Crude Preheat Curramix Coating Study

Objectives:

This study evaluates a Crude preheat exchanger service heat transfer performance with the following tube material and coatings and estimates the energy savings and CO2 Emissions Reduction:

- Carbon Steel
- Stainless Steel
- Carbon Steel Tube ID Coated
- Stainless Steel Tube ID Coated

Assumptions

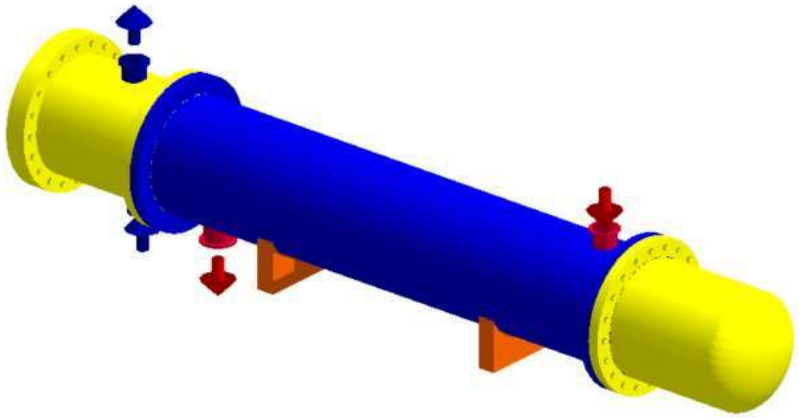
- Service – Desalted Crude vs Heavy Vacuum Gas Oil (HVGO)
- Tube ID Coating Thickness – 25 Microns (0.001 inch)
- Coating Thermal Conductivity – 0.722 Btu/hr-ft-F
- Fuel Value -$3.50 per MBtu/hr
- Furnace Efficiency = 0.9
- Network Factor = 0.75 [Part of the Duty Gain in the Exchanger Diminishes Heat Transfer on other Exchangers in the Preheat Train due to changes in temperature differentials]
- CO2 Reduction based on EPA Conversion Equations
- Heat Transfer Calculation performed with HTRI XIST
- Assumed Fouling Factor shown in the Comparison Tables below

- Assumed Inlet Operating
  - Crude Inlet Temp – 370 F
  - Crude Rate – 650 klb/hr
  - HVGO Inlet Temp - 505 F
  - HVGO Rate – 675 klb/hr
    - Stream Properties

Hot Shellside Fluid		Inlet	Outlet
Fluid name		VHGO	
Flow	(1000-lb/hr)	675.00	
Temperature	(F)	505.00	475.18
Pressure	(psia)	111.67	107.09
Weight fraction vapor	(--)	0.0000	0.0000
Vapor Properties			
Flow	(1000-lb/hr)	--	--
Density	(lb/ft3)	--	--
Viscosity	(cP)	--	--
Conductivity	(Btu/hr-ft-F)	--	--
Heat capacity	(Btu/lb-F)	--	--
Molecular weight	(--)	--	--
Liquid Properties			
Flow	(1000-lb/hr)	675.00	675.00
Density	(lb/ft3)	46.741	47.559
Viscosity	(cP)	1.4807	1.5337
Conductivity	(Btu/hr-ft-F)	0.0528	0.0537
Heat capacity	(Btu/lb-F)	0.6831	0.6657
Molecular weight	(--)	--	--
Latent heat	(Btu/lb)	--	--
Surface tension	(dyne/cm)	0.0000	0.0000

Cold Tubeside Fluid		Inlet	Outlet
Fluid name		Crude	
Flow	(1000-lb/hr)	650.00	
Temperature	(F)	370.00	402.61
Pressure	(psia)	381.37	372.57
Weight fraction vapor	(--)	0.0000	0.0000
Vapor Properties			
Flow	(1000-lb/hr)	--	--
Density	(lb/ft3)	--	--
Viscosity	(cP)	--	--
Conductivity	(Btu/hr-ft-F)	--	--
Heat capacity	(Btu/lb-F)	--	--
Molecular weight	(--)	--	--
Liquid Properties			
Flow	(1000-lb/hr)	650.00	650.00
Density	(lb/ft3)	44.085	42.918
Viscosity	(cP)	0.8648	0.6984
Conductivity	(Btu/hr-ft-F)	0.0671	0.0646
Heat capacity	(Btu/lb-F)	0.6233	0.6342
Molecular weight	(--)	--	--
Latent heat	(Btu/lb)	--	--
Surface tension	(dyne/cm)	0.0000	0.0000

- Heat Exchanger Geometry
  - TEMA – AES
  - Shell Id = 50”
  - 1054 Tubes
  - 1” Tube OD
  - 0.083” tube wall thickness
  - 4 Tube Passes
  - 20 ft length
  - 11 Baffle Cross Passes, Single Vert Seg , 20.9% Cut



