PLANT ITEM MATERIAL SELECTION DATA SHEET

R10344401

RLD-VSL-00007 (HLW)
Acidic Waste Vessel

- Design Temperature (°F)(max/min): 168/40
- Design Pressure (psig) (max/min): 15/FV
- Location: incell
- PJM Discharge Velocity (fps): 26
- Drive Cycle: 25 %

Offspring items

RLD-PJM-00005 – RLD-PJM-00008
RLD-VSL-00015A/B, RLD-RFD-00162A/B

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on sheets 5 and 6

ISSUED BY RPP-WTP PDC 8/10/04 INIT DATE

Operating Modes Considered:

- Vessel is operating at pH 2 at the normal operating temperature.
- Waste is neutralized in vessel.
- The vessel is alkaline.
- Wash solutions could be 5M NaOH, 0.5M nitric acid or DIW.

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 or N08926
Steam ejectors and piping: UNS N06022

The vessel head on the inside of the vessel under nozzles 7, 8, 29, 30, 36, and 37 shall have a band of Hastelloy C-276 clad layer a minimum of 4 inch wide surrounding the outer perimeter of the nozzle pipe.

Recommended Corrosion Allowance: 0.04 inch (includes 0.00 inch erosion allowance; localized protection is provided as necessary and is discussed elsewhere)

Process & Operations Limitations:

- Develop a lay-up strategy.
- Develop a rinsing/flushing strategy for acid and water.

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This bound document contains a total of 6 sheets.

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Corrosion Considerations:

This vessel collects liquids from the SBS, the SBS condensate receiver vessel, and the waste neutralization vessel. The collected waste consists of SBS purge and WESP and HEME drainage. Sodium hydroxide is added to the vessel to adjust pH based on sample analysis.

a General Corrosion

Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy. Under the same conditions, a 6% Mo alloy has a corrosion rate of about 3 mpy and C-22 <2 mpy. Extrapolating acid concentration, fluoride concentration, and temperature, suggests the corrosion rate for 304L and 316L would be less than about 1 mpy and 6% Mo and C-22 are much less. The presence of Al^{+++} is expected to reduce the corrosion rate but it is in insufficient quantities to be highly effective. 304L or 316L will not be satisfactory at the listed conditions. A minimum of a 6% Mo alloy is needed.

Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 μm/y) at 77°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Sedriks (1996) states that the 300 series are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. The usual corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect due to oxidizer contaminants – such as contained in the waste. The corrosion rates of the higher nickel alloys are expected to be lower. In this system, 304L or 316L stainless steel will be acceptable during alkaline conditions.

Conclusion:
One of the 6% Mo alloys is expected to be the minimum required. The uniform corrosion rate of higher alloys will be smaller – it is assumed a corrosion allowance of 0.04 inch would be satisfactory for them.

b Pitting Corrosion

Chloride is known to cause pitting in acid and neutral solutions. Normally the vessel is to operate at about 138°F at a pH ranging from 2 to 14. Extrapolating from Wilding & Paige data (1976), it appears that 304L would not pit due to the presence of the nitric acid and excess nitrate. Berhardsson et al (1981) have similar conclusions based solely on concentrations. 316L will provide added protection should chlorides concentrate during operation, though at the maximum operating conditions a 6% Mo is recommended.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit, more so with the 300 series than with 6% Mo alloys. 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:
Based on the expected operating conditions, a 6% Mo is expected to be satisfactory.

c End Grain Corrosion

End grain corrosion only occurs in hot concentrated oxidizing 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. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F for sensitized alloys. According to Koch (1995), the presence of fluoride exacerbates intergranular stress corrosion cracking. With the proposed normal conditions, a 6% Mo is expected to be the minimum acceptable.

Steam ejectors will be used to empty the vessel. A band of C-276 is needed in the high temperature zone of the dome to prevent cracking at the nozzle entry.

Conclusion:
For the normal operating environment, a 6% Mo alloy is required.

e Crevice Corrosion

With the stated operating conditions, a 6% Mo alloy would be the minimum acceptable. Also see Pitting.

Conclusion:
A 6% Mo alloy is recommended.

f Corrosion at Welds

It is expected that the heat tint will be removed during normal operation. NiCrMo-3 or similar filler metal should be used to avoid low-molybdenum areas in the welds.

Conclusion:
Weld corrosion is not considered a problem.

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

Conclusion:
MIC is not likely a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a problem.

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. Vessel is fitted with wash rings. Recommend more pitting resistant 6% Mo alloy.

Conclusion:
Vapor phase corrosion is not a concern.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. At least 0.090 inch of additional N08367 or N08926 should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 9.4 m/s with solids concentrations of 1.2 wt% for 100 % operation. A maximum solids concentration of 1.2 wt% occurs during normal operations using contract maximums in the leach case.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.075 inch of additional N08367 or N08926 should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations up to 1.2 wt% for 100 % operation.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel walls. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
For passive alloys there is negligible potential difference so galvanic corrosion is not a concern.

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
Vessel normally operates at low pH.

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. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
3. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
4. 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
5. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
6. Smith, HD and MR Elmore, 1992, *Corrosion Studies of Carbon Steel under Impinging Jets of Simulated Slurries of Neutralized Current Acid Waste (NCAW) and Neutralized Cladding Removal Waste (NCRW)*, PNL-7816, Pacific Northwest Laboratory, Richland, Washington.
7. 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

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), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. 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
5. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
6. 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 #) Acidic waste vessel (RLD-VSL-00007)

Facility HLW

In Black Cell? yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	2.28E-01	2.77E-01			
Chloride	g/l	4.96E-01	7.42E-01			
Fluoride	g/l	3.05E-01	4.95E-01			
Iron	g/l	1.64E+00	8.94E-01			
Nitrate	g/l	2.54E+01	2.57E+01			
Nitrite	g/l					
Phosphate	g/l	1.18E-02	2.74E-02			
Sulfate	g/l					
Mercury	g/l	2.72E+00	3.12E+00			
Carbonate	g/l					
Undissolved solids	wt %	1.20%	1.07%			Note 4
Other (NaMnO4, Pb,...)	g/l	7.85E-02	4.25E-02			
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

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. Tmin 137°F, T normal 138 °F, Tmax 143 °F
3. pH 2 to 14. Receives various streams of differing pH but is neutralized before transfer.
4. Receives non-routine high solids from SBS

Assumptions

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5.6.5 Acidic Waste Vessel (RLD-VSL-00007)

Routine Operations

The acidic waste vessel (RLD-VSL-00007) is in a black cell and collects liquid from the SBS (HOP-SCB-00001/2), the SBS condensate receiver vessels (HOP-VSL-00903/904), and the waste neutralization vessel (HDH-VSL-00003). The collected waste consists of SBS purge, WESP and HEME drainage, and neutralized canister decontamination waste. The vessel receives transfers approximately once per day. The vessel contents are sampled for pH before being transferred to the PT vessel PWD-VSL-00043. The PJMs keep the vessel contents well mixed for a representative sample. Sodium hydroxide is added to the vessel based on the sample analysis and the mass of effluent in the vessel. The vessel transfers to the pretreatment vessel PWD-VSL-00043 approximately once every day. The process flow diagrams for the RLD system (24590-HLW-M5-V17T-P0007001 and 24590-HLW-M5-V17T-P0007002) illustrate the RLD vessels, associated equipment, and stream data.

Non-Routine Operations that Could Affect Corrosion/Erosion

Receives high solids from the SBS.