Unit 50

Boiler Efficiency

(2 Oktober 2014)

STEAM GENERATOR PERFORMANCE TEST (INDIRECT METHOD)

Calculation

TEST COAL ANALYSIS	Symbol	Units	Calculation
HHV AF at constant pressure	Hf	Btu/lb	9038.96
LHV AF at constant pressure	Hfnet	Btu/lb	8364.91
ASH ANALYSIS	Symbol	Units	Calculation
Unburned Combustible in Refuse	Wcr'	% Combustible	0.49331
Heating Value in Refuse	Hdr'	Btu/lb refuse	71.52995
Dry Refuse	Wdr'	Lb/Lb AF fuel	0.0400
Carbon Burned	Cb	Lb/Lb AF fuel	0.5434
AIR TEMPERATURE	Symbol	Units	Calculation
AH Inlet Air Temperature Primary Average	tA8P	deg F	102.84
AH Inlet Air Temperature Secondary Average	tA8S	deg F	84.60
Weighted Average AH Inlet Air Temperature	tA8	deg F	88.65
GAS TEMPERATURE	Symbol	Units	Calculation
AH Inlet Gas Temperature Average	tG14	deg F	759.15
AH Outlet Gas Temperature Average	tG15	deg F	300.07
MOISTURE IN AIR AT FAN INLET	Symbol	Units	Calculation
Partial Pressure of Vapor in Wet Air	PmA	in Hg	0.7477
Moisture in Dry Air	Wma'	Lb/Lb dry air	0.0157
AH INLET GAS ANALYSIS (PTC 19.1)	Symbol	Units	Calculation
O2 Average	O2	% dry-vol	0
Theoretical dry air	Ao'	Lb/Lb AF fuel	7.2878
Excees air	Ax'14	%	0.000
Flue gas components			
O2, fg	O2, fg	cu.ft/Lb AF fuel	0.000
SO2, fg	SO2, fg	cu.ft/Lb AF fuel	0.046
CO2, fg	CO2, fg	cu.ft/Lb AF fuel	17.018
N2, fg	N2, fg	cu.ft/Lb AF fuel	75.388
Total, fg	tot, fg	cu.ft/Lb AF fuel	92.451
O2	O2	% dry-vol	0.000
SO2	SO2	% dry-vol	0.049
CO2	CO2	% dry-vol	18.407
N2 (by difference)	N2	% dry-vol	81.543
AH OUTLET GAS ANALYSIS (PTC 19.1)	Symbol	Units	Calculation
O2 Average	o2	% dry-vol	4.7855
Theoretical dry air	Ao'	Lb/Lb AF fuel	7.2878
Excees air	Ax'14	%	28.845
Flue gas components			
O2, fg	o2, fg	cu.ft/Lb AF fuel	5.739
SO2, fg	so2, fg	cu.ft/Lb AF fuel	0.046
CO2, fg	co2, fg	cu.ft/Lb AF fuel	17.018
N2, fg	n2, fg	cu.ft/Lb AF fuel	97.105
Total, fg	tot, fg	cu.ft/Lb AF fuel	119.907
O2	o2	% dry-vol	4.786
SO2	so2	% dry-vol	0.038
CO Average	co	% dry-vol	0.001
CO2	co2	% dry-vol	14.192
N2 (by difference)	n2	% dry-vol	80.982

Cont'd

GAS AND AIR WEIGHTS	Symbol	Units	Calculation
Dry Gas Entering Air Heater	Wg'14	Lb/Lb AF fuel	7.6275
Dry Gas Leaving Air Heater	Wg'15	Lb/Lb AF fuel	9.7386
Dry Air for Combustion	Wa'	Lb/Lb AF fuel	7.3178
Moisture in Gas Entering Air Heater	Wmg	Lb/Lb AF fuel	0.7570

Wet Gas Entering Air Heater	Wg14	Lb/Lb AF fuel	8.3845	
Wet Gas Leaving Air Heater	Wg15	Lb/Lb AF fuel	10.5288	
Wet Gas for Combustion	Wa	Lb/Lb AF fuel	7.4328	
SPECIFIED HEAT LOSSES				
Radiation loss per PTC4.1,figure 8, page 67	lB	% eff. loss	0.1700	
Unmeasured losses per specification	lum	% eff. loss	0.1700	

HEAT LOSS CALCULATION	**Symbol**	**Units**	**Calculation**	**Losses (%)**
Dry Gas	LG	Btu/Lb AF fuel	497.6708	5.51
Moisture in Fuel	Lmf	Btu/Lb AF fuel	271.6485	3.01
Combustion of H2 in Fuel	LH	Btu/Lb AF fuel	464.3134	5.14
Moisture in Air	LmA	Btu/Lb AF fuel	11.1478	0.12
Combustible in Refuse	Luc	Btu/Lb AF fuel	2.8646	0.03
Formation of CO	Lco	Btu/Lb AF fuel	0.3716	0.00
Radiation	LB	Btu/Lb AF fuel	15.3662	0.17
Unmeasured losses	Lum	Btu/Lb AF fuel	15.3662	0.17
Total	L	Btu/Lb AF fuel	1278.7492	14.15
MEASURED EFFICIENCY	Symbol	Units	Calculation	
Measured efficiency (HHV)	Eb-hhv	%	85.8529	
Measured efficiency (LHV)	Eb-lhv	%	92.7710	

