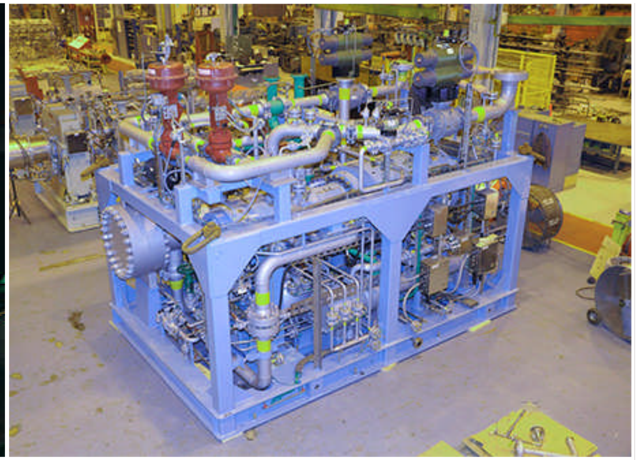
DRESSER-RAND

Equipment life-cycle, challenges for sour service in Oil & Gas handling → IIChE (NRC) New Delhi

Vinod Bhatt



May 2nd 2015

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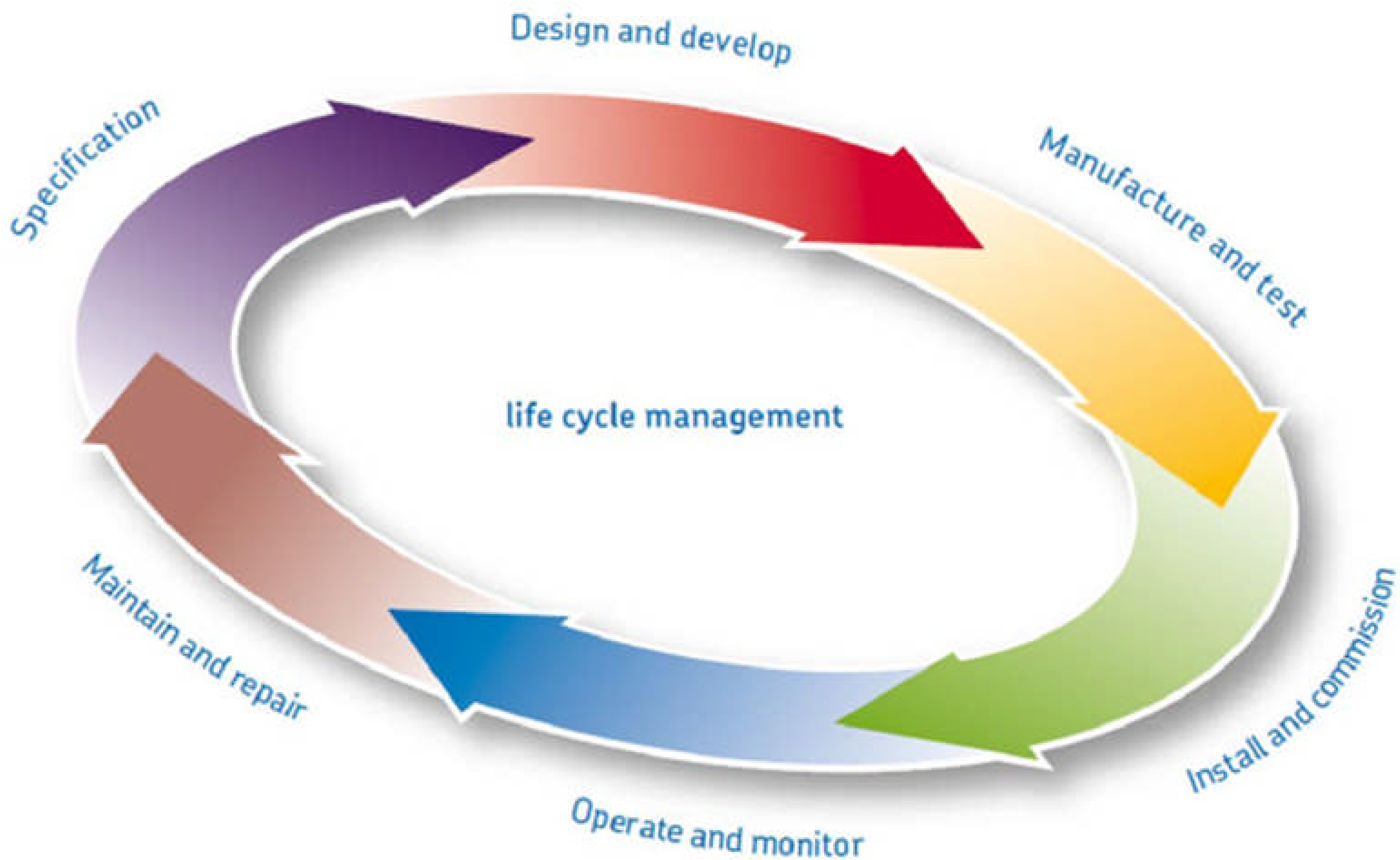
Safety Moment

