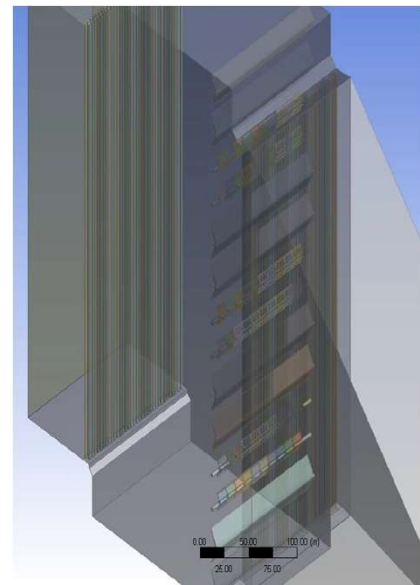
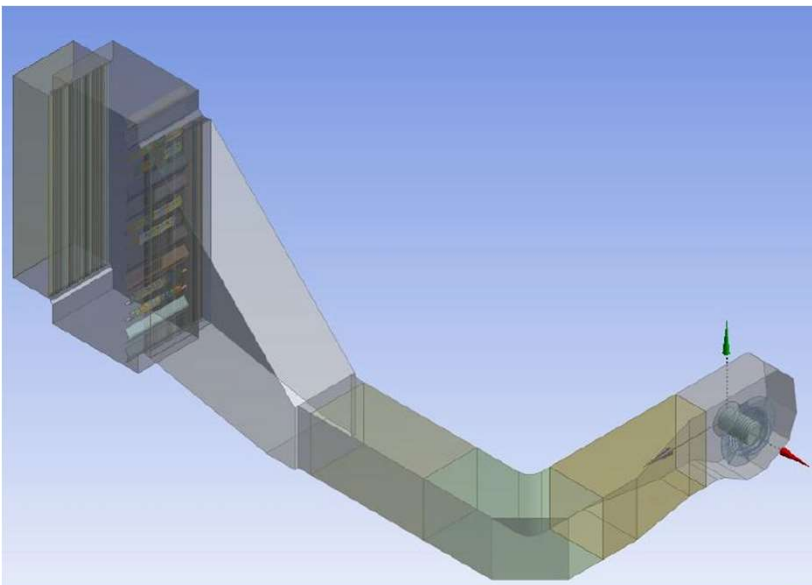
HRSG Design



Heat & Mass Balance



STREAM NO.		a	b	c	d	1	2	3	4	5	6	7	8
FLUID CONDITION		Exhaust Gas	Exhaust Gas	Exhaust Gas	Fuel Gas	Water	Water	Water	Saturated Steam	Superheated Steam	Water	Superheated Steam	Superheated Steam
LOCATION		Gas Turbine Outlet	Secondary Superheater Inlet	Main Stack Inlet	Duct Burner Inlet	Feed Water Pump Outlet	HP Eco. Inlet	HP Drum Inlet	Primary Superheater Inlet	Primary Superheater Outlet	DSH Control V/V Inlet	Secondary Superheater Inlet	Secondary Superheater Outlet
Case 2-A 110%MCR @ GT130% & Lean Gas Fired (Ambient Temp. 33°C)	PRESSURE (Fuel Gas, Steam, Water: bar g / Exhaust Gas: mmHg, G)	273.6	212.8	37.5	4.4	65.5	47.4	44.9	44.9	43.5	65.5	41.5	40.5
	TEMPERATURE (°C)	561.9	736.0	149.0	40.0	115.0	115.1	224.8	258.7	338.9	115.0	321.3	400.0
	FLOW RATE (kg/hr)	479000	482115	482115	3115	133050	130898	130898	129601	129601	2152	131753	131753
	ENTHALPY (Exhaust Gas, Steam, Water: kcal/kg / Fuel Gas: kcal/Nm ³)	140.1	192.6	29.4	6373.0	116.3	116.2	230.8	688.1	729.8	116.3	719.8	767.5



Thermal Design

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*****
* Supplemental Firing Calculation of Heat Recovery Steam Generators. Ver.2.0 *
* Date of Running      2021/ 2/17/14/13/40 *
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= Duct Burner Conditions(Fuel gas based) =

- Flue Gas Compositions

	Before		After	
	(Vol% / wt%)	(Vol% / wt%)	(Vol% / wt%)	(Vol% / wt%)
N2	75.18	73.80	74.48	73.40
O2	13.97	15.66	11.98	13.49
CO2	3.29	5.07	4.20	6.51
H2O	6.66	4.20	8.44	5.35
Ar	0.90	1.26	0.89	1.25
SO2	0.00	0.00	0.00	0.00
CO	0.00	0.00	0.00	0.00

