CORROSION EVALUATION

ISSUED BY
RPP-WTP PDC

R10433505

RLD-VSL-00004 (LAW)
C3/C5 Drains/Sump Collection Vessel

- Design Temperature (°F)(max/min): 183/-20
- Design Pressure (psig) (max/min): 15/FV

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Can be maintained, not replaced, during the 40 y design life. No method of totally removing solids or heels is present.

Operating Modes Considered:

- The tank is filled with waste at 115°F and drain waste
- Rinsed with plant water, a heel is expected to remain

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: 316 (max 0.030% C; dual certified). Bottom head to be clad with 0.1 inch of Inco 625 (UNS N06625) material or better.

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch erosion allowance)

Process & Operations Limitations:

- Develop lay-up strategy

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Concurrence DMB
Operations

5	3/28/06	Update wear allowance based on 24590-WTP-RPT-M-04-0008	DLAdler	HMKrafft	NA	SWVail
REV	**DATE**	**REASON FOR REVISION**	**PREPARER**	**CHECKER**	**MET**	**APPROVER**

6 February 2006

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REVISION HISTORY

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
4	7/1/04	Incorporate new PCDS Add Section p – Inadvertent Addition of Nitric Acid	DLAdler	JRDivine	NA	APRangus
3	4/3/03	Update design temp/pressure Append updated MSDS Add DWP note Extensive revisions to the text; no revision bars used.	DLAdler	JRDivine	NA	MHoffmann
2	9/17/02	Remove wording regarding open issues	DLAdler	JRDivine	SS	MHoffmann
1	4/29/02	Modify Material Recommendation	DLA	JRD	SS	SK
0	4/2/02	Initial Issue	DLAdler	JRDivine	NA	SK

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Corrosion Considerations:

RLD-VSL-00004 is designed to receive fire water from the C3/C5 area in case the sprinkler system is activated. RLD-VSL-00004 also collects liquid purge drained from the LOP-WESP-00001/2. It could also possibly receive overflow from the concentrate receipt vessels and washes from various other vessels.

a General Corrosion
Wilding and Paige (1976) have shown that in 5% nitric acid with 1,000 ppm fluoride at 290°F, the corrosion rate of 304L and 316L can be kept as low as 5 mpy by the use of Al^{+++}. The fluoride concentration in this situation is 566 ppm, the normal operating pH ranges from 0.71 to 1.57, and the normal operating temperature is 115°F. Based on the available data, the uniform corrosion rate will be small.

Conclusion:
304L and 316L 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 encourage pitting of stainless steel and related alloys in acid and neutral solutions. Alloys with higher molybdenum contents are more resistant to pitting. The stated conditions of pH and chloride conditions for this vessel are sufficient to cause 316L to be a marginal choice. However, with the cladding of the bottom head with a more resistant alloy, 316L is deemed satisfactory.

Conclusion:
Localized corrosion, such as pitting, is common but can be mitigated, if caused by chlorides, by alloys with higher nickel and molybdenum contents. Based on the expected operating conditions, 316L would be expected to be satisfactory with the addition of cladding of the bottom head.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
End grain corrosion, as normally defined, is not a concern.

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 because chloride tends to concentrate under heat transfer conditions. 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. Further, the "L" grade stainless steels are more resistant. With the proposed conditions, 316L will be acceptable.

Conclusion:
For the normal operating environment, a 316L is the minimum recommended.

e Crevice Corrosion
Though the solids content is not excessive under normal operations, there is no good method for removing all deposits or heels. At the proposed operating temperature, 304L and 316L alone are not acceptable. Either cladding the bottom head of the vessel is necessary or 6% Mo alloy or better is recommended. In addition, 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 normal operating conditions.

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 in the vessel.

Conclusions
Not a concern.

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i Vapor Phase Corrosion
Vapor phase corrosion will be a function the degree of agitation, solution chemistry, and temperature. Under normal operating conditions, vapor phase corrosion is not expected to be a concern.

Conclusion:
Not believed to be a concern. 316L is expected to be satisfactory.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.016 inch for components with solids content up to 27.3 wt% at velocities less than 4 mps is based on 24590-WTP-RPT-M-04-0008. Although the solids content can reach 43.9 wt% during non-routine operations, the vessel normally has solids content less than 0.1 wt% and 0.016 inch is considered an adequate erosion wear allowance.

Conclusion:
Not expected to be a problem.

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. Additionally, the vessel sees low pH under normal operating conditions.

Conclusion:
Not applicable.

