PROCESS SIDE HYDRAULIC REPORT

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FHinfinity 2025

Date	06/02/2026
Time	9:47:34 PM
Unit	Customized US Units

PROCESS HYDRAULIC DATA

** For convection section, row numbering is upward. For firebox and in case of horizontal / helical tubes, numbering is upward.*

*** Sonic Velocity for single-phase Gas flows and Critical Velocity for Two-Phase flows.*

Stream and Path

Stream Name	To 2H-101
Selected Path	2

Pressure Drop Data and Method

Two Phase Pressure Drop Model	FHinfinity Mixed Model
Pressure Drop Multiplier (Process Side)	1
Bend Pressure Drop Method (Process Side)	API-560
Static Pressure Drop in Vertical Tubes	N/A

Hydraulic Details

Section	Row / Tube *	Distance from Inlet [ft]	Temperature [F]	Pressure [Psia]	DP/DL [Psi/ft]	Mass Vapor Quality [Percent]	Linear Velocity [ft/s]	Mass Velocity [lb/s.ft2]	Residence Time [s]	Flow Regime [-]	Heat Transfer Region [-]	Sonic / Critical Velocity [ft/s]
Convection	13	61.634	453.18	164.314	1.11E-02	0	6.49	304.94	9.49	Liquid	Convective (API Method)	N/A
Convection	12	123.267	462.53	163.516	1.12E-02	0	6.53	304.94	9.43	Liquid	Convective (API Method)	N/A
Convection	11	184.901	473.97	162.712	1.13E-02	0	6.58	304.94	9.36	Liquid	Convective (API Method)	N/A

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Section	Row / Tube *	Distance from Inlet [ft]	Temperature [F]	Pressure [Psia]	DP/DL [Psi/ft]	Mass Vapor Quality [Percent]	Linear Velocity [ft/s]	Mass Velocity [lb/s.ft2]	Residence Time [s]	Flow Regime [-]	Heat Transfer Region [-]	Sonic / Critical Velocity [ft/s]
Convection	10	246.534	477.64	161.905	1.13E-02	0	6.6	304.94	9.34	Liquid	Convective (API Method)	N/A
Convection	9	308.168	482.21	161.096	1.13E-02	0	6.62	304.94	9.31	Liquid	Convective (API Method)	N/A
Convection	8	369.802	487.2	160.284	1.14E-02	0	6.64	304.94	9.28	Liquid	Convective (API Method)	N/A
Convection	7	431.435	492.56	159.384	1.28E-02	0.7616	8.12	304.94	7.59	Bubble / Froth	Convective (API Method)	141
Convection	6	493.069	498.17	158.373	1.44E-02	1.1023	8.78	304.94	7.02	Bubble / Froth	Convective (API Method)	144.73
Convection	5	554.702	504	157.239	1.61E-02	1.79	10.1	304.94	6.10	Bubble / Froth	Convective (API Method)	152.69
Convection	4	616.336	510.15	155.929	1.88E-02	2.7211	11.88	304.94	5.19	Bubble / Froth	Convective (API Method)	165.14
Convection	3	677.97	516.78	154.391	2.20E-02	3.8393	14.01	304.94	4.40	Bubble / Froth	Convective (API Method)	181.76
Convection	2	739.603	524.12	152.592	2.58E-02	5.0829	16.39	304.94	3.76	Bubble / Froth	Convective (API Method)	199.28
Convection	1	801.237	532.33	150.682	2.70E-02	6.4253	18.97	304.94	3.25	Bubble / Froth	Convective (API Method)	213.56
Radiant	32	863.046	541.07	148.741	3.14E-02	7.8523	21.7	304.94	2.85	Annular	Convective (API Method)	226.43
Radiant	31	924.855	549.6	146.533	3.57E-02	9.3928	24.69	304.94	2.50	Annular	Convective (API Method)	240.88
Radiant	1	986.664	557.98	144.041	4.03E-02	11.0088	27.89	304.94	2.22	Mist	Convective (API Method)	255.2
Radiant	2	1048.473	566.23	141.25	4.52E-02	12.6967	31.31	304.94	1.97	Mist	Convective (API Method)	268.73
Radiant	3	1110.282	574.31	138.135	5.04E-02	14.494	35.1	304.94	1.76	Mist	Convective (API Method)	282.4
Radiant	4	1172.091	582.28	134.674	5.60E-02	16.3419	39.14	304.94	1.58	Mist	Convective (API Method)	295.56