Agenda

- Safety moment
- Equipment Life cycle
- Sour Service
- Case study Sour Gas mix
- HIRI wisdom

Life Cycle Management

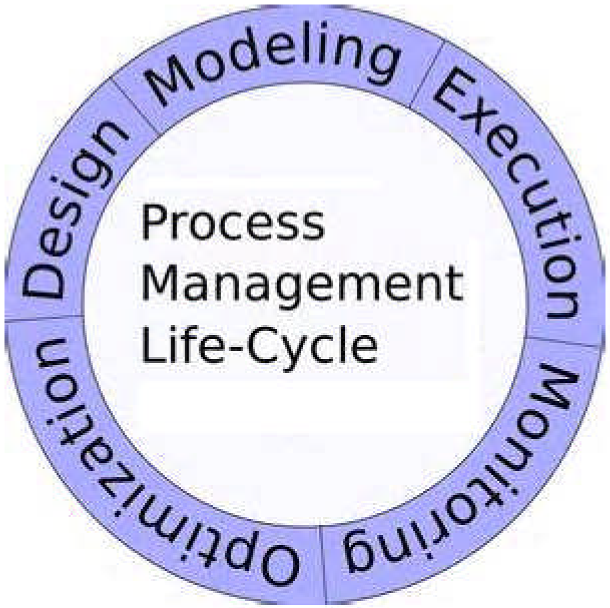


Life Cycle Management Contd.

- Freezing process specification, selection and design of equipment.
- Design adequacy checks & performing optimization.
- Material selection-Compliance to specifications.
- Necessary simulations suiting site & Licensor recommendation.
- Adequate instrumentation & controls-current technology.

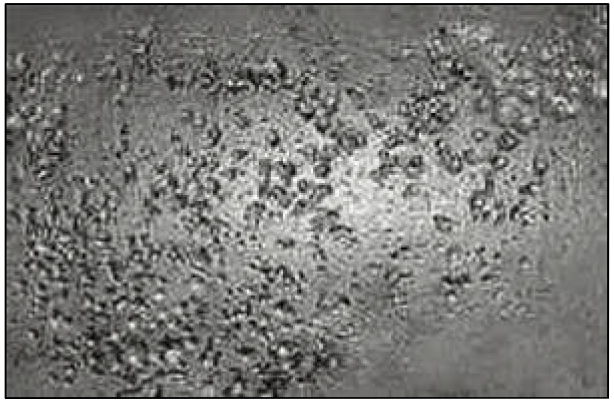
Life Cycle Management Contd.

- Quality controls and testing with up to date methods.
- Predictive and preventive maintenance plans-Stocking-Conditioning monitoring.
- Setting trends-continuous review-update all above.

