PLANT ITEM MATERIAL SELECTION DATA SHEET

R10667874

CXP-VSL-00005 - (PTF)
Cs IX Reagent Vessel

- Design Temperature (°F)(max/min): 138/40
- Design Pressure (psig) (max/min): 15/FV
- Location: incell

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RPP-WTP PDC

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Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is filled with caustic.
- The vessel is filled with demineralized water.
- The vessel is filled with nitric acid (standby condition).

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: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water (rinse prior to adding acid after receiving solids from CXP-VSL-00004).

STEVEN WAKEMAN VAIL
STATE OF WASHINGTON
39250
REGISTERED PROFESSIONAL ENGINEER
EXPIRES: 12/07/
3/8/06

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This bound document contains a total of 7 sheets.

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Corrosion Considerations:

This vessel is expected to receive demineralized water, nominal 0.25 M NaOH solution, nominal 0.1 M NaOH solution, standby nitric acid, and recycled spent regeneration caustic solution from CXP-VSL-00004.

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 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. Davis (1994) states the 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.

In this system, the normal hydroxide concentrations and temperatures are such that 304L or a higher alloy stainless steel will be acceptable.

The addition or presence of 0.5 M HNO_3 is not a concern for the given concentrations.

Conclusion:
At temperatures less than about 140°F, 304L or better is expected to be sufficiently resistant to the solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
The nitric acid does not contain chloride or fluoride. The NaOH may contain chloride impurities. The two possible opportunities for pitting are either acidifying high chloride waste or leaving the vessel full of DIW with residual chloride.

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 both of the opinion that fluoride will have little effect in an alkaline media. If the chloride concentrations are low at the low pH and high at the high pH, then even the low pH conditions are expected to be benign towards 304L. Revie (2000) and Uhlig (1948) note nitrate inhibits chloride pitting.

Normally the vessel is to operate with a fluid temperature 77°F. At this temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions.

The small quantity of halides will not be harmful even if the solution is neutralized or modified with HNO_3.

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 amount of residual chlorides.

Conclusion:
Localized corrosion, such as pitting, is not expected. It is expected that 304L will 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 expected 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, 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 a few 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. During the normal operations, either 304L or 316L are expected to be satisfactory.

Because of the potential for caustic cracking, 304L and 316L are generally not recommended for use above 140°F. However, based on the proposed temperatures, either is acceptable.

Conclusion:
At the normal operating environment, the alloy recommended is 304L stainless.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

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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 conditions are conducive to microbial growth if microbes were introduced. The use of DIW as process water should minimize the possibility of introduction of microbes.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Not expected to be a concern.

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. Wash rings within vessel should provide sufficient rinsing to minimize presence of deposits.

Conclusion:
Not believed to be of concern.

j Erosion
Velocities within the vessel are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not believed to be of concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

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.

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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:

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 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
5. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
6. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
7. 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
8. Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
9. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
10. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
11. 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. CCN 130171, 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.
2. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
3. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, 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 #) Cs IX reagent vessel (CXP-VSL-00005)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l					
Fluoride	g/l					
Iron	g/l					
Nitrate	g/l	8.83E-04	1.03E-03			
Nitrite	g/l	1.32E-04	1.57E-04			
Phosphate	g/l	1.37E-04	1.61E-04			
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l	2.56E-04	2.82E-04			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A	13.0	13.0			Note 2
Temperature	°F					Assumption 1

List of Organic Species:

References

System Description: 24590-PTF-3YD-CXP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CXP03
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T P0012, Rev 0
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. Normally pH is approximately 13. This vessel also receives 0.1M NaOH, 0.25M NaOH, and 0.5 M nitric acid for chemical adjustment.

Assumptions:

1. Tnormal operation is 77 °F, Tmax 113 °F (24590-PTF-MVD-CXP-P0016, Rev 0)

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24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

4.3.5 Cs-IX Reagent Vessel (CXP-VSL-00005)

The CS-IX reagent vessel (CXP-VSL-00005) provides reagents for the Cs ion exchange columns.

Routine Operations

The Cs-IX reagent vessel is designed to receive demineralized water, nominal 0.25 M NaOH solution, nominal 0.1 M NaOH solution, and standby nitric acid from outcell sources as fresh reagents. In addition, the Cs-IX reagent vessel receives recycled spent regeneration caustic solution from the Cs-IX caustic rinse collection vessel (CXP-VSL-00004).

The Cs-IX reagent vessel functions like a breakpot, feeding liquids to the suction of the Cs-IX feed pumps and preventing backflow of contaminated fluids to clean systems. Unlike a true breakpot, however, there are valves on the bottom draining discharge line of the Cs-IX reagent vessel because the discharge must serve two pumps on separate occasions. The Cs-IX reagent vessel also serves as a source for ventilation of the Cs IX columns. The Cs-IX reagent vessel has a demister (with pressure-drop-measurement included in the top portion of this vessel) to enable demisting of any potentially entrained liquid with the vented column gasses.

The Cs-IX reagent vessel normally receives the following:

- Demineralized water from outcell tank DIW-TK-00001 during the pre-elution rinse and post-elution rinse sequences
- Nominal 0.25 M NaOH solution from the balance of facilities (BOF) header during the regeneration sequence

Non-Routine Operations that Could Affect Corrosion/Erosion

In abnormal situations, the Cs-IX reagent vessel can receive the following:

- Nominal 0.1 M NaOH solution as recycled spent regeneration solution from the Cs-IX caustic rinse collection vessel (CXP-VSL-00004). This solution is used in the LAW displacement sequence. The vessel can also receive fresh nominal 0.1 M NaOH solution for emergency cooling from outcell tank SHR-TK-00001.
- Standby (0.5 M) nitric acid from outcell tank NAR-TK-00007.

This vessel also overflows to PWD-VSL-00033.