- Fuel Composition (vol%,wt%)

CH4	94.5600	89.3009
C2H6	1.4300	2.5312
C3H8	0.1200	0.3115
N-C4H10	0.0100	0.0342
I-C4H10	0.0000	0.0000
N-C5H12	0.0000	0.0000
I-C5H12	0.0000	0.0000
C6H14	0.0000	0.0000
CO	0.0000	0.0000
H2	0.0000	0.0000
N2	2.2600	3.7274
CO2	1.5600	4.0417
C	0.0000	0.0000
S	0.0000	0.0000
C2H4	0.0000	0.0000
C3H6	0.0000	0.0000
N-C4H8	0.0000	0.0000
C6H6	0.0000	0.0000
H2O	0.0500	0.0530
O2	0.0000	0.0000
H2S	0.0000	0.0000

- Exhaust Gas of Duct Burner Inlet -
 Flow Rate kg/hr 545400.00
 Nm³/hr 428328.34
 Density kg/Nm³ 1.2733
 Temperature degC 484.81

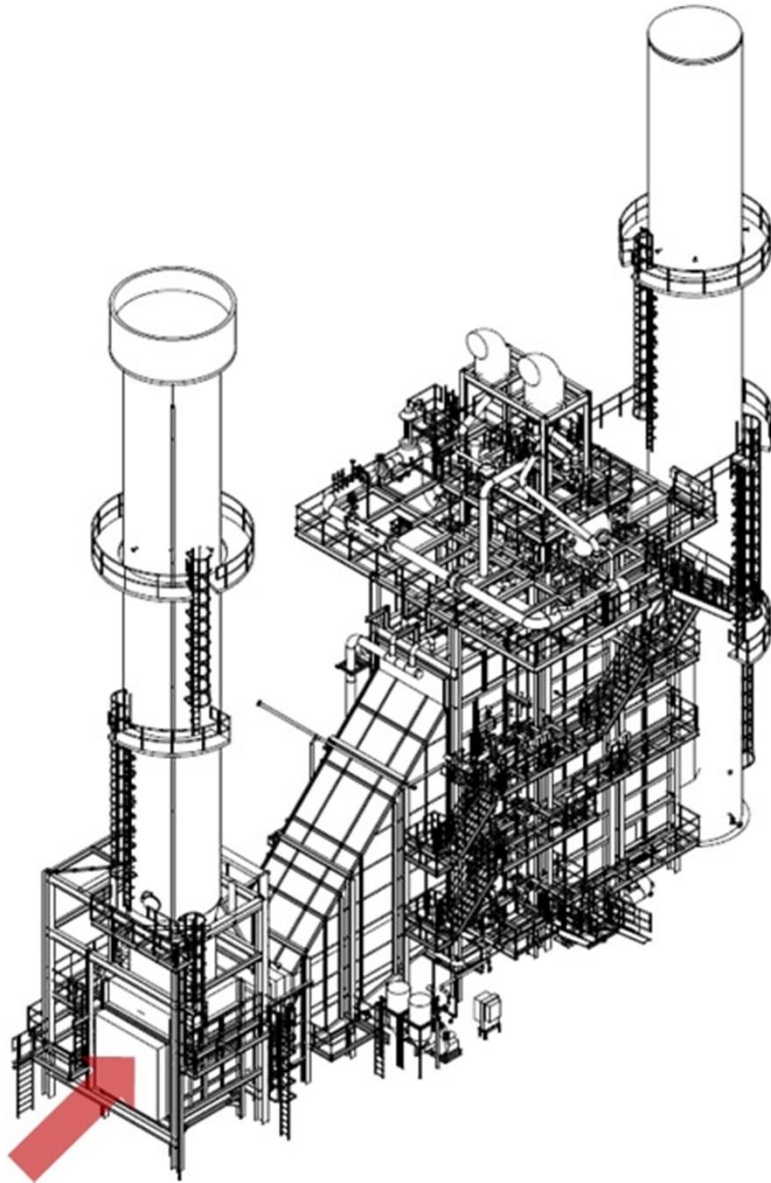
- Fuel Gas of Duct Burner Inlet -
 Flow Rate kg/hr 3115.00
 Nm³/hr 4110.24
 Density kg/Nm³ 0.7579
 Low Heating value kcal/Nm³ 8360.46
 kcal/kg 11031.62

