CORROSION EVALUATION

LVP-EXHR-00001A/B/C (LAW)
MELTER OFFGAS EXHAUSTER

- Design Temperature (°F): 315
- Design Pressure (inches WC) (Inlet/Outlet): -166/+14
- Location: Rooms L-0304C/D/E; outcell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operations at temperature up to 282 °F
- Exposure to decontamination chemicals during maintenance shut-down
- Stand-by operations at room temperature at high relative humidity

Materials Considered:

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

Recommended Material:

Housing: Type 316 (max 0.030% C; dual certified)
Shaft: Type 410
Impeller: Type 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- None

Concurrence NA
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
3	5/21/13	Expand discussion throughout Correct sect i typo Correct typo in references Additional reference	DLAdler	JRDivine	NA	SWVail
2	11/15/12	Update design pressure Sect d—Remove mercury reference	DLAdler	RBDavis	NA	DJWilsey
1	7/18/12	Update wear allowance based on 24590-WTP-RPT-M-04-0008 Update design and operating temps Additional operating modes Add DWPA note Expand section d to discuss mercury and liquid metal embrittlement Incorporate revised PCDS Minor non-technical edits	DLAdler	RBDavis	NA	SWVail
0	8/11/04	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:

The off-gas exhauster is an assembled component consisting of a structure, housing, impeller, shaft, bearings, seals, and cooling system. Corrosion, wear, and fatigue affect each part. Materials selection for these assembled components is based on the function, service environment, and material properties. Often a trade-off is required for availability and life attributes. Exhauster inlet, outlet, housing, and impeller are exposed to potentially aggressive and halogen-containing gases, variable humidity, and decontamination agents at low pressure. No condensation is expected.

The recommended material for the shaft is Type 410, a hardenable stainless steel commonly used for valve stems, motor shafts and mounting lugs and brackets. Type 410 combines the superior wear resistance of the chromium-carbon steels and excellent corrosion resistance of chromium stainless steel. Type 410 provides good corrosion resistance to mild atmospheres. It resists corrosion in many light industrial and domestic environments as well as potable and mine waters. Type 410 stainless steel exhibits good corrosion resistance to atmospheric corrosion, potable water, and to a lesser degree to corrosive chemical environments because of the ability to form a tightly adherent passive oxide film which protects their surfaces from further attack.

a General Corrosion
Standard exhauster/blowers can be fabricated with a manufactured (cut and welded) housing or cast housing. The materials as allowed by design code can be either carbon steel or stainless steel; although corrosion and erosion resistant alloys are required unless there is sufficient bulk to the carbon steel material to ensure integrity while corroding at a high rate. The required corrosion allowance should be adjusted depending on the material selected; carbon steel or corrosion resistant steel.

Carbon steel or low alloy steel does not have sufficient corrosion resistance in this environment. The shaft is recommended to be fabricated from a corrosion resistant material such as a martensite or precipitation-hardened stainless steel. Depending on how the attachments are made, the inlet and outlet material should match either the piping or the housing where the weld is made. Copper and aluminum alloys should be avoided for any part of this fabrication because of the corrosion caused by the decontamination acids and nitrogen compounds in the gas. If the housing is manufactured, the alloys need to be wrought carbon or stainless steel.

Conclusion:
Stainless and corrosion resistant alloys (such as 300 series stainless steel) are recommended and are required to have an allowance of 0.04 inch to allow for corrosion, erosion, and synergistic losses. If carbon steel is used in the same service conditions, it is required to have a corrosion allowance of greater than 0.125 inch for corrosion, erosion, and synergistic losses. All carbon steel cast materials require additional ductility to prevent fatigue and brittle fracture. A minimum of 15 % elongation is required for all materials fabricated from castings.

b Pitting Corrosion
Pitting corrosion will only be a concern if moisture is present during normal operation. Shut-down and heat-up thermal transients will likely condense vapors on the cold surfaces. Locations at crevices, at dead-legs, at low points, and under deposits will host conditions that support corrosion. The constituents in the off-gas vapor phase can be aggressive in oxidizing environments, when mixed with aqueous condensate, towards 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. Type 316L is recommended.

c End Grain Corrosion
End grain corrosion only occurs in concentrated acid conditions at elevated temperatures. However, without the presence of liquid, such corrosion is not a concern.

Conclusion:
Not expected in this system.

d Stress Corrosion Cracking
At operations at the stated temperatures, aqueous stress corrosion cracking will only be a concern in the presence of moisture. It is assumed that there will be no condensation during normal operation, so stress corrosion cracking is not expected.

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

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Providing correct weld procedures are followed, no preferential corrosion of weld beads or heat-affected zones occurs. Further, weld corrosion is not a concern because the alloy of the piping and alloy of the exhauster housing are similar (Type 316L), therefore the welding process and filler materials are compatible. No additional allowance is made for weld bead corrosion.

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Conclusion:
Weld corrosion is not a problem for this system.

