PLANT ITEM MATERIAL SELECTION DATA SHEET

R10661286

ISSUED BY RPP-WTP PDC

PWD-VSL-00044 (PTF)
Plant Wash Vessel

- Design Temperature (°F)(max/min): 237/40
- Design Pressure (psig) (max/min): 15/-8
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

Offspring items

PWD-VSL-00121 – PWD-VSL-00125
PWD-PJM-00021 – PWD-PJM-00028,
PWD-RFD-00121 – PWD-RFD-00125

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operating conditions

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)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; additional localized protection required and discussed in section j)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water.

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Corrosion Considerations:

PWD-VSL-00044 routinely receives recycle materials from the PVP, PJV, RLD and PWD systems as well as laboratory wastes. During non-routine operation, the vessel can receive plant wash solution through the PWD breakpots. Vessel is equipped with wash rings. 19 M sodium hydroxide reagent header is available to adjust excess acidic effluent to pH > 12.

a General Corrosion
The normal operating temperature is between 59 and 111 °F. Periodically, steam can heat incoming streams to 212 °F (with a design temperature of 237 °F). The high temperature is anticipated to be localized and of short duration.

In this vessel, the temperatures normally will be sufficiently low that uniform corrosion will not be a concern. 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 shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. 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. Divine's work (1986) with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy); Ni 200, pure nickel, was much less resistant (≈7 mpy) probably due to the complexants. Zapp (1998) notes that the Savannah River evaporator vessels, operating at about 266°F, are made of 304L and no failures are known to have occurred. Failures have occurred in the 304L heat transfer surfaces. Gray's review of the Savannah River evaporators (1994), confirms that all failures experienced since the system start-up in 1960 have been from failed tube bundles, not the evaporator vessels. Ohl & Carlos (1994), in their review of the 242-A Evaporator, found in waste similar to that expected in LAW, the corrosion of 304L after about two years of operation at 140°F was less than the accepted variability of the plate. Because of uncertainties in the starting thickness of the metal, a review of the raw data was inconclusive.

Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.11 mpy up to about 212°F though Sedriks (1996) states the data beyond about 122°F are low due to oxidizing agents. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F.

Conclusion:
At the stated operating conditions and in an alkaline environment, both 304L and 316L have very low corrosion rates and either is acceptable. However, 316L is considered somewhat better suited to the possible cleaning conditions and is recommended.

b Pitting Corrosion
Chloride is known to cause pitting 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. Dillon and Koch (1995) are of the opinion that fluoride will have little effect. Further, Revie (2000) and Uhlig (1948) note that nitrates inhibit chloride pitting. Wilding and Paige (1976) note that nitric acid inhibits chloride attack though their data are at higher temperatures and concentrations.

Conclusion:
Under normal 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, and the environment. But it is also unknown 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. If the concentrations are as stated, stress corrosion cracking will be minimized. Although caustic cracking is possible above 140°F, it is not expected under these conditions due to the presence of oxidizing species such as nitrate.

Conclusion:
Because of the normal operating environment, 316L stainless steel is expected to be acceptable.

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e Crevice Corrosion
The pitting discussion covers this area.

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.

g Microbiologically Induced Corrosion (MIC)
The proposed operating temperatures are suitable for microbial growth but, additionally, the location of the system in the process suggests little chance of the introduction of microbes.

Conclusion:
MIC is not expected to be a problem.

h Fatigue/Corrosion Fatigue
At the operating pH, corrosion fatigue is not expected to be a problem in a proper designed vessel.

Conclusions
Not considered to be a problem.

i Vapor Phase Corrosion
The vapor phase portion of the vessel will be spattered with solution and pitting or crevice corrosion may be a concern. The presence of wash rings within the vessels will allow this area to be rinsed.

Conclusion:
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. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt% at velocities less than 4 m/s. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s with solids concentrations of 13.5 wt% for a usage of 43 % operation as documented in 24590-WTP-M0C-50-00004. PWD-VSL-00044 requires at least 0.067-inch additional protection. The 13.5 wt% is considered to be conservative and is based on the WTP Prime Contract maximum. The fraction of the time that the solids concentration is expected to be at maximum is 10 %. During normal operation, the solids content of PWD-VSL-00044 is expected to be well below the anticipated maximum.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.046–inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations of 13.5 wt% for usage of 43 % operation as documented in 24590-WTP-M0C-50-00004.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. 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.

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l Fretting/Wear
Fretting/wear is not anticipated due to the lack of moving parts.

Conclusion:
Not a concern.

m Galvanic Corrosion
In the proposed environment and with the lack of dissimilar alloys, there are no potential differences. Therefore, no galvanic corrosion is expected.