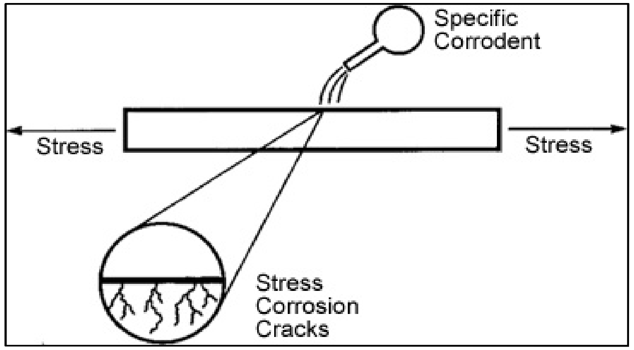


Corrosion in Sour Environment

- Presence of sulfide in chemical mix and SOUR environment causes major threat on life cycle. The result is corrosion.
- While handling oil & gas(refining process), such as pitting corrosion(water droplets), embrittlement from H2 & stress corrosion cracking(sulfides).
- From a materials standpoints, carbon steel is used for upwards of 80% of equipment components, which is beneficial due to its low cost and availability.



Pitting corrosion



Stress corrosion

Corrosion in Sour Environment

- Common replacement materials are low alloy steels with Chromium & Molybdenum with Stainless steel.
- Now a days Nickel, Titanium, Copper, Duplex SS & Super duplex are widely used.
- Material selection has to be optimistic considering the most problematic areas as also the economic optimal use.
- Corrosion has to be tackled by complex system of monitoring, preventive repairs and careful use of materials.

Gas cylinder corrosion

Review of Coolers (AES type) for H_2S (51.31 mole %) & MeSH (47.95 mole %) service

3-stage Reciprocating gas compressor

Having Gas MW: 40.75

Service	Intercooler 1	Intercooler 2
Gas inlet T ◦ C	114	121
Gas discharge T ◦C	60	90
Gas Operating Pressure BARG	8.527	18.986
Cooling water inlet T ◦C	33	33
Cooling water outlet T ◦C	40.3	37.2

P-T Dew point table

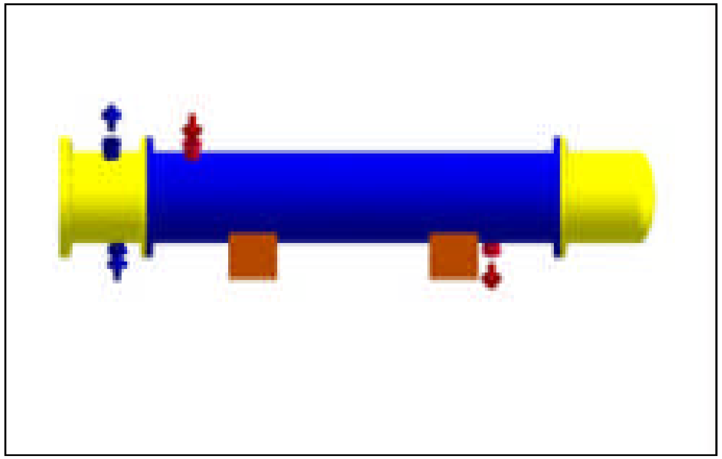
Contd.

POINT #	VAP FRAC	PRES	TEMP
		bar a	℃
1	1	3.0	19.0
2	1	3.4	22.7
3	1	3.9	26.1
4	1	4.3	29.2
5	1	4.7	32.1
6	1	5.2	34.8
7	1	5.6	37.3
8	1	6.0	39.7
9	1	6.4	42.0
10	1	6.9	44.1
11	1	7.3	46.1
12	1	7.7	48.1
13	1	8.2	49.9
14	1	8.6	51.7
15	1	9.0	53.5
16	1	9.5	55.1
17	1	9.9	56.7
18	1	10.3	58.3
19	1	10.7	59.8
20	1	11.2	61.3
21	1	11.6	62.7
22	1	12.0	64.1
23	1	12.5	65.4
24	1	12.9	66.7
25	1	13.3	68.0
26	1	13.8	69.2
27	1	14.2	70.4
28	1	14.6	71.6
29	1	15.1	72.8
30	1	15.5	73.9
31	1	15.9	75.0
32	1	16.3	76.1
33	1	16.8	77.1
34	1	17.2	78.2
35	1	17.6	79.2
36	1	18.1	80.2
37	1	18.5	81.2
38	1	18.9	82.2
39	1	19.4	83.1
40	1	19.8	84.1
41	1	20.2	85.0
42	1	20.6	85.9
43	1	21.1	86.8
44	1	21.5	87.6
45	1	21.9	88.5
46	1	22.4	89.3
47	1	22.8	90.2
48	1	23.2	91.0
49	1	23.7	91.8
50	1	24.1	92.6
51	1	24.5	93.4
52	1	24.9	94.2
53	1	25.4	94.9
54	1	25.8	95.7
55	1	26.2	96.4
56	1	26.7	97.2
57	1	27.1	97.9
58	1	27.5	98.6
59	1	28.0	99.3
60	1	28.4	100.0
61	1	28.8	100.7
62	1	29.3	101.4
63	1	29.7	102.1
64	1	30.1	102.7
65	1	30.5	103.4
66	1	31.0	104.1
67	1	31.4	104.7
68	1	31.8	105.3
69	1	32.3	106.0
70	1	32.7	106.6
71	1	33.1	107.2
72	1	33.6	107.8
73	1	34.0	108.4
74	1	34.4	109.0
75	1	34.8	109.6
76	1	35.3	110.2
77	1	35.7	110.8
78	1	36.1	111.4
79	1	36.6	111.9
80	1	37.0	112.5

