R10526389

CORROSION EVALUATION

LOP-WESP-00001 & LOP-WESP-00002 (LAW)
Melter 1 and Melter 2 Wet Electrostatic Precipitator (WESP)

- Design Temperature (°F)(max/min): 170/45
- Design Pressure (psig)(max/min): -1/+1
- Location: incell

ISSUED BY
RPP-WTP PDC

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is at stated pH and at minimum stated temperature, 122°F
- The vessel is at stated pH and at maximum stated temperature, 170°F

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18		X
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: UNS N08367

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

Process & Operations Limitations:

- Develop a rinse/flush procedure
- Develop a lay-up strategy

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Concurrence DMB
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
3	5/5/05	Update wear allowance based on 24590-WTP-RPT-M-04-0008	DLAdler	JRDivine	NA	APRangus
2	8/11/04	Incorporate new PCDS Add section p – Inadvertent Addition of Nitric Acid	DLAdler	JRDivine	NA	APRangus
1	1/29/04	Update quantity Update equipment description Update design temp/pressure Re-format references Remove reference to open issues Append updated MSDS Add DWP note	DLAdler	JRDivine	APR	APRangus
0	1/29/02	Initial Issue	JRDivine	DLAdler	NA	BPosta

CORROSION EVALUATION

Corrosion Considerations:

The WESPs provide further removal of aerosols from the offgas after initial aerosol and soluble gas removal in the SBS. Spray wash rings are available for washdown when required. Process air is used to keep the conductors clean and dry.

a General Corrosion
Little uniform corrosion is expected for the stated conditions. Either 304L or 316L would be suitable.

Conclusion:
304L or 316L would be acceptable for the conditions stated.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. The normal operating range of temperature for this vessel is 122 °F to 140 °F at a pH in the range 0.71 to 1.57. Data from Phull et al (2000) imply that with these conditions, a 6% Mo alloy or the equivalent will be needed at temperatures above 150°F. With the higher temperature, and expected pH below about 6, a more resistant alloy than 304L or 316L is required.

In addition, because of the high electrical potentials involved, the environment may be more oxidizing than is common. Consequently a strongly pitting resistant alloy is needed.

Further, there would be a tendency to pit if the vessel were filled with process water and left stagnant. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW. Pitting has been observed in both cases, and is likely caused by residual chlorides. Pitting is less likely for the higher alloys such as a 6% Mo alloy. The use of an alloy with $\leq$ 0.5% Cu is recommended to minimize the effects of mercury.

Conclusion:
Based on the stated operating conditions, 6% Mo is the minimum alloy acceptable.

c End Grain Corrosion
End grain corrosion only occurs in high acid conditions.

Conclusion:
Not believed likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, the environment, and also because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. For the normal operating conditions with good flushing, 316L would be satisfactory. However, with the possible off-normal conditions where there will be a tendency to concentrate salts, a 6% Mo alloy is recommended.

Conclusion:
For the normal operating environment, 316L is satisfactory. However, off normal conditions dictate the necessity for a more resistant alloy such as a 6% Mo.

e Crevice Corrosion
WESPs are known to accumulate solid deposits. Because the solids will probably contain halides, crevice corrosion will be likely. A 6% Mo is recommended. Also see pitting.

Conclusion:
A 6% Mo should be used.

f Corrosion at Welds
Weld corrosion is not expected to be a problem.

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

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth – the average operating temperature is approximately correct but the pH is too acid.

Conclusion:
MIC is not considered a problem.

CORROSION EVALUATION

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not a concern in a properly designed unit.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing.

Conclusion:
Not expected to be a concern.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No metal/metal contacting surfaces expected.

Conclusion:
Not expected to be a concern.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not expected to be a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

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

Conclusion:
Not applicable.

p Inadvertent Addition of Nitric Acid
This equipment normally operates at low pH.

Conclusion:
Not applicable.

CORROSION EVALUATION

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. 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

Bibliography:

1. 24590-WTP-3PS-MKE0-T0001, *Engineering Specification For Wet Electrostatic Precipitators*
2. Agarwal, DC, *Nickel and Nickel alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
3. 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
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
5. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
6. Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000
7. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
8. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
9. 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
10. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
11. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
12. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

CORROSION EVALUATION

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) WESP (LOP-WESP-00001, LOP-WESP-00002)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	6.57E-03	6.97E-03			
Chloride	g/l	7.10E-01	7.15E-01			
Fluoride	g/l	4.88E-01	5.66E-01			
Iron	g/l	1.39E-03	1.41E-03			
Nitrate	g/l	2.35E+00	1.96E+00			
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt %	0.1%	0.1%			
Other (Pb)	g/l	4.52E-03	3.00E-04			
Other	g/l					
pH	N/A					Note 2
Temperature	°F					Note 3

List of Organic Species:

References

System Description: 24590-LAW-3YD-LOP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: LOP07
Off Normal Input Stream # (e.g., overflow from other vessels):
P&ID: 24590-LAW-M6-LOP-00001, 24590-LAW-M6-LOP-00002, Rev 1
PFD: 24590-LAW-M5-V17T-00007, -00008 Rev. 4
Technical Reports:

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. pH approx. 0.71 to 1.57(24590-101-TSA-W000-0009-111-02, Rev 00B, pp. T-29 -T31)
3. T operation 122 °F to 140 °F (24590-WTP-M4C-V11T-00005, Rev A) Tmax 170 °F (24590-WTP-3PS-MKE0-T0001)

Assumptions:

6.3.2 Wet Electrostatic Precipitators (LOP-WESP-00001,2)

Routine Operations

After initial aerosol and soluble gas removal in the SBS is routed to the wet electrostatic precipitator (LOP-WESP-00001/2) for further removal of aerosols. Each melter system has a dedicated WESP.

The offgas enters the unit and passes through a distribution plate. The evenly distributed saturated gas then flows upward through the tubes of the WESP. The tubes act as positive electrodes. Each tube also has a single negatively charged electrode that runs down the center of the tube. A high voltage transformer/rectifier supplies the power to these electrodes. A strong electric field is generated along the electrode, giving a negative charge to aerosols as they pass through the tubes. The negatively charged aerosols move towards the positively charged tube walls and are intercepted. The inlet is also provided with an inlet spray to enhance rundown and cleaning. The condensate then drains into the C3/C5 drain/sump collection vessel (RLD-VSL-00004). Each WESP is equipped with a spray wash ring for washdown when required.

Process air is added through the electrical ducts to keep the conductors clean and dry. Downstream of the WESPs, the individual offgas lines and the vessel vent header join.

Non-Routine Operations that Could Affect Corrosion/Erosion

- **Loss of electrical power -** Loss of power, whether offsite or in the WESP electrical system, causes the system to pass particulates, therefore loading the HEPA filters faster. The melter is idled until power is restored.
- **Loss of one or more electrodes -** Loss of one or more electrodes results in lowered equipment efficiency, causing a more rapid HEPA loading. To correct the problem, the melter is idled and the maintenance bypass is used until repairs are made on the WESP. If decreased efficiency is not significant, maintenance is performed at the next melter changeout.