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

Conclusion:
MIC is not considered a problem.

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

Conclusions
Not expected to be 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 conditions expected are not severe, the gas is relatively particulate free, and the flow through the exhauster is relatively low (based on 24590-LAW-M6C-LVP-00004). The impingement erosion is not likely when there are very low particulates and moisture in the gas stream.

Conclusion:
Not expected to be a concern

k Galling of Moving Surfaces
The corrosion evaluation is specific to the process fluid and the inside components of the exhauster. Although the rotating shaft will have a bearing set, the set should be on the outside of the seals. Inside the exhauster the metallic surfaces will not contact and therefore galling is not possible.

Conclusion:
Conditions which lead to galling are not present in this component.

l Fretting/Wear
The corrosion evaluation is specific to the process fluid and the inside components of the exhauster. Although the rotating shaft will have a bearing set, the set should be on the outside of the seals. Inside the exhauster the metallic surfaces will not contact and therefore fretting wear is not possible

Conclusion:
Conditions which lead to fretting are not present in this component.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not a concern.

n Cavitation
Cavitation is the formation and rapid collapse of cavities or bubbles of vapor or gas within a liquid resulting from mechanical or hydrodynamic forces. Cavitation is not likely in the offgas system components because the fluid density of the gas is too low.

Conclusion:
Conditions in this system do not lead to cavitation.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Addition of Nitric Acid
Inadvertent introduction of nitric acid into the offgas system is not a plausible scenario. Nitric acid and decontamination agents may be used over short durations. Procedures will be used to control exposures and keep corrosion losses down.

Conclusion
Not applicable.

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References:

1. 24590-LAW-M4C-LOP-00001, Rev. 003, *LAW Melter Offgas System Design Basis Flowsheets* with the change notice 24590-LAW-M4E-LOP-00009
2. 24590-LAW-M6C-LVP-00004, Rev. 1, *Offgas Pipe And Exhauster Sizing For LOP And LVP Systems*
3. 24590-WTP-RPT-M-04-0008, Rev. 3, *Evaluation Of Stainless Steel And Nickel Alloy Wear Rates In WTP Waste Streams At Low Velocities*
4. 24590-WTP-RPT-PR-04-0001, Rev. 0CD, *WTP Process Corrosion Data*
5. Deleted

Bibliography:

1. 24590-LAW-MAD-LVP-00006, *Mechanical Data Sheet, 24590-LAW-MA-LVP-EXHR-00001A/B/C - Law Offgas Exhauster Blower*
2. 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
3. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
4. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
5. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
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. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
9. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
10. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
11. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084
12. 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

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

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) LAW melter offgas exhausters (LVP-EXHR-00001 A/B/C)

Facility LAW

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	1.7E-04	1.8E-04			
HF	g/m^3	4.4E-04	4.8E-04			
Iron	g/m^3					
NO	g/m^3	6.4E-02	6.7E-02			
NO2	g/m^3	1.1E-01	1.3E-01			
Phosphate	g/m^3					
SO2	g/m^3	1.7E-04	1.7E-04			Note 3
Mercury	g/m^3					Assumptions 2
Carbonate	g/m^3					
Particulate	g/m^3					
HNO_3	g/m^3					
HNO_2	g/m^3					
Relative Humidity	%	100%	100%			
Temperature	°F					Assumption 1

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: LVP18, LVP08
Off Normal Input Stream # (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/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. Source: 24590-LAW-M4C-LOP-00001, Rev 2A, pages 43 and 44

Assumptions:

** 1. Operating temperature ranges from 119 °F to 275 °F (pages 37, and 41, 24590-LAW-M4C-LOP-00001, rev 2A).
2. Mercury concentrations are an assumption based on inputs and assumptions identified in Attachment A of 24590-WTP-M4C-V11T-00005, Rev A.

* Error in PCDS Report. Referenced PFD should be 24590-LAW-M5-V17T-00010. This is supporting information for production of PCDS, but is not used in the development of the Corrosion Evaluation. Correction will be made at next revision of PCDS.

** Referenced document 24590-LAW-M4C-LOP-00001 has been revised. The nominal operating range is 122 °F at the inlet and 243 °F at the discharge. The maximum range is 122 °F at the inlet and 282 °F at the discharge.

6.4.9 LAW Melter Offgas Exhausters (LVP-EXHR-00001A/B/C)

Routine Operations

Three multistage centrifugal exhausters (blowers) (LVP-EXHR-00001A/B/C) each with adjustable speed drive, are located downstream of the caustic scrubber. Each exhauster is rated at 50 % of the full system capacity. The exhausters feed offgas to the offgas stack.

Non-Routine Operations that Could Affect Corrosion or Erosion

- **Loss of exhausters** - If an exhauster fails, the backup exhauster automatically activates.
- **General electrical failure** - Each exhauster is supplied with a separate UPS. Upon loss of offsite power, there is a seamless transfer to the UPS units for the exhauster(s) operation.