CORROSION EVALUATION

HOP-HX-00001 & HOP-HX-00003 (HLW)
Catalyst Skid Preheater

- Design Temperature (°F): 1000
- Design Pressure (in WG) (internal/external): 84/82
- Location: outcell; Room H-A123

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Selections Data Sheet

Operating Modes Considered:

- Assume off-normal conditions same as normal operations.
- Assume equipment will be monitored during operations for build-up of deposits (e.g. oxides and carbon fines)
- Design to include a cool down mode that will prevent condensation of acid gasses

Materials Considered:

Material (UNS No.)	Acceptable Material	Unacceptable Material
Carbon Steel	X[3]	
Type 304L (S30403)	X[1]	
Type 316L (S31603)	X[2]	
Type 347 (S34700)	X	
Type 439 (S43035)	X	
6% Mo (N08367/N08926)		X
Hastelloy® C-22® (N06022)		X
Ti-2 (R50400)		X

Recommended Material:

- Hot-side components: Type 347 stainless steel or heat-resistant nickel-base alloy
- Heat transfer surface: Type 347 or Type 439 stainless steel or heat-resistant nickel-base alloy, no corrosion allowance required for heat transfer surface
- [2]Cold-side components and enclosure: Type 347 stainless steel (max 0.030% C; dual certified)
- High temperature seals identified by Supplier shall be reviewed and approved by MET
- [1]Structural support (not in contact with offgas stream): Type 304 (or Type 316) stainless steel (max 0.030% C; dual certified)
- [3]Base (weldment to floor embeds): Carbon steel

Recommended Corrosion Allowance: 0.010 inch (includes 0.00 inch erosion allowance)

Process & Operations Limitations:

- Effort shall be made to prevent condensation at all times. This does not preclude cleaning with water with approved procedures.
- Operating limits shall be included in the operating procedures.

Concurrence DR
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
2	6/30/11	Incorporate revised PCDS Mat'l recommendation for cold-side Mat'l for seals to be approved Specify addt'l operating modes Various format and editorial changes	DLAdler	RBDavis	NA	SWVail

CORROSION EVALUATION

REVISION HISTORY

1	11/6/09	Update design temp Editorial and format change Include additional material recommendation Modify sections l and o Add AEA notice	DLAdler	RBDavis	NA	SWVail
0	7/21/08	Initial Issue	DLAdler	JRDivine	RBDavis	SWVail
REV	**DATE**	**REASON FOR REVISION**	**PREPARER**	**CHECKER**	**MET**	**APPROVER**

Please note that source, special nuclear and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

This bound document contains a total of 7 sheets.

CORROSION EVALUATION

Corrosion Considerations:

The gas treatment system is designed to remove aerosols, acid gases, and radionuclides from the off-gas. The system includes coolers, scrubbers, precipitators, mist eliminators, heaters, fans, pre-heaters, catalytic beds, and exhaust blowers. The type of corrosion mechanism and its rate of attack depend on the nature of the atmosphere (temperature, chemistry, moisture, and particulates). In general, corrosion occurs when process gases contain moisture, N_2, O_2, CO_2, NH_3, NO, N_2O, NO_2, HCl, HF, I_2, SO_2 and Hg. The temperature in the component is higher than the condensation temperature of water; therefore the component will remain dry during operation.

Preventing condensation during off normal operation is important. Proper insulation and its maintenance can sometimes solve corrosion problems during short temperature transients or cause the condensation to occur on surfaces distant from the housing. However, insulated equipment with operating gas temperatures during startup and shutdown will pass through the dew point can still have significant corrosion issues. Using corrosion resistant material will limit corrosion losses due to the condensation.

The moisture content in the gas that reaches the catalyst skid components (pre heater, heater, SCO and SCR) is less than 30% relative humidity. Dry surfaces do not corrode. The uniform corrosion, crevice corrosion, and pitting corrosion can be managed with austenitic stainless steel alloys Type 304/304L and Type 316/316L. The corrosion with these alloys is expected to be relatively low, 0.25 mpy max. Therefore, a total corrosion allowance of 0.010 inch is adequate for the offgas treatment system.

a General Corrosion
The anticipated dry-air conditions are not conducive to general corrosion and none is expected.

Conclusion
Type 304L is satisfactory on the basis of uniform corrosion and for structural support components not in contact with the offgas stream at an elevated temperature (>500 °F). Surfaces exposed to the offgas stream shall be fabricated using Type 347 stainless steel to minimize oxidation and the potential for intermetallic compound formation.

b Pitting Corrosion
Pitting corrosion will only be a concern if moisture is present. It is assumed that there will be no condensation in the unit, but Type 316L is recommended for added assurance.

Conclusion
At the stated operating conditions, pitting corrosion is not a serious concern. Type 316L is recommended.

c End Grain Corrosion
End grain corrosion only occurs in high acid conditions and is not a concern.

Conclusion:
Not a concern

d Stress Corrosion Cracking
Stress corrosion cracking will only be a concern if the preheaters experience multiple cooling cycles below 225°F in the presence of moisture.

Conclusion
At the stated operating conditions, stress corrosion cracking is not a concern.

e Crevice Corrosion
With no moisture present, crevice corrosion is not a concern.

