R10404275

ISSUED BY RPP-WTP PDC

CORROSION EVALUATION

LFP-VSL-00002 & LFP-VSL-00004 (LAW)

Melter 1 & 2 Feed Vessels

- Design Temperature (°F) (max/min): 150/40
- Design Pressure (psig) (max/min): 15/FV
- Location: process cell

Offspring items

LFP-AGT-00002, LFP-AGT-00004
LFP-PMP-00007 – LFP-PMP-00018

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 filled with waste at up to 150°F
- The vessel will be washed with demineralized water

Assumptions:

- No steam ejector
- There will be no acid used in LAW systems (based on information from T Anderson)

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: Vessels: 316 (max 0.030%C; dual certified)

Agitator: Stellite 712 or equivalent

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

0.125 inch required on bottom head and shell (includes erosion and corrosion)

Process & Operations Limitations:

- Develop rinsing/flushing procedure.
- Do not allow untreated process water to remain stagnant in the vessel without approval by Materials Specialist.

Concurrence TD
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
0	10/4/04	Initial Issue Vessels removed from 24590-LAW-N1D-LFP-00006 due to new Process Corrosion data	DLAdler	JRDivine		APRangus

 10 August 2004

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Corrosion Considerations:

LFP-VSL-00002 and LFP-VSL-00004 receive blended melter feed consisting of LAW and glass formers. Mechanical agitators are present in vessel for blending. Agitators are maintainable and replaceable

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F He also states 316 (and 316L) has a rate of less than 2 mpy in 50% NaOH at temperatures up to 122°F. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Similar results were observed by Edgemon et al (1995) for the 242-A Evaporator at Hanford. Recent testing at PNNL (2004) showed corrosion rates of Stellite 12 and 712, Ultimate and 316L to be less than 1 mpy.

In this system, the normal pH, nitrate concentrations and temperatures are such that 304L and 316L stainless steels will be acceptable

Conclusion:
304L, 316L, Ultimet, and Stellite 12 and 712 are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
Chloride is known to cause pitting of stainless steels and related alloys in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices such as might form after partial removal of deposits during multiple rinse cycles. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media Edgemon et al (1995) did not observe pitting in the 242-A Evaporator but the chloride concentrations were only about 0.2% of those in this system.

Nominal operating temperature is 122°F with a range of 77 to 150°F. At this temperature, 304L or 316L stainless steels would be acceptable in the proposed alkaline-nitrate waste in the absence of concentrating effects

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. 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.

Conclusion:
Localized corrosion, such as chloride induced pitting, is common but can be mitigated using alloys with higher nickel and molybdenum contents. Based on the expected operating conditions, 316L is expected to be satisfactory

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
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 Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F With the proposed temperatures, either 304L or 316L is acceptable. No cracking has been observed in similar waste (Zapp, 1998) at temperatures to about 266°F.

Conclusion:
At the normal operating conditions 304L and 316L stainless are acceptable, although 316L is recommended.

e Crevice Corrosion
At the proposed operating conditions, 316L is the minimum recommended. See Pitting.

Conclusion:
See Pitting.

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system under the stated operating conditions

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g Microbiologically Induced Corrosion (MIC)
The normal operating conditions are not conducive to microbial growth.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue does not appear to be a concern.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
Vapor phase corrosion will be a function of the degree of agitation, solution chemistry, and temperature. Under the stated, conditions, and assuming agitation, 316L will be required.

Conclusion:
Not expected to be a concern.

j Erosion
Velocities at the walls and bottom of the vessels are expected to be below 10 f/s. The wear of the vessel bottom and wall due to both erosion and corrosion is expected to be below 0.125 inch of 316L stainless steel based on 24590-WTP-M0E-50-00002.

Conclusion:
A minimum corrosion allowance on the bottom head and shell of 0.125 inch is recommended. Agitator blades should be Stellite 712. Ultimet is acceptable if the agitator design takes into consideration Ultimet's higher wear rate.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No significantly 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 Nitric Acid Addition
At this time, the design does not provide for the presence of nitric acid reagent in this system.

Conclusion:
Not applicable.