Unit 60

Boiler Efficiency

(18 Februari 2014)

STEAM GENERATOR PERFORMANCE TEST (INDIRECT METHOD)

Calculation

TEST COAL ANALYSIS	Symbol	Units	Calculation
HHV AF at constant pressure	Hf	Btu/lb	8955.74
LHV AF at constant pressure	Hfnet	Btu/lb	8299.21
ASH ANALYSIS	Symbol	Units	Calculation
Unburned Combustible in Refuse	Wcr'	% Combustible	0.2987
Heating Value in Refuse	Hdr'	Btu/lb refuse	43.3115
Dry Refuse	Wdr'	Lb/Lb AF fuel	0.0236
Carbon Burned	Cb	Lb/Lb AF fuel	0.5240
AIR TEMPERATURE	Symbol	Units	Calculation
AH Inlet Air Temperature Primary Average	tA8P	deg F	102.61
AH Inlet Air Temperature Secondary Average	tA8S	deg F	83.80
Weighted Average AH Inlet Air Temperature	tA8	deg F	88.28
GAS TEMPERATURE	Symbol	Units	Calculation
AH Inlet Gas Temperature Average	tG14	deg F	757.67
AH Outlet Gas Temperature Average	tG15	deg F	290.53
MOISTURE IN AIR AT FAN INLET	Symbol	Units	Calculation
Partial Pressure of Vapor in Wet Air	PmA	in Hg	0.8487
Moisture in Dry Air	Wma'	Lb/Lb dry air	0.0182
AH INLET GAS ANALYSIS (PTC 19.1)	Symbol	Units	Calculation
O2 Average	O2	% dry-vol	4.195
Theoretical dry air	Ao'	Lb/Lb AF fuel	6.8354
Excees air	Ax'14	%	24.515
Flue gas components			
O2, fg	O2, fg	cu.ft/Lb AF fuel	4.575
SO2, fg	SO2, fg	cu.ft/Lb AF fuel	0.039
CO2, fg	CO2, fg	cu.ft/Lb AF fuel	16.411
N2, fg	N2, fg	cu.ft/Lb AF fuel	88.014
Total, fg	tot, fg	cu.ft/Lb AF fuel	109.039
O2	O2	% dry-vol	4.196
SO2	SO2	% dry-vol	0.036
CO2	CO2	% dry-vol	15.051
N2 (by difference)	N2	% dry-vol	80.718
AH OUTLET GAS ANALYSIS (PTC 19.1)	Symbol	Units	Calculation
O2 Average	o2	% dry-vol	4.915
Theoretical dry air	Ao'	Lb/Lb AF fuel	6.8354
Excees air	Ax'14	%	30.018
Flue gas components			
O2, fg	o2, fg	cu.ft/Lb AF fuel	5.602
SO2, fg	so2, fg	cu.ft/Lb AF fuel	0.039
CO2, fg	co2, fg	cu.ft/Lb AF fuel	16.411
N2, fg	n2, fg	cu.ft/Lb AF fuel	91.900
Total, fg	tot, fg	cu.ft/Lb AF fuel	113.952
O2	o2	% dry-vol	4.916
SO2	so2	% dry-vol	0.034
CO Average	co	% dry-vol	0.002
CO2	co2	% dry-vol	14.402
N2 (by difference)	n2	% dry-vol	80.646

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GAS AND AIR WEIGHTS	Symbol	Units	Calculation
Dry Gas Entering Air Heater	Wg'14	Lb/Lb AF fuel	8.8871
Dry Gas Leaving Air Heater	Wg'15	Lb/Lb AF fuel	9.2636
Dry Air for Combustion	Wa'	Lb/Lb AF fuel	8.5436
Moisture in Gas Entering Air Heater	Wmg	Lb/Lb AF fuel	0.7805

Wet Gas Entering Air Heater	Wg14	Lb/Lb AF fuel	9.6676	
Wet Gas Leaving Air Heater	Wg15	Lb/Lb AF fuel	10.0509	
Wet Gas for Combustion	Wa	Lb/Lb AF fuel	8.6989	
SPECIFIED HEAT LOSSES				
Radiation loss per PTC4.1,figure 8, page 67	lB	% eff. loss	0.1700	
Unmeasured losses per specification	lum	% eff. loss	0.1700	

HEAT LOSS CALCULATION	**Symbol**	**Units**	**Calculation**	**Losses (%)**
Dry Gas	LG	Btu/Lb AF fuel	453.5157	5.06
Moisture in Fuel	Lmf	Btu/Lb AF fuel	302.6314	3.38
Combustion of H2 in Fuel	LH	Btu/Lb AF fuel	411.6242	4.60
Moisture in Air	LmA	Btu/Lb AF fuel	14.4081	0.16
Combustible in Refuse	Luc	Btu/Lb AF fuel	1.0209	0.01
Formation of CO	Lco	Btu/Lb AF fuel	0.7222	0.01
Radiation	LB	Btu/Lb AF fuel	15.2248	0.17
Unmeasured losses	Lum	Btu/Lb AF fuel	15.2248	0.17
Total	L	Btu/Lb AF fuel	1214.3720	13.56
MEASURED EFFICIENCY	Symbol	Units	Calculation	
Measured efficiency (HHV)	Eb-hhv	%	86.4403	
Measured efficiency (LHV)	Eb-lhv	%	93.2784	