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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. CCN 092184, Memo from Dolores Mitchell to Jim Divine, 11 June 2004, "Update to RLD-VSL-00004 Process Corrosion Data"
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
5. 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
6. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
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. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
4. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
5. 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.
6. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
7. Van Delinder, LS (Ed), 1984, Corrosion Basics, NACE International, Houston, TX 77084

CORROSION EVALUATION

CCN 092184
UPDATE TO RLD-VSL-00004
PROCESS CORROSION DATA

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) C3/C5 drains/sump collection vessel (RLD-VSL-00004)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine (Note 3)		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	6.57E-03	6.97E-03	4.10E+01	3.84E+01	
Chloride	g/l	7.10E-01	7.15E-01	1.84E+01	2.00E+01	
Fluoride	g/l	4.88E-01	5.66E-01	1.84E+01	2.01E+01	
Iron	g/l	1.39E-03	1.41E-03	2.84E+00	2.90E+00	
Nitrate	g/l	2.35E+00	1.96E+00	2.73E+02	2.89E+02	
Nitrite	g/l			8.22E+01	8.93E+01	
Phosphate	g/l			5.93E+01	6.30E+01	
Sulfate	g/l			3.16E+01	3.43E+01	
Mercury	g/l			9.48E-02	3.16E-02	
Carbonate	g/l			1.29E+02	1.11E+02	
Undissolved solids	wt%	0.1%	0.1%	43.9%	43.3%	
Other (Pb)	g/l	4.52E-03	3.00E-04	6.89E-01	2.94E-02	
Other	g/l					
pH	N/A					Note 4, Note 5
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-LAW-3YD-30-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: LOP10 (or LOP07 from WESP)
Off Normal Input Stream # (e g , overflow from other vessels): Note 3
P&ID: 24590-LAW-M6-RLD-00002, Rev 3
PFD: 24590-LAW-M5-V17T-00014, 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. T routine Operation 115°F (cooling occurs via transfer and from other input/flush streams).
3. Non-routine is max concentration from overflow of LCP, LFP vessels, and RLD-VSL-00003.
4. pH 0.71 to 1.57 (24590-101-TSA-W000-0009-111-02, Rev. 00B, ppT30,T32)
5. Non-routine pH 1 to 8, same as RLD-VSL-00003.

Assumptions:

6.6.2 C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004)

Routine Operations

The C3/C5 drains/sump collection vessel (RLD-VSL-00004) and its cell are designed to contain the most probable maximum amount of fire protection water necessary to cover the largest C3/C5 area, approximately 30,000 gallons. In the event of a fire and activation of the sprinkler system, the fire water will drain into the vessel through floor drains. Once the volume reaches the overflow level of the vessel, the contents will overflow onto the floor of the C3/C5 cell. The sump pump transfers the contents of the cell to the plant wash vessel (RLD-VSL-00003).

The C3/C5 drains/sump collection vessel also collects a constant liquid purge gravity drained from the wet electrostatic precipitators (LOP-WESP-00001 and LOP-WESP-00002).

The vessel is equipped with:

- A centrifugal transfer pump
- Vessel mixing eductors
- A centrifugal pump
- Level instruments
- Density instruments
- Temperature instruments pressure

The C3/C5 drains/sump collection vessel pumps are centrifugal pumps and are used to discharge to the SBS condensate collection vessel (RLD-VSL-00005) or to the plant wash vessel (RLD-VSL-00003). Routine process-related effluent from WESP drains can be pumped out daily to the SBS condensate collection vessel (RLD-VSL-00005). Effluent generated from other sources will be periodically pumped to the plant wash vessel (RLD-VSL-00003) when it reaches a predetermined level. Sampling capability is provided using a sampling leg off the pump recirculation line to an autosampler unit.

Non-Routine Operations that Could Affect Corrosion/Erosion

The overflow from the concentrate receipt vessels (LCP-VSL-00001 and LCP-VSL-00002) and the melter feed preparation vessels (LFP-VSL-00001 and LFP-VSL-00003) is also routed to this vessel.

The C3/C5 drains/sump collection vessel (RLD-VSL-00004) overflows to a sump (RLD-SUMP-00028) in the same cell. This sump is emptied by a pump (RLD-PMP-00004) into the plant wash vessel (RLD-VSL-00003)

The vessel can also be washed down with internal spray nozzles (RLD-NOZ-00006, RLD-NOZ-00007). If chemical adjustment is needed, reagents can be introduced through the spray nozzles.

The C3/C5 drains/sump collection vessel also receives washes from vessels.

Eductors in the C3/C5 drains/sump collection vessel (RLD-VSL-00004) and pumps with recirculation capability are operated to suspend captured solids. Suspended solids are entrained into the effluent and are periodically removed from the vessels when the vessel contents are pumped to the specified vessel in PT. If necessary, vessels can be flushed with water.