Conclusion:
Not 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
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

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References:

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2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
3. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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3. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
4. Jenkins, CF, 1998, *Performance of Evaporators in High Level Radioactive Chemical Waste Service*, Presented at Corrosion 98, NACE International, Houston TX 77084
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24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Plant wash vessel (PWD-VSL-00044)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	4.2E-02	5.3E-02	2.30E-01	2.31E-01	
Chloride	g/l	1.2E-01	1.4E-01	8.85E-02	1.06E-01	
Fluoride	g/l	7.2E-02	9.5E-02	1.05E-01	1.26E-01	
Iron	g/l	3.2E-01	2.5E-01	1.69E-02	1.89E-02	
Nitrate	g/l	1.6E+01	1.5E+01	1.54E+01	8.61E+00	
Nitrite	g/l	4.4E-02	5.1E-02	4.88E-01	5.83E-01	
Phosphate	g/l	6.6E-02	7.5E-02	3.53E-01	4.13E-01	
Sulfate	g/l	3.5E-02	4.1E-02	1.88E-01	2.24E-01	
Mercury	g/l	4.0E-01	6.0E-01	5.47E-04	1.42E-04	
Carbonate	g/l	4.7E-02	5.1E-02	6.59E-01	7.24E-01	
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					Note 4
Other	g/l					
pH	N/A					
Temperature	°F					Note 3
						Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-PWD-00001, Rev 1
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: The incoming streams will be diluted to a minum dilution ratio of 8 to 1 (water to fluid). Data in table represent pre-dilution.
Off Normal Input Stream # (e.g., overflow from other vessels): See section 4.9.13
P&ID: 24590-PTF-M6-PWD-P0002, Rev 2
PFD: 24590-PTF-M5-V17T-P0022002, Rev 2
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. T normal operation 59 °F to 111 °F (24590-PTF-MVC-PWD-00028, Rev 0)
3. pH approximately 10 to 11
4. Overflow is diluted to Newtonian fluid with water as soon as normal operation is achieved. Expected minimum dilution ratio 8.

Assumptions:

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4.9.13 Plant Wash Vessel (PWD-VSL-00044)

Routine Operations

PWD-VSL-00044 is located on the ground level in a black cell. It has a batch volume of 60,000 gallons. The vessel is sized to receive washes from the largest potential wash and still be able to handle routine transfers from other sources.

An air in-bleed and forced purge air are provided to dilute hydrogen generated in vessel PWD-VSL-00044. Pulse jet mixers are used to provide a uniform mixture during neutralization within vessel PWD-VSL-00044. An RFD supplies a representative sample of the vessel contents, which will be analyzed for pH in the laboratory. Excess acidic effluent is adjusted (to pH>12) with 19 M sodium hydroxide supplied from a reagent header.

An RFD supplies a representative sample of the contents of vessel PWD-VSL-00044 to the lab for analysis. Normally, the contents of vessel PWD-VSL-00044 are blended with those of vessels PWD-VSL-00015 and PWD-VSL-00016 within vessel FEP-VSL-00017A or B to maintain a consistent evaporator feed.

Vessel PWD-VSL-00044 vents to the vessel vent caustic scrubber (PVP-SCB-00002) via the vessel vent header.

During normal operations, vessel PWD-VSL-00044 receives recycle material from the following sources:

- HEME drains via vessel PVP-VSL-00001 and demister drains via PJV-VSL-00002
- Spent scrub solution from PVP-SCB-00002
- Contaminated effluent from RLD-VSL-00003 (LAW vitrification facility)
- Waste from PWD-VSL-00043
- Active material from PWD-VSL-00033
- Laboratory wastes

Overflows from non-Newtonian vessels (marked with *) will be diluted with water as soon as normal operation is achieved/recovered. A minimum dilution ratio (water/fluid) of 8 to 1 is expected.

Non-Routine Operations that Could Affect Corrosion/Erosion

- Vessel PWD-VSL-00044 overflows to PWD-VSL-00033.
- Wash rings are used for vessel and breakpot washing. A vessel-emptying ejector, installed from the UFP system end, is used for non-routine transfers to the acidic/alkaline effluent vessel (PWD-VSL-00016).
- During non-routine operations, vessel PWD-VSL-00044 receives plant wash from the following sources:
  - Plant wash solution from interior surfaces of pretreatment vessels via vessel-emptying ejectors discharging to plant wash/sump breakpots PWD-BRKPT-00007 through 10 and PWD-BRKPT-00017 and 19
  - Plant wash solution from pretreatment cell walls, equipment exterior surfaces, and cell cladding via sump-emptying ejectors discharging to breakpots PWD-BRKPT-00007 through 10 and PWD-BRKPT-00017 and 19
- Condensate drain from pretreatment vessel vent header
- Active condensate from the high- and low-pressure steam condensate headers
- Active material from the closed loop chilled water