R10378686

PLANT ITEM MATERIAL SELECTION DATA SHEET

HOP-WESP-00001&2 (HLW)
MELTER 1 & 2 WET ELECTROSTATIC PRECIPITATOR (WESP)

- Design Temperature (°F)(max/min): 170/45
- Design Pressure (max/min): +1 atm/ -1 atm
- Location: out cell

ISSUED BY
RPP-WTP PDC

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on sheets 5 and 6

Operating Modes Considered:

- The vessel is acid, pH 2.4 to 2.6.
- Temperature up to 149 °F in the event the SBS loses cooling.

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)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: UNS N08367

Recommended Corrosion Allowance: 0.04 inch (includes 0.00 inch erosion allowance)

Process & Operations Limitations:

- Develop a rinse/flush strategy

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This bound document contains a total of 6 sheets.

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Corrosion Considerations:

The WESP is used to collect radioactive aerosols from the SBS to extend the life of the downstream equipment filter media. Spray rings are provided above and below the internal tubes for vessel and tube flushing. Water and acid flushing capability can be used for WESP cleanout for decontamination and decommissioning. Acid flushing may be required non-routinely to prevent buildup of solids in the WESP.

a General Corrosion
At the stated concentrations and pH, the general corrosion rate is expected to be low, ≤ 1 mpy. In this system, during normal operation, either 304L or 316L would be acceptable.

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. Normally the vessel is to operate at 122°F at a pH of 2.4 to 2.6 but could approach pH 0 during acid flushing . Berhardsson et al (1981) conclude 304L or 316L could be used based on temperatures and concentrations. However, the temperature could approach 150 °F and data from Phull et al (2000) imply that with these conditions, a 6% Mo alloy or the equivalent will be needed during an off-normal event involving SBS cooling.

In addition, because of the high electrical potentials involved, the environment may be more oxidizing than is common. Consequently, a strongly pitting resistant alloy may be 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 because residual chlorides are likely to remain. Pitting is less likely for the higher alloys such as a 6% Mo alloy.

Conclusion:
Based on the stated operating conditions, 316L is marginal and 6% Mo is recommended.

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. With the possible off-normal conditions and the tendency to concentrate salts, 6% Mo or better is recommended.

Conclusion:
For the normal stated operating environment, 316L is satisfactory. However, possible higher temperature off-normal conditions require a more resistant alloy.

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
Corrosion at welds is not expected to be a concern.

Conclusion:
Not a concern.

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. No process water is shown as entering the vessel.

Conclusion:
MIC is not considered a problem.

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h Fatigue/Corrosion Fatigue
Only minimal temperature cycling is expected. The presence of tubular internal components could be a concern but the vessel will be designed to accommodate any fatigue arising from the presence of the tubes during the design life of the equipment.

Conclusions
Not a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. Equipment is designed to allow the removal of solids as necessary.

Conclusion:
Not a concern.

j Erosion
Velocities within the vessel are relatively low.

Conclusion:
Not a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

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

Conclusion:
Not a concern.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not a concern.

n Cavitation
None expected.

Conclusion:
Not a concern.

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

Conclusion:
Not applicable.

p Inadvertent Addition of Nitric Acid
Equipment normally operates at a low pH and will be rinsed with nitric acid.

Conclusion:
Not applicable.

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References:

1 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
2. 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. Agarwal, DC, *Nickel and Nickel alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
2. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
3. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
4. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
5. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
6. 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
7. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
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

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OPERATING CONDITIONS

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Melter 1 & 2 wet electrostatic precipitators (HOP-WESP-00001, HOP-WESP-00002)

Facility HLW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum Al+3	g/l	5.56E-04	6.85E-04			
Chloride	g/l	3.23E-02	4.23E-02			
Fluoride	g/l	1.37E-02	1.95E-02			
Iron	g/l	3.99E-03	2.21E-03			
Nitrate	g/l	1.52E-01	1.73E-01			
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury Hg+3	g/l					
Carbonate	g/l					
Undissolved solids	wt %					
Other (NaMnO4, Pb,...)	g/l	9.2E-04	6.6E-04			
Other	g/l					
pH	N/A					Note 2
Temperature	°F					Note 3, Assumption 1

List of Organic Species:

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max
2. Average pH 2.4 to 2.6
3. T routine 122 °F (range not provided) condensate temperature

Assumptions

1. Temperature could rise as high as 149 °F in an off normal event involving SBS cooling

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5.4.10 Melter 1 and Melter 2 Wet Electrostatic Precipitators (HOP-WESP-00001, HOP-WESP-00002)

Routine Operations

A wet electrostatic precipitator (WESP) is a vessel assembly used to collect radioactive aerosols from the SBS to extend the life of downstream equipment filter media. The WESP internals consist of vertical tubes mounted on a tube sheet(s) connected to the vessel that serve as particle collection surfaces. Discharge rods extend from above each tube down through the tube center to the tube bottom. The discharge electrode array is supported by a conducting structure above the tubes and attached to the external power supply rods that extend through the pipes on the WESP top. Other WESP services such as gas inlet/outlet, demineralized flush water/nitric acid, instrumentation, and drains are provided through the vessel walls in the active services pipe area. Spray rings are provided in the vessel above and below the tubes for vessel and tube flushing. A gas flow distributor plate(s) is located below the tubes to ensure even gas flow through the tubes. The WESP drain is located in the vessel bottom and is routed to the SBS condensate receiver vessels (HOP-VSL-00903, HOP-VSL-00904). There is a remotely operated drain valve in the drain line located in the melter cave. The drain line is hydraulically sealed by the solution in the SBS condensate receiver vessel. The valve on the line is used to close the vessel for filling with nitric acid and flushing. Water and acid flushing capability can be used for WESP cleanout for decontamination and decommissioning. The offgas enters from the side, near the bottom of the vessel. A water atomizing nozzle is mounted on the gas inlet. The offgas flows through the distributor plate, through the tubes, and out through the outlet nozzle.

Non-Routine Operations that Could Affect Corrosion/Erosion

Acid flushing may be required periodically to prevent buildup of solids in the WESP.