SHEET 4 OF 9

Review of Coolers (AES type) for H2S (51.31 mole %) & MeSH (47.95 mole %) service Contd.

- Coolers IC1 & IC2 designed using HTRI which showed following results.
- It gave weight fraction vapour at outlet of coolers as 1 that means no liquid in the outlet stream.
- Reviewing the reports in detail, it showed local weight fraction vapour as 1.



HTRI wisdom

- At site during actual run, condensation was noticed in both the coolers.
- Referred to HTRI Technical support. HTRI stated:
  - If the dew point of gas is @ 55 ◦C then condensation may take place if the skin temperature on that side falls below that temperature.
  - Looking at final HTRI run min. skin temperature = 44.1 ◦C & max. skin temperature = 56.9 ◦C

HTRI wisdom

Contd.

- HTRI therefore feels that site will definitely get some condensation on the surface of the fouling layer.
- However gas/ fluid temp at exit from exchanger is above the dew point
- Thus any condensation will re-evaporate into the vapour phase (assuming its in contact with vapour and does not drain to the bottom of the shell and collect there).

HTRI response

Contd.

- In conclusion HTRI statement assumes that calculated dew point is correct.
- If it is wrong then, depending on the dew point one may or may not get condensation taking place.
- HTRI also suggested to re- verify actual gas mix, properties and dew point at site.

Output Summary

Page 1

Released to the following HTRI Member Company:

DRESS RAND INDIA PVT.LTD

DRESS RAND INDIA PVT.LTD

Xist Ver. 6 SP3 21-03-2013 11:06 SN: 1500214814 **Barg Units**

TUBE LAYOUT, BAFFLE CUT,SEAL ROD DIA CHANGED

INTERCOOLER1

Rating - Horizontal Multipass Flow TEMA AES Shell With Single-Segmental Baffles

No Data Check Messages.

See Runtime Message Report for Informative Messages.

Process Conditions		Hot Shellside		Cold Tubeside	
Fluid name			GAS		COOLING WATER
Flow rate	(1000-kg/hr)		2.8340		5.8500
Inlet/Outlet Y	(Wt. frac vap.)	1.0000	1.0000	0.0000	0.0000
Inlet/Outlet T	(Deg C)	114.00	60.00	33.00	40.30
Inlet P/Avg	(barG)	8.527	8.496	4.000	3.926
dP/Allow.	(bar)	0.061	0.088	0.147	0.343
Fouling	(m2-K/W)		0.000258		0.000344

Exchanger Performance

Shell h	(W/m2-K)	416.90	Actual U	(W/m2-K)	293.01
Tube h	(W/m2-K)	5421.3	Required U	(W/m2-K)	290.32
Hot regime	(--)	Sens. Gas	Duty	(kcal/hr)	42639.
Cold regime	(--)	Sens. Liquid	Eff. area	(m2)	3.800
EMTD	(Deg C)	44.9	Overdesign	(%)	0.93

