ISSUED BY
RPP-WTP PDC

CORROSION EVALUATION

HOP-SCO-00001 & HOP-SCO-00004(HLW)
Selective Catalytic Oxidizer

R11416990

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

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:
- Assume off-normal conditions same as normal operations.
- 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
Type 304L (S30403)	X[1]	
Type 316L (S31603)	X[2]	
Type 347 (S34700)	X	
Incoloy® 800 (N08800)	X	
Hastelloy® C-22® (N06022)		X
Ti-2 (R50400)		X

Recommended Material:

- Enclosure/shell-side components: Type 347
- Catalyst support frame & instrument housings: Type 347 stainless steel or Incoloy® 800
- [1]Structural support (not in contact with offgas stream): Type 304 (or Type 316) stainless steel (max 0.030% C; dual certified)
- [2]Instrument materials: Type 316 stainless steel (max 0.030% C, dual certified)

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

Process & Operations Limitations:
- None

Concurrence NA
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
5	8/30/11	Make correction to Recommended Materials and Page 1 to match change made to text at last revision	DLAdler	RBDavis	NA	SWVail

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REVISION HISTORY

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
4	6/30/11	Update equipment description Replace alloy 690 with alloy800 for instrument housings Incorporate revised PCDS Update design temp Add AEA notice Editorial and format changes	DLAdler	RBDavis	NA	SWVail
3	1/25/05	Update design conditions based on vendor submittal Revise material recommendation based on updated design temp	DLAdler	JRDivine	APR	SWVail
2	9/15/04	Update equipment quantity Update equipment description Update temperature Incorporate new PCDS Add section p -- Inadvertent Addition of Nitric Acid Extensive non-technical revisions	DLAdler	JRDivine	NA	APRangus
1	9/17/02	Add DWP note Update format Eliminate open issues	DLAdler	JRDivine	SS	SMKirk
0	2/7/02	Initial Issue	JRDivine	DLAdler	NA	BP

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.

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Corrosion Considerations:

The selective catalytic oxidizers oxidize organics to carbon dioxide, water, and possibly acid gases. The equipment operates at low relative humidity. 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
Uniform corrosion is not anticipated for all normal operating conditions. The dry air eliminates the electrolyte necessary to support electrochemical processes. However, because sections of the selective catalytic oxidizer may experience elevated temperatures, both types 304L and 316L stainless steel are precluded from use as the primary pressure boundary or enclosure. The stabilized austenitic grade of type 347 stainless steel is recommended and is suitable for the elevated temperatures and design conditions for the enclosure.

Conclusion
Type 304L is satisfactory for structural components not in contact with the offgas stream. Type 347 is recommended for all components of the pressure boundary and enclosure that are in contact with the offgas. A uniform corrosion allowance is added for normal wear and corrosion during off-normal events.

b Pitting Corrosion
Pitting corrosion is not anticipated for all normal, dry-air operating conditions. Localized corrosion for short durations during off-normal conditions may occur.

Conclusion
At the stated operating conditions, pitting corrosion is not a concern. Type 316L and Type 347 are both resistant to pitting corrosion.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
Stress corrosion cracking will only be a concern in the presence of moisture. It is assumed that there will be no condensation in the unit. During cleaning, the surfaces shall be well-flushed.

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

e Crevice Corrosion
Crevice corrosion will only be a concern if column is allowed to have multiple cooling cycles and the formation of liquid. The enclosure design uses lap joints that form crevices.

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

f Corrosion at Welds
None anticipated.

Conclusion
Not a concern.

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g Microbiologically Induced Corrosion (MIC)
Conditions in this equipment are not conducive to MIC

Conclusion
Not a concern.

h Fatigue/Corrosion Fatigue
Equipment shall be designed to accommodate the expected fatigue cycles over the 40 year design life.

Conclusion
Not a concern.

i Vapor Phase Corrosion
Offgas equipment is essentially entirely vapor space. Comments under General Corrosion apply.

Conclusion
See comments under General Corrosion.

j Erosion
Velocities are not expected to be sufficient to cause concern.

Conclusion
Not a concern.

k Galling of Moving Surfaces
None expected.

Conclusion
Not a concern.

l Fretting/Wear
None anticipated.

Conclusion
Not a concern.

m Galvanic Corrosion
None anticipated.

Conclusion
Not a concern.

n Cavitation
None anticipated.

Conclusion
Not a concern.

o Creep
The operating and design temperatures do not extend into the creep range.

Conclusion
Creep is not a concern under these conditions.

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

Conclusion
Not applicable.

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References:

1. 24590-HLW-M4C-HOP-00011, Rev. 1, *HLW Melter Offgas System Design Basis Flowsheets*
2. 24590-WTP-RPT-PR-04-0001, Rev. 0CD, *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-CM-POA-MBT0-00002-03-00001, *Data Sheet – HLW Thermal Catalytic Oxidizers/Reducers – Mechanical Data Sheet*
2. Allegheny Ludlum, 2003, *Stainless Steels, Types 321, 347, and 348, Technical Data Blue Sheet*, Allegheny Technologies, Inc.
3. Maziasz, PJ, RW Swindeman, JP Shingledecker, KL More, BA Pint, E Lara-Curzio, and ND Evans, 2003, *Improving High-Temperature Performance of Austenitic Stainless Steels for Advanced Microturbine Recuperators,* The Institute for Materials, Minerals and Mining, Maney Publishing, London, UK
4. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
5. Special Metals Corp, *Inconel Alloy 690*, Huntington, WV, 25701

CORROSION EVALUATION

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

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Thermal catalytic oxidizer (HOP-SCO-00001, HOP-SCO-00004)

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	2.92E-01	3.02E-01			
NO_2	g/m^3	1.07E-01	1.16E-01			
Phosphate	g/m^3					
SO_2	g/m^3	9.0E-04	9.0E-04			Note 5
Mercury	g/m^3					
Carbonate	g/m^3					
Particulate	g/m^3					
HNO_3	g/m^3	2.6E-03	2.6E-03			Assumption 1
HNO_2	g/m^3	3.4E-03	3.4E-03			Assumption 1
Humidity	%	0.1%	0.1%			Note 5
Temperature	°F					Note 3

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: HOP27, HOP28
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 1x 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.

4. The normal and maximum operating temperature is 750 °F at the inlet and outlet (pages A-6 and 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.

5.3.8.3 Thermal Catalytic Oxidizer (HOP-SCO-00001, HOP-SCO-00004)

Routine Operations

The gas from the catalyst skid electric heater flows to the thermal catalytic oxidizer (TCO). The TCO oxidizes organics to carbon dioxide and water and possibly acid gases (depending on the presence of halogenated organics in the gas). The TCO operates at about the same temperature as the NO_x selective catalytic oxidizer reducer (NO_x SCR). The TCO is placed in front of the NO_x SCR to take advantage of the decomposition reaction heat generation to maintain the NO_x SCR operating temperature. This arrangement also prevents the formation of NO_x in the TCO from the oxidation of ammonia used in the NO_x SCR. The TCO catalyst is likely to be a platinum-based material deposited on a substructure that is held in frames and is inserted and removed through access doors. This facilitates easy changeout.

Non-Routine Operations

None identified.