ISSUED BY
RPP-WTP PDC

R10930322

CORROSION EVALUATION

RDP-VSL-00002A/B/C (PTF)
Spent Resin Slurry Vessels

- Design Temperature (°F)(Max/min): 148/30
- Design Pressure (psig) (Max/min): 15/FV
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

Associated Items

RDP-PJM-00001 – RDP-PJM-00012
RDP-PMP-00008A/B

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheets

Options Considered:

- Normal operations include receipt, storage and transfer of spent IX media
- Slurry received contains approximately 20 volume% solids (not considered normal operating condition)
- Off-normal conditions include the receipt of fresh resin overflow from system CRP and the receipt of un-eluted or off-spec Cs resin to be returned for further elution

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
Type 304L (S30403)	1.00		X
Type 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: Type 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; localized protection will be provided as necessary as discussed in section j)

Process & Operations Limitations:

- Develop flushing/rinsing procedure

Concurrence JR for KW
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
6	7/30/08	Incorporate revised PCDS Update design temperature	JLAdler	JRDivine	RBDavis	SWVail

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REVISION HISTORY

5	1/6/05	Update wear allowance based on 24590-WTP-RPT-M-04-0008	DLAdler	JRDivine	RBDavis	SWVail
4	1/24/05	Update PJM and erosion info based on 24590-WTP-M0E-50-00003	DLAdler	JRDivine	NA	SWVail for APRangus
3	5/17/04	Addition of information regarding inadvertent nitric acid addition Append updated PCDS	DLAdler	APRangus	NA	SWVail
2	5/12/04	Revised to incorporate new PCDS	DLAdler	JRDivine	NA	APRangus
1	4/26/04	Update design temp/pressure Include assoc. items Add PJM information Delete reference to system TRP and Tc resin Revise erosion section Re-format references Add DWP note Append updated MSDS	DLAdler	JRDivine	NA	APRangus
0	6/2/02	Initial Issue	DLAdler	JRDivine	SS	SMKirk
REV	**DATE**	**REASON FOR REVISION**	**PREPARER**	**CHECKER**	**MET**	**APPROVER**

This bound document contains a total of 7 sheets.

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Corrosion Considerations:

RDP-VSL-00002A/B/C collect and transfer spent resin. These vessels receive both transport liquid and spent resin slurry streams. Normally the vessels operate between 50 and 123 °F.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and type 304L) in 2 M HNO_3 of less than 2 mpy. Davis (1994) states the corrosion rate for type 304L in 12% HNO_3 will be less than about 1 mpy up to about 212°F.

In this system, the conditions are such that type 304L stainless steel will be acceptable.

Conclusion:
Under normal conditions either type 304L or type 316L will be satisfactory.

b Pitting Corrosion
While chloride is known to cause pitting in acid and neutral solutions, with no chloride present in reportable concentrations, both type 304L and type 316L stainless steel are acceptable.

Conclusion:
The use of type 304L or type 316L is acceptable.

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 type 304L or type 316L is expected to be satisfactory.

Conclusion:
At the normal operating environment, either type 304L or type 316L is acceptable.

e Crevice Corrosion
Comments under Pitting are generally applicable here. However, the one additional factor is the presence of resin beads. These will form crevices at the wall that could initiate crevice corrosion.

Conclusion:
The presence of resin increases the probability of initiating crevice corrosion. The more resistant type 316L is recommended.

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)
MIC is not considered a problem in this system.

Conclusion:
Not a concern.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a concern. The pressures encountered are so low and the strength of the material is so comparatively high that corrosion fatigue is not a problem.

Conclusions
Not a concern.

i Vapor Phase Corrosion
Not expected in this system.

Conclusion:
Not considered to be a concern.

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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%. Additional type 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 normal maximum solids concentrations of 7.0 wt% and maximum solids concentrations of 53 wt% with a usage of 19 % operation as documented in 24590-WTP-M0C-50-00004. Vessels RDP-VSL-00002A/B/C require at least 0.060-inch additional protection. The 53 wt% is considered to be conservative. The fraction of time the solids concentration is expected to be at maximum is 10 %. During normal operation, 90 % of the time, the solids content of RDP-VSL-00002A/B/C is expected to be 7.0 wt%.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.038–inch of additional type 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 normal solids concentrations of 7.0 wt% and a maximum solids concentrations of 53 wt% with a usage of 19 % 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.