Conclusion
At the stated operating conditions, crevice corrosion is not a concern.

f Corrosion at Welds
Assuming dry conditions and proper welding procedures, corrosion at welds is not anticipated.

Conclusion
At the stated operating conditions, weld corrosion is not a concern.

g Microbiologically Induced Corrosion (MIC)
The stated operating conditions are not suitable for microbial growth.

Conclusion
At the stated operating conditions, MIC is not a concern.

CORROSION EVALUATION

h Fatigue/Corrosion Fatigue
Extreme temperature cycling or fluctuations are not expected.

Conclusion
At the expected operating conditions, corrosion fatigue is not a concern.

i Vapor Phase Corrosion
Components essentially consist entirely of vapor space so general corrosion comments apply.

Conclusion:
See comments under general corrosion.

j Erosion
The velocity and solids content are sufficiently low that erosion is not a concern.

Conclusion
Erosion is not a concern.

k Galling of Moving Surfaces
There are no unlubricated moving surfaces present.

Conclusion:
Galling is not a concern.

l Fretting/Wear
Tube to tube support plates will likely move and fretting is likely unless designed to minimize movement.

Conclusion:
Fretting is a concern. Design will preclude tube movement using baffles and support plates.

m Galvanic Corrosion
No significantly dissimilar metals are present and it is assumed that condensation is controlled by design.

Conclusion:
Galvanic corrosion is not a concern.

n Cavitation
Cavitation is not expected in an off-gas system

Conclusion:
Cavitation is not a concern.

o Creep
At the design and operating temperatures, creep is not a concern. Although the design temperature is within the creep range of common stainless steels, the materials selected have higher creep threshold temperatures.

Conclusion
At the stated operating conditions, creep is not a concern.

p Inadvertent Addition of Nitric Acid
Introduction of nitric acid into the offgas stream is not a likely scenario.

Conclusion
Not applicable.

CORROSION EVALUATION

References:

1. 24590-HLW-M4C-HOP-00011, Rev. 1, *HLW Melter Offgas System Design Basis Flowsheets*
2. 24590-WTP-RPT-PR-04-0001, Rev. 0CC, *WTP Process Corrosion Data*
3. CCN 174990, e-mail from J Wood to R Davis, 25 March, 2008, "Design Temperatures For HOP TCOs"

Bibliography:

1. 24590-HLW-MED-HOP-00031, *24590-HLW-ME-HOP-HX-00002 & 24590-HLW-ME-HOP-HX-00004 - Welded Plate And Frame Heat Exchanger Mechanical Data Sheet*

CORROSION EVALUATION

24590-WTP-RPT-PR-04-0001, Rev. 0CC
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Catalyst skid preheater (HOP-HX-00001, HOP-HX-00003)

Facility HLW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum[2]		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/m^3					
HCl	g/m^3					
HF	g/m^3					
Iron	g/m^3					
NO	g/m^3	4.02E-01	4.16E-01			
NO_2	g/m^3	1.46E-01	1.59E-01			
Phosphate	g/m^3					
SO_2	g/m^3	1.4E-03	1.4E-03			Note 5
Mercury	g/m^3					
Carbonate	g/m^3					
Particulate	g/m^3					
HNO_3	g/m^3	3.9E-03	3.9E-03			Assumption 1
HNO_2	g/m^3	5.0E-03	5.0E-03			Assumption 1
Humidity	%	3%	3%			Note 5
Temperature	°F					Note 3, Note 4

List of Organic Species:

References

System Description: 24590-HLW-3YD-HOP-00001
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normally Associated Streams: HOP23, HOP26, HOP30, HOP25
Off Normal Streams (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-HLW-M5-V17T-00004; 24590-HLW-M5-V17T-20004
Technical Reports: N/A

Notes:

1. Concentrations less than 1×10^{-4} g/m^3 do not need to be reported; list concentration values to three significant digits max.
2. Data developed from a mass balance model which has constituents in the plant feed which are important to corrosion, adjusted to contract maximum values, except as noted.
3. Normal operating temperatures range from 330 °F at inlet of the cool side, to 624 °F at the outlet of the cool side and 678 °F at inlet of the hot side, to 421 °F at the outlet of the hot side (page A-6, 24590-HLW-M4C-HOP-00011, Rev 1).
4. Maximum operating temperatures range from 330 °F at inlet of the cool side, to 621 °F at the outlet of the cool side and 689 °F at inlet of the hot side, to 431 °F at the outlet of the hot side (page A-10, 24590-HLW-M4C-HOP-00011, Rev 1).
5. Source: 24590-HLW-M4C-HOP-00011, Rev 1, pages A-10 through A-13

Assumptions

1. Based on empirical data from testing per Attachment 28 of 24590-HLW-M4E-HOP-00005, page 4.

5.3.8.2 Catalyst Skid Preheaters (HOP-HX-00001, HOP-HX-00003)

Routine Operations

The catalyst skid preheater is a plate-type recuperative heat exchanger to recover heat from the skid offgas exhaust. The preheater recovers heat from the NO_x selective catalytic oxidizer reducer (SCR) offgas to reduce the electrical load on the catalyst skid electric heater.

Non-Routine Operations that Could Affect Corrosion or Erosion

None identified.