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Section	Row / Tube *	Distance from Inlet [ft]	Temperature [F]	Pressure [Psia]	DP/DL [Psi/ft]	Mass Vapor Quality [Percent]	Linear Velocity [ft/s]	Mass Velocity [lb/s.ft2]	Residence Time [s]	Flow Regime [-]	Heat Transfer Region [-]	Sonic / Critical Velocity [ft/s]
Radiant	5	1233.9	590.13	130.843	6.20E-02	18.2691	43.55	304.94	1.42	Mist	Convective (API Method)	308.48
Radiant	6	1295.709	597.83	126.608	6.85E-02	20.2752	48.42	304.94	1.28	Mist	Convective (API Method)	321.06
Radiant	7	1357.518	605.4	121.93	7.57E-02	22.3619	53.86	304.94	1.15	Mist	Convective (API Method)	333.18
Radiant	8	1419.327	612.82	116.756	8.37E-02	24.5387	60.02	304.94	1.03	Mist	Convective (API Method)	344.76
Radiant	9	1481.136	620.07	111.014	9.29E-02	26.8248	67.16	304.94	0.92	Mist	Convective (API Method)	355.8
Radiant	10	1542.945	627.12	104.605	1.04E-01	29.2512	75.66	304.94	0.82	Mist	Convective (API Method)	366.37
Radiant	11	1604.754	633.91	97.39	1.17E-01	31.8693	86.16	304.94	0.72	Mist	Convective (API Method)	376.64
Radiant	12	1666.563	640.35	89.152	1.33E-01	34.7656	99.76	304.94	0.62	Mist	Convective (API Method)	387.07
Radiant	13	1728.372	646.28	79.532	1.56E-01	38.0894	118.67	304.94	0.52	Mist	Convective (API Method)	398.5
Radiant	14	1790.181	651.38	67.85	1.89E-01	42.0936	147.99	304.94	0.42	Mist	Convective (API Method)	411.3
Radiant	15	1850.681	656.91	58.988	1.46E-01	45.7001	179.67	304.94	0.34	Mist	Convective (API Method)	422.58

HEATER GEOMETRY REPORT

HEATER GEOMETRY REPORT (Firebox)

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FIREBOX GEOMETRY

*** In case of Gas side or Process side fouling, effective value (considering fouling) is reported.*

Firebox Type	Cubical	
Number of Firebox	Twin-Cell	
Firebox Width (I/S Refrac.) [ft]	10	
Firebox Height (I/S Refrac.) [ft]	29.724	
Firebox Depth (I/S Refrac.) [ft]	60	
Height to Width Ratio (API-560)	3.2	
Number of Parallel Paths	8	
Tube Orientation	Horizontal	
Tube Location	Refractory Backed	
Tube Circle Diameter [ft]	N/A	
Number of Total Tubes	136	
Tube Straight Length [ft]	60.5	
Number of Total Roof Tubes	16	
Number of Tube Traverse	4	
Number of Tube Rows	One Row	
Total Tube Surface Area [ft2] **	11983.18	(Excl. Bends) (Incl. Projection)
Roof Type	Flat Roof	
Roof Opening Area [ft2]	400	
Number of Burners	48	
Burner Location	Floor	
Direction of Firing	Vertically-Fired	
Burner Circle Diameter [ft]	N/A	
Number of Burner Lanes	2	
U-Bend Included in Heat Transfer Area?	No	

HEATER GEOMETRY REPORT (Firebox)

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FIREBOX TUBES GEOMETRY

** In case of horizontal / helical tubes, numbering is upward.*

Tube No *	Path	Pass	Tube Material	Tube Outside Diameter [inch]	Tube Wall Thickness (AW) [inch]	Tube Outside Area [ft2] **	Tube Inside Area [ft2] **	Tube Spacing [inch]
16	1	17	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
17	1	16	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
18	1	15	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
19	1	14	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
20	1	13	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
21	1	12	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
22	1	11	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
23	1	10	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
24	1	9	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
25	1	8	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
26	1	7	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
27	1	6	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
28	1	5	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
29	1	4	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
30	1	3	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
33	1	2	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10
34	1	1	ASTM A335 Gr P5	5.563	0.258	87.38	79.28	10

HEATER GEOMETRY REPORT (Conv.)

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CONVECTION SECTION GEOMETRY

*** In case of Gas side or Process side fouling, effective value (considering fouling) is reported.*

Number of Tube Banks	3
Number of Streams	2
Corbel Width [inch]	N/A
Convection Section Height [ft]	24.984
Convection Section Width (I/S Refrac.) [ft]	7.13
Convection Section Length (I/S Refrac.) [ft]	60.5