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References:

1. 24590-WTP-M0E-50-00002, *Increases the Wear Rate of Vessels Containing Glass Formers to Account for the Increased Velocities Along the Bottom Head Wall and to Account for Perpendicular Flow Against the Bottom Head and Wall*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. CCN 079661, Perform Scoping Studies To Determine The Suitability Of Construction Materials To Caustic Environments, 12 March 2004
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
5. Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
6. Edgemon, GL and RP Anantatmula, 1995, *Hanford Waste Tank Degradation Mechanisms*, WHC-SD-WM-ER-414, Rev 0a, Lockheed Martin Hanford corporation, Richland, WA 99352
7. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
8. 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
9. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
10. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc

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. Anderson, TD, 21 December 2000, to JR Divine: No provision for adding nitric or other acid.
3. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
4. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
5. Miles RE, 2001, Telecon to JR Divine, *LAW and HLW Gamma Radiation Exposures Estimates*, RPP-WTP, Richland, WA 99352
6. Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
7. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
8. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

CORROSION EVALUATION

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Melter 1& 2 feed vessel (LFP-VSL-00002, LFP-VSL-00004)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	4.10E+01	3.84E+01			
Chloride	g/l	1.18E+01	1.29E+01			
Fluoride	g/l	1.18E+01	1.30E+01			
Iron	g/l	1.82E+00	1.87E+00			
Nitrate	g/l	1.75E+02	1.86E+02			
Nitrite	g/l	5.26E+01	5.75E+01			
Phosphate	g/l	3.80E+01	4.06E+01			
Sulfate	g/l	2.03E+01	2.21E+01			
Mercury	g/l	6.19E-01	2.03E-02			
Carbonate	g/l	8.41E+01	7.12E+01			
Undissolved solids	wt%	44%	43%			
Other (Pb)	g/l	4.50E-01	2.83E-02			
Other	g/l					
pH	N/A					Note 2
Temperature	°F					Note 3, Note 4

List of Organic Species:

References

System Description: 24590-LAW-3YD-LFP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: LFP05
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-LAW-M6-LFP-00001, 24590-LAW-M6-LFP-00003, Rev 1
PFD: 24590-LAW-M5-V17T-00001, -00002, Rev 4
Technical Reports: N/A

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 13.9 to 14.7 (24590-WTP-M4C-V11T-00005, Rev A)
3. T operation 77 °F to 150 °F, T nominal 122 °F (24590-LAW-MVC-LFP-00001, Rev C)
4. The 150 F is maximum temperature from pretreatment and no additional design margin is required.

Assumptions:

6.2.2 Melter 1 and Melter 2 Feed Vessels (LFP-VSL-00002 and LFP-VSL-00004)

Routine Operations

The melter feed vessels (MFVs) (LFP-VSL-00002 and LFP-VSL-00004) receive blended melter feed, consisting of LAW and glass formers, from the MFPVs. Each MFV, like each MFPV, is sized to supply melter feed for 16 hours of operation to a melter operating at a glass production rate of 15 t/day/melter. Each MFV is equipped with the following:

- One mechanical agitator with current
- Air displacement slurry (ADS) pumps to transfer feed to the corresponding LAW melter
- One vertical pump
- Liquid level indicators and control
- Density indicator
- Pressure indicator
- Temperature indicator
- Rotary vessel cleaning jets for periodic vessel washdown
- Overflow line to the corresponding MFPV

The agitators will blend the glass formers and concentrate to a homogeneity criteria that ensures that the final product will meet qualification requirements.

The agitators and pumps are expected to require maintenance and/or replacement during the life of the plant. The wet process cell is designed to allow for replacement of the vessels (not expected), agitators, and pumps.

The ADS Pump, lines, and nozzles are water flushed once every 2 to 4 hours, after every pump shutdown and before initiation of feed to the melter. Flush water is transferred directly to melter.

The agitators and pumps are expected to fail within the lifetime of the plant. The facility is designed to allow for replacement of agitators and pumps. ADS pumps were selected for their few moving parts to minimize maintenance. The lines from the ADS pumps to the melter are flexible hoses designed to resist effects of thermal stress and distortions.

Each MFV interfaces with autosampling system ASX-SMPLER-00011 (24590-LAW-M6-ASX-00001). Before a sample is taken, the melter feed is pumped through a sample circulation loop. The sampler will pull a portion of the process stream from the circulation loop.

Non-Routine Operations that Could Affect Corrosion/Erosion

- Overflows to LFP-VSL-00001 or LFP-VSL-00003
- Washing required on failure of agitator