Heat Input Required to Increase Exhaust Gas Temperature for SCR Control (Recuperative" Air Heater)

Current Gas Temp	286	^oF
Current Gas Temp	414.26	K
Required Gas Temp.	500	^oF
Required Gas Temp.	533.15	K
Air Molecular Weight	28.967	lb/lbmol
Molal Ideal Gas (STP)	22.41	m^3/kmol
Diameter of Stack	10.0	ft
Exit Velocity	118.8	ft/sec
Heat Capacity Constant a	28.09	
Heat Capacity Constant b	1.97E-03	
Heat Capacity Constant c	4.80E-06	
Heat Capacity Constant d	-1.97E-09	

Heat Capacity of Air [1]

Cp (J/mol - K) = $a + bT + cT^2 + dT^3$

= 2.96E+01 @ 500 ^oF

3.02E+01 @ 650 ^oF

Volumetric Flow Rate

Volumetric Flow Rate = (Pi x D^2/4) x exit velocity x 3600 sec/hr

= 33,589,909 ft^3/hr

= 951,160 m^3/hr

Convert Volumetric Flow Rate to Molar Flow Rate

Molar Flow Rate = Volumetric Flow Rate (m^3/hr) x (1/molal ideal gas, at STP) x Temperature Conversion

= 30,020 kmol/hr

30,019,709 mol/hr

Calculate Heat Input Required

Heat Input = Molar Flow Rate x (Delta T K) x Average Heat Capacity over Temp. Range

= 106,699,844,000 J/hr

= 101,199,467 Btu/hr

140,554,815 Btu/hr (corrected for efficiency of boiler
- 72% per Mark Sajer 10 Apr 08)

165,358,606 Btu/hr (corrected for efficiency of air heater
- 85% per Mark Sajer 10 Apr 08)

Notes:

[1] Elementary Principles of Chemical Process, 1986

Heat Input Required to Increase Exhaust Gas Temperature for SCR Control (Duct Burner)

Current Gas Temp	500	^{o}F
Current Gas Temp	533.15	K
Required Gas Temp.	650	^{o}F
Required Gas Temp.	616.48	K
Air Molecular Weight	28.967	lb/lbmol
Molal Ideal Gas (STP)	22.41	m^3/kmol
Diameter of Stack	10.0	ft
Exit Velocity	118.8	ft/sec
Heat Capacity Constant a	28.09	
Heat Capacity Constant b	1.97E-03	
Heat Capacity Constant c	4.80E-06	
Heat Capacity Constant d	-1.97E-09	

Heat Capacity of Air [1]

Cp (J/mol - K) = $a + bT + cT^2 + dT^3$

= 3.02E+01 @ 500 ^{o}F

3.07E+01 @ 650 ^{o}F

Volumetric Flow Rate

Volumetric Flow Rate = (Pi x D^2/4) x exit velocity x 3600 sec/hr

= 33,589,909 ft^3/hr

= 951,160 m^3/hr

Convert Volumetric Flow Rate to Molar Flow Rate

Molar Flow Rate = Volumetric Flow Rate (m^3/hr) x (1/molal ideal gas, at STP) x Temperature Conversion

= 23,325 kmol/hr

23,325,452 mol/hr

Calculate Heat Input Required

Heat Input = Molar Flow Rate x (Delta T K) x Average Heat Capacity over Temp. Range

= 59,155,652,011 J/hr

= 56,106,178 Btu/hr

59,500,000 Btu/hr   Burns & Roe estimate 10 Apr 08

Notes:

[1] Elementary Principles of Chemical Process, 1986