- Exhaust Gas of Duct Burner Outlet -
 Flow Rate kg/hr 548515.00
 Nm³/hr 432473.03
 Density kg/Nm³ 1.2683
 Temperature degC 699.65

Thermal Design

GAS FLOW	545400. kg/hr	430017. Nm3/hr	1.2683 kg/Nm3	151.50 kg/sec			
MODULE NUMBER		1	2	3	4	5	6
GAS SIDE		HP_SH1	Duct_Burner	HP_SH2	HP_Evap	HP_Evap	HP_Econ
GAS FLOW	kg/hr	545400.	548515.	548515.	548515.	548515.	548515.
INLET PRESSURE	mmAq	243.2	0.0	225.5	213.7	176.7	71.3
PRESSURE DROP	mmAq	17.7	0.0	11.8	37.0	105.4	71.3
INLET TEMPERATURE	deg C	539.3	699.6	699.6	663.8	459.8	269.8
OUTLET TEMPERATURE	deg C	484.8	699.6	663.8	459.8	269.8	155.0
TEMPERATURE DIFF.	deg C	54.5	0.0	35.8	204.1	190.0	114.8
SPECIFIC HEAT	kcal/kg-C	0.2731	0.0000	0.2861	0.2793	0.2680	0.2596
HEAT REJECTED	Gcal/hr	8.12	0.00	5.62	31.26	27.93	16.34
SETTING LOSS	%	0.9300	0.0000	0.9300	0.9300	0.9300	0.9300
FOULING FACTOR	m2-hr-c/kcal	0.00020	0.00000	0.00020	0.00020	0.00020	0.00020
MODULE NUMBER		1	2	3	4	5	6
TUBE SIDE		HP_SH1	Duct_Burner	HP_SH2	HP_Evap	HP_Evap	HP_Econ
FLUID FLOW	kg/hr	135112.	0.	135436.	71363.	63749.	136463.
INLET PRESSURE(abs)	bar	44.66	9.81	42.75	44.66	44.66	46.28
OUTLET PRESSURE(abs)	bar	42.75	9.81	41.48	44.66	44.66	44.66
TUBE PRESSURE DROP	bar	1.91	0.00	1.27	0.00	0.00	1.62
ADDITIONAL PRESSURE DROP	bar	0.00	0.00	0.00	0.00	0.00	0.00
INLET TEMPERATURE	deg C	256.9	0.0	331.7	228.2	228.2	115.0
OUTLET TEMPERATURE	deg C	334.0	0.0	400.0	256.9	256.9	228.2
TEMPERATURE DIFF.	deg C	77.0	0.0	68.3	28.7	28.7	113.2
HEAT ABSORBED	Gcal/hr	8.04	0.00	5.57	30.97	27.67	16.18
FOULING FACTOR	m2-hr-c/kcal	0.00010	0.00000	0.00010	0.00010	0.00010	0.00010
ATEMP FLOW	kg/hr	323.	0.	0.	0.	0.	0.
BLOWDOWN	%	0.00	0.00	0.00	1.00	1.00	0.00
Extraction Flow (water)	kg/hr	0.	0.	0.	0.	0.	0.
Extraction Flow (Steam)	kg/hr	0.	0.	0.	0.	0.	0.
Additional Flow (water)	kg/hr	0.	0.	0.	0.	0.	0.
Additional Flow (Steam)	kg/hr	0.	0.	0.	0.	0.	0.
Additional Flow Temp	deg C	0.0	0.0	0.0	0.0	0.0	0.0
Gas Side							
Inlet Velocity	m/sec	22.03	0.00	26.64	25.94	20.29	12.83
Outlet Velocity	m/sec	20.55	0.00	25.65	20.29	14.98	10.12
Max Fin Temp	deg C	437.6	0.0	563.6	454.3	328.5	242.8
Max Tube Temp	deg C	375.4	0.0	464.1	297.5	282.0	234.2
Min tube Temp	deg C	302.9	0.0	402.7	277.2	258.5	120.8
Water Side							
Inlet Velocity	m/sec	31.72	0.00	43.49	6.28	1.49	1.28
Outlet Velocity	m/sec	42.46	0.00	51.84	6.28	1.49	1.46
Steam/water Density	kg/m3	19.0832	0.0000	15.3927	292.0591	292.0591	898.0742

Layout



ABU DHABI GAS INDUSTRIES LTD.(GASCO)



HYUNDAI
ENGINEERING AND CONSTRUCTION CO., LTD.

HRSG Start-up