Shell Geometry			Baffle Geometry		
TEMA type	(--)	AES	Baffle type		Single-Seg.
Shell ID	(mm)	254.10	Baffle cut	(Pct Dia.)	36.5
Series	(--)	1	Baffle orientation	(--)	Perpend.
Parallel	(--)	1	Central spacing	(mm)	154.85
Orientation	(deg)	0.00	Crosspasses	(--)	9

Tube Geometry			Nozzles		
Tube type	(--)	Plain	Shell inlet	(mm)	102.26
Tube OD	(mm)	19.050	Shell outlet	(mm)	102.26
Length	(mm)	2200.	Inlet height	(mm)	44.700
Pitch ratio	(--)	1.3333	Outlet height	(mm)	44.700
Layout	(deg)	90	Tube inlet	(mm)	42.850
Tubecount	(--)	32	Tube outlet	(mm)	42.850
Tube Pass	(--)	4			

Thermal Resistance, %		Velocities, m/s	Min	Max	Flow Fractions	
Shell	70.28				A	0.027
Tube	6.54	Tubeside	--	--	B	0.485
Fouling	19.76	Crossflow	--	--	C	0.285
Metal	3.42	Window	--	--	E	0.071
					F	0.131

HTRI

Output Summary

Page 1

Released to the following HTRI Member Company:

DRESS RAND INDIA PVT.LTD

DRESS RAND INDIA PVT.LTD

Xist Ver. 6 SP3 21-03-2013 11:19 SN: 1500214814 **Barg Units**

INTERCOOLER2

Rating - Horizontal Multipass Flow TEMA AES Shell With Single-Segmental Baffles

No Data Check Messages.

See Runtime Message Report for Warning Messages.

Process Conditions		Hot Shellside		Cold Tubeside	
Fluid name			GAS		COOLING WATER
Flow rate	(1000-kg/hr)		2.8340		6.3490
Inlet/Outlet Y	(Wt. frac vap.)	1.0000	1.0000	0.0000	0.0000
Inlet/Outlet T	(Deg C)	121.00	90.00	33.00	37.22
Inlet P/Avg	(barG)	18.986	18.967	4.000	3.972
dP/Allow.	(bar)	0.038	0.206	0.056	0.343
Fouling	(m2-K/W)		0.000258		0.000344

Exchanger Performance

Shell h	(W/m2-K)	730.98	Actual U	(W/m2-K)	418.55
Tube h	(W/m2-K)	5238.0	Required U	(W/m2-K)	413.40
Hot regime	(--)	Sens. Gas	Duty	(kcal/hr)	26732.
Cold regime	(--)	Sens. Liquid	Eff. area	(m2)	1.091
EMTD	(Deg C)	68.9	Overdesign	(%)	1.25

Shell Geometry			Baffle Geometry		
TEMA type	(--)	AES	Baffle type		Single-Seg.
Shell ID	(mm)	193.68	Baffle cut	(Pct Dia.)	33
Series	(--)	1	Baffle orientation	(--)	Perpend.
Parallel	(--)	1	Central spacing	(mm)	104.40
Orientation	(deg)	0.00	Crosspasses	(--)	5

Tube Geometry			Nozzles		
Tube type	(--)	Plain	Shell inlet	(mm)	73.660
Tube OD	(mm)	19.050	Shell outlet	(mm)	73.660
Length	(mm)	1219.	Inlet height	(mm)	42.388
Pitch ratio	(--)	1.3333	Outlet height	(mm)	42.388
Layout	(deg)	90	Tube inlet	(mm)	42.850
Tubecount	(--)	18	Tube outlet	(mm)	42.850
Tube Pass	(--)	2			

Thermal Resistance, %		Velocities, m/s	Min	Max	Flow Fractions	
Shell	57.26				A	0.039
Tube	9.67	Tubeside	--	--	B	0.597
Fouling	28.23	Crossflow	--	--	C	0.219
Metal	4.85	Window	--	--	E	0.144
					F	0.000

DRESSER-RAND *Heritage*


Dresser-Rand, Naroda-Ind
NARODA,
AHMEDABAD
India
DRESSER-RAND
Strong focus on Safety

Questions - ??

Sincere Thanks to IIChE- HTRI and you all

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