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.

p Inadvertent Nitric Acid Addition
Vessels normally operate at low pH.

Conclusion:
Not applicable.

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References:

1. 24590-WTP-M0C-50-00004, *Wear Allowance for WTP Waste Slurry Systems*
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. C, *WTP Process Corrosion Data*
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. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
8. Smith, H. D. and M. R. 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.
9. Zapp, PE, 2000, *Material Corrosion and Plate-Out Test of Types 304L and 316L Stainless Steel*, WSRC-TR-2000-00434, Savannah River Site, Aiken, SC

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. CCN 130172, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
3. CCN 170127, Cook, S to J Julyk, "Red Lined Data Sheets for the Equipment & In-Line Components for the RDP in the PT Facility, 30 January 2008.
4. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
5. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
6. 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
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

Attachment to CCN 163061
Replaces Page A-45 of
24590-WP-RPT-PR-04-0001, Rev C
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Spent resin slurry vessel (RDP-VSL-00002 A/B/C)
Spent resin dewatering moisture separation vessel (RDP-VSL-00004)

Facility PTF

In Black Cell? Yes (RDP-VSL-00002A/B/C only)

Chemicals	Unit[1]	Contract Max[2]		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/L					
Chloride	g/L					
Fluoride	g/L					
Iron	g/L					
Nitrate	g/L	6.0E+00	6.0E+00			
Nitrite	g/L					
Phosphate	g/L					
Sulfate	g/L					
Mercury	g/L					
Carbonate	g/L					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/L					
Other	g/L					
pH	N/A					Note 4
Temperature	°F					Note 3, Assumption 1

List of Organic Species:

References
System Description: 24590-PTF-3YD-RDP-00001
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CXP19, CXP18, RDP01
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID N/A
PFD: 24590-PTF-M5-V17T-00020
Technical Reports:

Notes:
1 Concentrations less than 1x 10^{-4} g/L do not need to be reported, list concentration values to three significant digits max
2 Data developed from a mass balance model which has constituents in the plant feed which are important to corrosion, adjusted to contract maximum values
3. For RDP-VSL-00002ABC: 50 °F to 123 °F (24590-WTP-RPT-ENG-07-007, Rev 0)
4 Minimum pH approximately 1

Assumptions:
1 For RDP-VSL-00004 123 °F maximum operating temperature based on maximum temperature in RDP-VSL-00002ABC, and given that there is no heating in the dewatering unit

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

4.10.1 Spent Resin Slurry Vessel (RDP-VSL-00002 A/B/C)

Routine Operations

The spent resin slurry vessels (RDP-VSL-00002-A/B/C) are designed to collect and transfer a batch of spent resin every week. After commissioning, the time between spent resin batch transfers will be determined by operational experience.

The spent resin slurry vessels (RDP-VSL-00002-A/B/C) receive both liquid and slurry streams.

These vessels, with associated piping and controls, serve as both the source of transport liquid and the receipt vessels for spent resin slurry. Each vessel is designed to contain one full batch of IX resin plus the transport liquid associated with transferring the resin bed out of an IX column. The total batch volume required for removing the spent resin from an IX column is 7500 gallons per vessel (6900 gallons of transport fluid and 600 gallons of resin). During normal operation, the vessels will contain approximately 8 % vol/vol solids. The solids content is greater during the first few minutes of displacement when the incoming slurry line could be very high in solids, but the high solids content is gradually diluted to 8 % vol/vol solids as the clear column sequence is completed and the full batch of transport fluid is transferred. Nozzles will be included as required for process feed streams, overflow lines, reagent addition, ventilation, and recycle return lines.

Each vessel contains pulse jet mixers which provide mixing of the vessel contents to suspend resin particles for slurry transport and representative sample collection.

Non-Routine Operations that Could Affect Corrosion or Erosion

None identified.

See Appendix A for process corrosion data sheet.