Tube Bank No.	**Tube Bank 1**	**Tube Bank 2**	**Tube Bank 3**
Process Stream ID	To 2H-101	To 2H-101	LPS
Number of Rows of Tubes	10	3	4
Number of Tubes per Row	8	8	10
Number of Parallel Paths per Row	8	8	5
Number of Tubes per Path per Row	1	1	2
Total Number of Tubes	80	24	40
Total Number of Bare Tubes	80	0	40
Total Number of Finned / Studded Tubes	0	24	0
Tube Bank Height [ft]	6.959	1.907	2.107
Tube Bank Width [ft]	6.25	6.25	6.333
Tube Layout	Triangular	Triangular	Triangular
Tube Logitudinal Pitch (TB. Avg.) [inch]	8.66	8.66	6.928
Tube Transverse Pitch (TB. Avg.) [inch]	10	10	8
Tube Diagonal Pitch (TB. Avg.) [inch]	10	10	8
Tube Straight Length [ft]	60.5	60.5	60.5
Tube Bare Surf. Area (Exposed) [ft2] **	7048.93	2114.68	2851
Tube Primary Surf. Area (Exposed) [ft2] **	7048.93	1612.63	2851
Tube Extended Surf. Area (Exposed) [ft2] **	0	4518.4	0
Tube Total Surf. Area (Exposed) [ft2] **	7048.93	6131.03	2851
Extension Ratio [-]	1	2.9	1

HEATER GEOMETRY REPORT (Conv.)

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CONVECTION SECTION TUBES GEOMETRY

** Row numbering is upward.*

Row No *	Tube Type	Tube OD [inch]	Tube Wall Thick. (AW) [inch]	Tube ID [inch]	Tube Material	Tube Outside Area [ft2] **	Tube Inside Area [ft2] **	Tube Primary Area [ft2] **	Tube Extended Area [ft2] **
17	Bare	4.5	0.237	4.026	ASTM A106 Gr B (Medium-CS)	712.75	637.67	712.75	N/A
16	Bare	4.5	0.237	4.026	ASTM A106 Gr B (Medium-CS)	712.75	637.67	712.75	N/A
15	Bare	4.5	0.237	4.026	ASTM A106 Gr B (Medium-CS)	712.75	637.67	712.75	N/A
14	Bare	4.5	0.237	4.026	ASTM A106 Gr B (Medium-CS)	712.75	637.67	712.75	N/A
13	Studded	5.563	0.258	5.047	ASTM A335 Gr P5	2043.68	639.51	537.54	1506.13
12	Studded	5.563	0.258	5.047	ASTM A335 Gr P5	2043.68	639.51	537.54	1506.13
11	Studded	5.563	0.258	5.047	ASTM A335 Gr P5	2043.68	639.51	537.54	1506.13
10	Bare	5.563	0.258	5.047	ASTM A335 Gr P5	704.89	639.51	704.89	N/A
9	Bare	5.563	0.258	5.047	ASTM A335 Gr P5	704.89	639.51	704.89	N/A
8	Bare	5.563	0.258	5.047	ASTM A335 Gr P5	704.89	639.51	704.89	N/A
7	Bare	5.563	0.258	5.047	ASTM A335 Gr P5	704.89	639.51	704.89	N/A
6	Bare	5.563	0.258	5.047	ASTM A335 Gr P5	704.89	639.51	704.89	N/A
5	Bare	5.563	0.258	5.047	ASTM A335 Gr P5	704.89	639.51	704.89	N/A
4	Bare	5.563	0.258	5.047	ASTM A335 Gr P5	704.89	639.51	704.89	N/A
3	Bare	5.563	0.258	5.047	ASTM A335 Gr P5	704.89	639.51	704.89	N/A
2	Bare	5.563	0.258	5.047	ASTM A335 Gr P5	704.89	639.51	704.89	N/A
1	Bare	5.563	0.258	5.047	ASTM A335 Gr P5	704.89	639.51	704.89	N/A

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CONVECTION SECTION EXTENDED SURFACE GEOMETRY

Row No *	Ex. Surface Type	Height [inch] **	Thickness / Diameter [inch]	Plane Frequency [1/inch]	Plane Spacing [inch]	Number of Stud per Plane	Material
17	Bare	N/A	N/A	N/A	N/A	N/A	N/A
16	Bare	N/A	N/A	N/A	N/A	N/A	N/A
15	Bare	N/A	N/A	N/A	N/A	N/A	N/A
14	Bare	N/A	N/A	N/A	N/A	N/A	N/A
13	Stud	1	0.5	1.625	0.615	13	Carbon Steel
12	Stud	1	0.5	1.625	0.615	13	Carbon Steel
11	Stud	1	0.5	1.625	0.615	13	Carbon Steel
10	Bare	N/A	N/A	N/A	N/A	N/A	N/A
9	Bare	N/A	N/A	N/A	N/A	N/A	N/A
8	Bare	N/A	N/A	N/A	N/A	N/A	N/A
7	Bare	N/A	N/A	N/A	N/A	N/A	N/A
6	Bare	N/A	N/A	N/A	N/A	N/A	N/A
5	Bare	N/A	N/A	N/A	N/A	N/A	N/A
4	Bare	N/A	N/A	N/A	N/A	N/A	N/A
3	Bare	N/A	N/A	N/A	N/A	N/A	N/A
2	Bare	N/A	N/A	N/A	N/A	N/A	N/A
1	Bare	N/A	N/A	N/A	N/A	N/A	N/A