Results

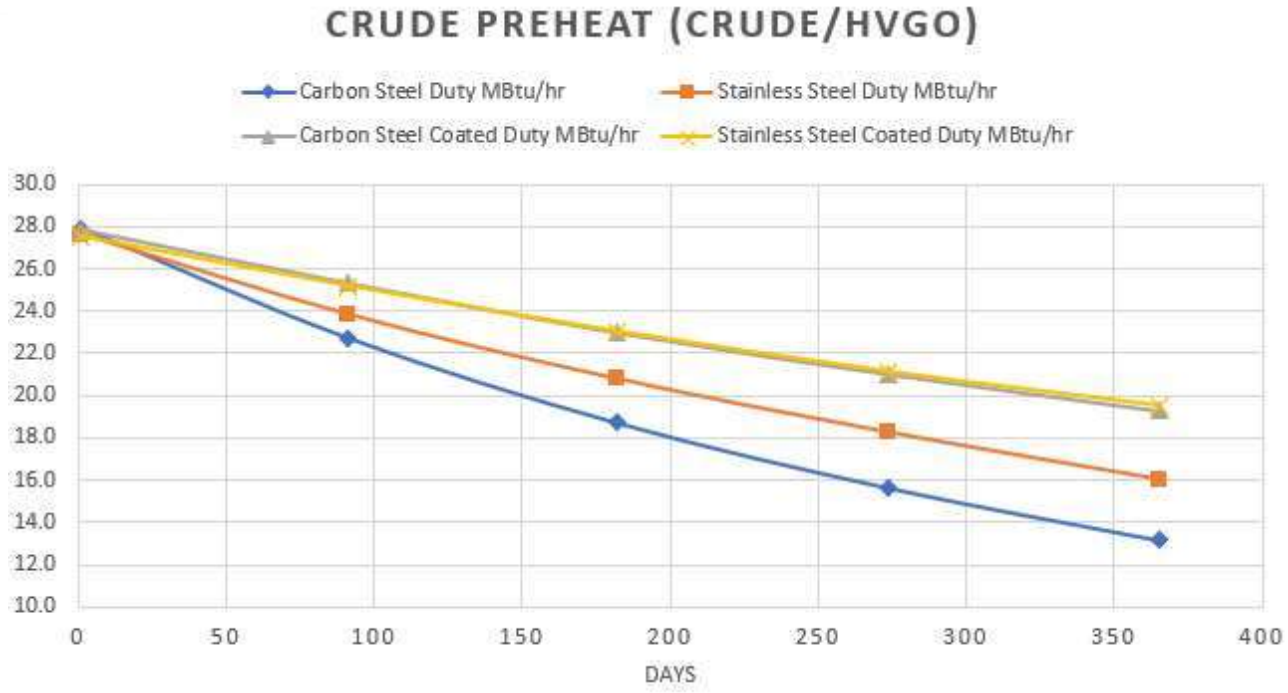
Comparison Tables

Carbon Steel						
Days	Qactual	Qclean	Qact/Qclean	Tubeside DP	Tubeside Fouling Factor	Shellside Fouling Factor
	MBtu/hr	MBtu/hr		psi	ft2-hr-F/Btu	ft2-hr-F/Btu
1	27.9	27.9	1.00	3.9	0.0000	0.0000
91	22.7	27.9	0.81	4.7	0.0044	0.0013
182	18.7	27.9	0.67	5.8	0.0088	0.0025
274	15.6	27.9	0.56	7.1	0.0131	0.0038
365	13.2	27.9	0.47	8.8	0.0175	0.0050

Stainless Steel						
Days	Qactual	Qclean	Qact/Qclean	Tubeside DP	Tubeside Fouling Factor	Shellside Fouling Factor
	MBtu/hr	MBtu/hr		psi	ft2-hr-F/Btu	ft2-hr-F/Btu
1	27.6	27.6	1.00	3.9	0.0000	0.0000
91	23.8	27.6	0.86	4.5	0.0030	0.0010
182	20.8	27.6	0.75	5.1	0.0060	0.0020
274	18.2	27.6	0.66	5.1	0.0090	0.0030
365	16.0	27.6	0.58	6.7	0.0120	0.0040

Carbon Steel Coated (0.001 inch)						
Days	Qactual	Qclean	Qact/Qclean	Tubeside DP	Tubeside Fouling Factor	Shellside Fouling Factor
	MBtu/hr	MBtu/hr		psi	ft2-hr-F/Btu	ft2-hr-F/Btu
1	27.8	27.8	1.00	3.9	0.0000	0.0000
91	25.3	27.8	0.91	4.2	0.0015	0.0013
182	23.0	27.8	0.83	4.5	0.0030	0.0025
274	21.0	27.8	0.75	4.8	0.0045	0.0038
365	19.3	27.8	0.69	5.1	0.0060	0.0050

Stainless Steel Coated (0.001 inch)						
Days	Qactual	Qclean	Qact/Qclean	Tubeside DP	Tubeside Fouling Factor	Shellside Fouling Factor
	MBtu/hr	MBtu/hr		psi	ft2-hr-F/Btu	ft2-hr-F/Btu
1	27.5	27.5	1.00	3.9	0.0000	0.0000
91	25.2	27.5	0.91	4.2	0.0015	0.0010
182	23.0	27.5	0.84	4.5	0.0030	0.0020
274	21.1	27.5	0.77	4.8	0.0045	0.0030
365	19.5	27.5	0.71	5.1	0.0060	0.0040



Economic & CO2 Reduction Benefit

1. Coated Versus Carbon Steel
    - Annualized Duty Reduction = 3.6 MBtu/hr
    - Energy benefit = $93k a year
    - CO2 Equivalent Benefit = 1,407 Tons a year
2. Coated Versus Stainless Steel
    - Annualized Duty Reduction = 2.0 MBtu/hr
    - Energy benefit = $50k a year
    - CO2 Equivalent Benefit = 760 Tons a year

Note if the Crude preheat furnace is limited and/or the Preheat Train is Hydraulicly limited, the margin benefits could be significant more than the credits listed above.