RNG WORKS

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How to Manage Thermal Oxidizers: Best Practices & Advancements in Technology

Edward T Boys, P.E.
Engineering Manager
Perennial Energy, LLC

THE COALITION FOR RENEWABLE NATURAL GAS

PEI PERENNIAL ENERGY

RNG WORKS Technical Workshop & Trade Expo
Produced by the RNG COALITION
to educate, demonstrate & promote best industry practices.

OVERVIEW

- Every Project has a Lifecycle
- The Lifecycle has Identifiable Phases
- Understanding & Managing the Overall Lifecycle is Critical to Project Success.

Waterfall Management

Pools on the Waterfall

- Initial Design
- Construction Documents
- Construction
- Startup
- Production

The Top of The Waterfall
Initial Design

- Design Basis- Flow Rates, Gas Compositions, Rate of Change
- Team & Equipment Selection
- Information- Low
- Cost of Changes- Low
- Degrees of Freedom- High

Bottom of the Waterfall Production

- Knowledge- High
- Cost of Changes- High
- Degrees of Freedom- Low

The Top of the Waterfall has a huge impact on the Management at the Bottom of the Waterfall

Captain Obvious

What we can see from The Top

- A Journey of Discovery
- Start up will be interesting
- Over the long term expect the energy in the tail gas to decline
- If the TOU isn’t running the RNG plant is down
- TOU Must meet Air Permit
- Your Client doesn’t like fire out the top
- Your Client doesn’t like buying fuel
- TOUs don’t like sudden changes

TOU 101

- Time, Temperature & Turbulence
- Hold it, Heat it & Beat it
- Mass & Heat Balance determines TOU design
- Energy In= Energy Out

Energy In

- Energy in is straight forward -Use the LHV (910 BTU/SCF CH_4) as we are not condensing the products of combustion

$$Q=\sum_{k=0}^{n} x \quad a$$

Where:

X= SCFH of Gas

A= BTU/SCF (LHV)

The complication is that we aren't certain of the gas flow rates & compositions

Energy Out
$Q=M*Cp*\Delta T$ plus Environmental Losses

- Environmental Losses are Due to Radiation & Convection
- Losses Don't scale with flow- same Environmental heat loss at low Flow as High Flow
- Bigger TOUs have Bigger Losses- Oversizing the TOU has a long term fuel penalty
- Undersizing the TOU results in Fire out the Top, Failing Source Test

Exhaust Calculation
$Q=M*Cp*\Delta T$

- Mass Flow is from Mass Balance
- Cp is taken from published values
- Operational Temperature is unknown until source test- the specific contaminants will set temperature
- Operational temperature impacts size, which impacts Environmental Losses & Fuel Consumption, which impacts Mass & Energy Balance...

Destruction Efficiency Vs Time & Temperature

A General Table that isn’t always True

Destruction Efficiency	Degrees Above AIT (F)	Time (S)
95%	300	0.50
98%	400	0.50
99%	475	0.75
99.9%	550	1.00
99.99%	650	2.00

					Supplemental Fuel			20	CFM
Stream 1	entering Gas Stream:								
					Total Energy Available			**3,822,000**	BTU/Hr
Gas	BTU/Hr	lb-mol/Hr				Blended Stream		152	BTU/Cu Ft
CH_4	2,730,000	8					% CH_4	16.68%	
CO_2		38							
N_2		16							
O_2		1							
H_2S		0							
H20		0							
	Total	63						Mean Molar Heat Capacity	
Exhaust Energy Balance:								From Lewandowski table 5.1	
		Entering	Reacted	Created	Exit				BTU/lb-mol-R
	Tail Gas	lb-mol/Hr	lb-mol/Hr	lb-mol/Hr	lb-mol/Hr	BTU/Hr			**1700**
	CH_4	8	8	0	0	0		Gas	Cp
	CO_2	38	0	8	46	908,598		CO_2	11.64
	N_2	16	0	0	16	203,962		N_2	7.43
	O_2	1	1	0	0	0		O_2	7.84
	H_2S	0	0	0	0			H20	9.09
	H20	0	0	16	16	248,553			
	Total	63							
	Sup Fuel								
	CH_4	3	3	0	0	0			
	CO_2	0	0	3	3	62,653		Env Loss	818,318
	N_2	0	0	0	0	0		**BTU Delta**	**810,275**
	O_2	0	0	0	0	0			
	H_2O	0	0	6	6	97,855			
	Total	3							
	Air								
	O_2	29	21	0	8	103,776			
	N_2	110	0	0	110	1,386,328			
	Total	139			205	**3,011,725**	Wet O2%	3.79%	
Total Air		139	Lb-Mol/Hr				Dry O2%	4.26%	
		876	CFM				Excess Air	35.13%	
Air Through Burner		43	Lb-Mol/Hr						
		270	CFM						
Air Through Louver		606	CFM						

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In the end- What is important in the early design phase?

- Eliminate Fragility
- Build a Team that can deal with change
- Most accurate & complete data possible
- Understand & Embrace the inherent unknowns
- Leave as many options open as possible

CONTACT INFO

- Edward T Boys, PE
- Engineering Manager
- Perennial Energy, LLC
- 417.256.2002
- eboys@perennialenergy.com

- RNG WORKS Exhibit Space # 202