HEATER GEOMETRY REPORT (Stack)

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STACK GEOMETRY

Duct Work Present	No
Stack Support	Ground Supported
Stack Type	Simple Stack
Stack Height [ft]	185.515
Damper Elevation [ft]	126.263
Damper Opening Angle (Degree)	45.00
Stack Area at End (I/S Conc.) [ft]	113.1
Stack with Insulation	No

COMBUSTION REPORT

COMBUSTION REPORT

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BURNER INLET STREAMS DATA

Fuel Type	Fuel Oil
Oxidant Type	Ambient Air
Fuel LHV [Btu/lb]	17226.9
Fuel HHV [Btu/lb]	18249.1
Fuel Temperature [F]	230
Fuel Mass Flow Rate (Heater) [lb/hr]	15063.4
Fuel Gas Vol. Flow Rate (Heater) [SCFH]	N/A
Fuel Specific Gravity [@ 60 F / 15 C]	0.958
Atomising Steam Flow Rate [lb/hr]	3012.7
Steam Temperature & Pressure [F / Psia]	302 / 72.51

FUEL COMPOSITION (ULTIMATE ANALYSIS)

Total Carbon	[Wt.%]	84.4181
Total Hydrogen	[Wt.%]	10.9919
Total Oxygen	[Wt.%]	0
Total Nitrogen	[Wt.%]	0
Total Sulfur	[Wt.%]	2.59
Total Ash	[Wt.%]	2
Moisture	[Wt.%]	0

COMBUSTION AIR PROPERTIES

Total Air Flow Rate (Heater) [lb/hr]	255985.1
Air Temperature [F]	105
Excess Air Amount [Percent]	25
Relative Humidity [Percent]	0

AIR COMPOSITION (Vol. Basis)

		[Wet]	[Dry]
Total Nitrogen	[Vol.%]	78.08	78.08
Total Oxygen	[Vol.%]	20.96	20.95
Total Carbon Dioxide	[Vol.%]	0.04	0.04
Total Water	[Vol.%]	0	0
Total Argon	[Vol.%]	0.93	0.93

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FLUE GAS CHARACTERISTICS

Mass Basis		[Wet]	[Dry]
Carbon Dioxide	[Wt.%]	17.057	18.2424
Water	[Wt.%]	6.498	0
Sulfur Dioxide	[Wt.%]	0.2844	0.3042
Excess Oxygen	[Wt.%]	4.3254	4.626
Nitrogen	[Wt.%]	70.5296	75.4312
Argon	[Wt.%]	1.1956	1.2787
Ash	[Wt.%]	0.1099	0.1176
Total	[Wt.%]	100	100

Mole (Vol.) Basis		[Wet]	[Dry]
Carbon Dioxide	[Vol.%]	11.2814	12.6048
Water	[Vol.%]	10.499	0
Sulfur Dioxide	[Vol.%]	0.1292	0.1444
Excess Oxygen	[Vol.%]	3.9346	4.3961
Nitrogen	[Vol.%]	73.2846	81.8814
Argon	[Vol.%]	0.8711	0.9733
Total	[Vol.%]	100	100

Flue Gas Formed / Consumed Fuel [lb/lb]	18.2
Flue Gas Molecular Weight [lb/lbmol]	29.1
Flue Gas Mass Flow Rate [lb/hr]	274061.2
Flue Gas Volumetric Flow Rate (77 F, 14.695 psia) [ft3/hr]	3693734.7
Flue Gas Temperature at Bridgewall [F]	1714.95
Flue Gas Tempearature at Firebox [F]	1714.95
Hottel Bridgewall Parameter [-]	0.000

HEAT RELEASE & FLAME PROPOERTIES

Total Heat Release [MMBtu/hr]	259.496
Heat Release per Burner [MMBtu/hr]	5.4062
Adiabatic Flame Temperature [F]	3301.64
Flame Length (Individual Burner) [ft]	10.812
Average Flame Emissivity [-]	0.332

COMBUSTION REPORT

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FLUE GAS DEW POINT

Dew Point Temperature (Water) [F]	116.33
Dew Point Temperature (Acidic) (1.5% Conversion of SO2) [F]	288.53
Dew Point Temperature (Acidic) (3% Conversion of SO2) [F]	301.51