CORROSION EVALUATION

LVP-ADBR-00001A/B (LAW)
ACTIVATED CARBON BED ADSORBER

- Design Temperature (°F): 300
- Design Pressure (psig): full vacuum/ +4
- Location: Room L-304F; outcell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Equipment is maintainable.

Materials Considered:

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

Recommended Material:

- [1]Offgas components: type 316L stainless steel (max 0.030% C; dual certified)
- [2]Components not in direct contact with offgas stream: coated carbon steel (housing support frame, pipe supports, maintenance platform)

Recommended Corrosion Allowance: 0.010 inch (0.00 inch for carbon steel)

Process & Operations Limitations:

- None

Concurrence NA
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
2	12/21/11	Update design pressure Incorporate revised PCDS Addition text in section b	DLAdler	RBDavis	NA	SWVail
1	4/1/11	LVP-ADBR-00002A/B eliminated Update component description Update design conditions Incorporation of revised PCDS Expand section d to discuss mercury and liquid metal embrittlement Minor non-technical edits	DLAdler	RBDavis	NA	SWVail
0	8/24/04	Initial Issue	DLAdler	JRDivine	APR	APRangus

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This bound document contains a total of 7 sheets.

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Corrosion Considerations:

Treated activated carbon and other media are used to remove mercury and acid gases.

a General Corrosion
The anticipated dry-air conditions are not conducive to general corrosion and none is expected. A corrosion allowance of 0.010 inch is added to the wall thickness for a conservative design. Carbon steel is appropriate for items not in contact with the offgas stream.

Conclusion
Either austenitic Type 304L or 316L would be satisfactory.

b Pitting Corrosion
Pitting corrosion will only be a concern if moisture is present during normal operation. While the equipment is to operate dry and be laid-up dry, postulated short-term shut-down and heat-up thermal transients, during which temperatures may drop as far as to ambient, could condense vapors on the cold surfaces. Condensation does not occur above the boiling point and is expected to be minimal and transient and of minor affect on Type 316L. The constituents in the off-gas vapor phase can be aggressive in oxidizing environments, when mixed with aqueous condensate, and might lead to minor pit initiation in carbon steel and Type 304L stainless steel. Therefore, a material with a higher pitting corrosion resistance than Type 304L is necessary. Type 316L stainless steel, or better, is recommended for this application.

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

c End Grain Corrosion
Nitric acid is an oxidizing acid that could cause end grain attack. However, the exposure period is low. Therefore, end grain corrosion is not a concern.

Conclusion:
Not a concern

d Stress Corrosion Cracking
Liquid metal embrittlement (LME) and aqueous stress corrosion cracking are potential types of stress corrosion cracking (SCC).

This system will be exposed to mercury vapor and, probably, liquid mercury at temperatures up to 300 °F According to Pawel (1999), mercury does not wet Type 316L below 437 °F; without being wetted, then, Type 316L will not crack.

At expected operating temperatures between 160 °F and 189 °F, aqueous SCC will only be a concern in the presence of moisture. It is assumed that there will be little or no condensation in the unit when operating in the specified temperature range. Also see Pitting.

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

e Crevice Corrosion
Crevice corrosion will only be a concern if moisture is present. The offgas humidity is controlled so that there will be little or no condensation.

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

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

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

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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.

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
No metal/metal contacting surfaces are expected.

Conclusion:
Fretting is not a concern.

m Galvanic Corrosion
No significantly dissimilar metals are present. Further, it is assumed that no moisture is present.

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
Stated operating temperatures are too low for creep to occur.

Conclusion
Creep is not a concern.

p. Inadvertent Addition of Nitric Acid
Addition of nitric acid to the offgas lines is not a plausible scenario.

Conclusion
Not applicable

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References:

1. 24590-WTP-RPT-PR-04-0001, Rev. 0CD, *WTP Process Corrosion Data*
2. Pawel, SJ, JR DiStefano, and ET Manneschmidt, 1999, *Corrosion of Type 316L Stainless Steel in a Mercury Thermal Convection Loop*, ORNL/TM-13754.

Bibliography:

1. 24590-LAW-MVD-LVP-00003, *Mechanical Data Sheet - 24590-LAW-MV-LVP-ADBR-00001A, 24590-LAW-MV-LVP-ADBR-00001B - Activated Carbon Adsorber*
2. 24590-QL-POA-MWK0-00001-09-00023, *Data Sheet - Mechanical Data Sheet: Activated Carbon Adsorber, LAW*
3. CCN 130178, Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho National Engineering Laboratory, Idaho Falls, ID
4. Berhardsson, S, R Mellstrom, and J Oredsson, 1981, *Properties of Two Highly Corrosion Resistant Duplex Stainless Steels*, Paper 124, presented at Corrosion 81, NACE International, Houston, TX 77218
5. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
6. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
7. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
8. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
9. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

CORRESPONDENCE EVALUATION

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Activated carbon bed adsorber (LVP-ADBR-00001 A/B)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum[2]		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/m³					
HCl	g/m³	2.51E-02	2.83E-02			
HF	g/m³	6.58E-02	7.44E-02			
Iron	g/m³					
NO	g/m³	4.77E+00	4.99E+00			
NO2	g/m³	1.27E+01	1.43E+01			
Phosphate	g/m³					
SO2	g/m³	1.14E-01	1.28E-01			
Mercury	g/m³	2.09E-02	6.93E-04			Assumption 3
Carbonate	g/m³					
Particulate	g/m³	7.97E+00	8.0E+00			
HNO_3	g/m³	3.7E-02	3.7E-02			Assumption 4
HNO_2	g/m³	7.5E-02	7.5E-02			Assumption 4
Relative Humidity	%	35%	35%			
Temperature	°F					Assumptions 1 and 2

List of Organic Species:

References

System Description: 24590-LAW-3YD-LOP-00001
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normally Associated Streams: LVP06, LVP26
Off Normal Streams (e.g., overflow from other vessels):
P&ID: N/A
PFD: 24590-LAW-M5-V17T-00011
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/m³ 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.

Assumptions:

1. The normal operating temperature is 160 °F at the inlet, and 169 °F at the outlet (page 37, 24590-LAW-M4C-LOP-00001, Rev 2A).
2. * The maximum operating temperature is 162 °F at the inlet, and 189 °F at the outlet (page 41, 24590-LAW-M4C-LOP-00001, Rev 2A).
3. * Mercury concentrations are an assumption based on inputs and assumptions identified in Attachment A of 24590-WTP-M4C-V11T-00005, Rev A.
4. Based on empirical data from testing per Attachment 26 of 24590-LAW-M4C-LOP-00001, Rev 2A, page 171.

* Referenced calculation 24590-LAW-M4C-LOP-00001 has been revised. Temperatures are unchanged.

6.4.3 Offgas Mercury Adsorber (LVP-ADBR-00001A/B)

Routine Operations

AC is used to remove mercury and acid gases. The offgas flows to two adsorbers, which are normally operated in series. Each adsorber contains an AC bed.

Non-Routine Operations that Could Affect Corrosion or Erosion

- **Bed Fire** - The offgas isolation valve is automatically closed based on differential inlet/outlet carbon monoxide concentration, melter feed is stopped and the adsorber bed bypass valve is opened. Following detection of a high bed temperature, manual valves are opened to flood the bed with water, and isolation valves are automatically closed on high bed level to prevent water from blocking the offgas system flow. The adsorber would then be drained and the AC bed replaced.
- **Mercury or Sulfur Dioxide gas breakthrough** - If breakthrough occurs, that is, increasing concentrations of mercury or sulfur dioxide gases occur downstream of the lead column, the offgas is routed to the "lag" column and the AC in the "lead" column is replaced. The former lead column is then valved back in as the lag column.
- **High offgas inlet temperature** - A high offgas temperature could initiate a carbon bed fire. Upon detection of a high offgas temperature, melter feed is interlocked to stop, the bypass valve is interlocked to open, and isolation valves are interlocked to close. The HEPA preheaters are de-energized upon detection of high differential temperature.