CORROSION EVALUATION

R10381328

ISSUED BY
RPP-WTP PDC

CNP-DISTC-00001 (PTF)
Cs Evaporator Nitric Acid Rectifier

- Design Temperature (°F)(max/min): 250/40
- Design Pressure (psig) (internal/external): 50/15
- Location: out cell

Design temperature and pressure information is considered bounding and to be confirmed by Vendor.

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 heel is present.

Operating Modes Considered:

- The vessel is at the stated pH at the normal operating temperature.

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/N08926

Recommended Corrosion Allowance: 0.04 inch (includes 0.00 inch erosion allowance)

Process & Operations Limitations:

- None

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Concurrence NA
Operations

1	9/8/04	Update design temp/pressure Incorporate new PCDS Add section p – Inadvertent Addition of Nitric Acid	DLAdler	JRDivine	NA	APRangus
0	1/26/04	Initial Issue	DLAdler	JRDivine	APR	APRangus
REV	**DATE**	**REASON FOR REVISION**	**PREPARER**	**CHECKER**	**MET**	**APPROVER**

 28 June 2004

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Corrosion Considerations:

Nitric acid vapor enters CNP-DISTC-00001 where water is separated from the acid. The CNP-DISTC-00001 (bottom of column) should be approximately 0.5M nitric acid.

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; AL6XN has a rate of about 2 mpy; and C-22 or equivalent has a corrosion rate of about 1.5 mpy. The presence of Al^{+++} is expected to reduce the corrosion rate to near zero. However, the expected conditions indicate no Al^{+++} is present. At the temperature, pH and halide concentrations stated, an alloy more corrosion resistant than the 300 series stainless steels will be required. 6% Mo alloy is recommended.

Conclusion:
A 6% Mo alloy or better is recommended.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Normally the vessel is to operate at between 115 and 140 °F at a pH of 0.3. 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. Because of the presence of deposits in acidic conditions and the possible localized concentration of halides due to the rectification process, 304L and 316L would be insufficient and a 6% Mo alloy is the minimum recommended.

Conclusion:
A 6% Mo alloy is recommended.

c End Grain Corrosion
Not believed to be applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel 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), stress corrosion cracking does not usually occur below about 140 °F. Further, the use of "L" grade stainless reduces the opportunity for sensitization. However, because of the likelihood that halides will concentrate, 6% Mo alloy or equivalent is required.

Conclusion:
The minimum alloy recommended is 6% Mo or equivalent.

e Crevice Corrosion
For the most part, comments under Pitting also apply here. The stated conditions indicate that 316L might be acceptable when no deposits are allowed to form, but it is expected that deposits will remain. Further, it is anticipated that the design of the column will create crevices and crevice corrosion is a concern. A more resistant alloy, such as a 6% Mo or better, is required.

Conclusion:
6% Mo is recommended.

f Corrosion at Welds
Corrosion at welds is not a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are generally too hot and too acidic for MIC.

Conclusion:
MIC is not considered a problem.

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

Conclusions
Not applicable.

i Vapor Phase Corrosion
Not applicable to this system.

Conclusion:
Vapor phase corrosion is not expected.

j Erosion
There are no solids and the velocities are not sufficient to cause a problem.

Conclusion:
None expected.

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 Addition of Nitric Acid
Column regularly operates at very low pH.

Conclusion:
Not applicable.

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References:

1. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
2. CCN 089621, Dolores Mitchell e-mail to Jim Divine, 11 May 2004
3. 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
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
5. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
6. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho Chemical Programs, Idaho National Engineering Laboratory, Idaho Falls, ID

Bibliography:

1. Cole, HS, 1974, *Corrosion of Austenitic Stainless Steel Alloys Due to HNO_3 – HF Mixtures*, ICP-1036, Idaho Chemical Programs – Operations Office, Idaho Falls, ID
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
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

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Evaporator recovered nitric acid vessel (CNP-VSL-00004)
Cs evaporator nitric acid distillation column (CNP-DISTC-00001)

Facility PTF

In Black Cell? Yes (only CNP-VSL-00004)

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.84E-04	3.86E-04			
Chloride	g/l	4.28E-04	5.12E-04			
Fluoride	g/l					
Iron	g/l					
Nitrate	g/l					Assumption 1
Nitrite	g/l	5.11E-04	6.11E-04			
Phosphate	g/l	8.88E-04	1.04E-03			
Sulfate	g/l	3.36E-04	4.01E-04			
Mercury	g/l					
Carbonate	g/l	1.66E-03	1.82E-03			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2
						Note 4

List of Organic Species:

References

System Description: 24590-PTF-3YD-CNP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CNP13, CNP14
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T-00014, Rev 1
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. Tnormal operation 115 °F to 140 °F (24590-PTF-M5C-CNP-00001, Rev 0)
3. Will be highly acidic. pH approximately 0.3
4. 2M nitric acid is added to the vessel.

Assumptions:

1. Based on the presence of 0.5M HNO_3 the nitrate concentration is expected to be approximately 31 g/l (24590-WTP-M4E-V11T-00001, Rev A)

4.1.3 Cs Evaporator Nitric Acid Distillation Column (CNP-DISTC-00001), Cs Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004)

Routine Operations

Nitric acid vapor enters the nitric acid distillation column, CNP-DISTC-00001, which separates water from the acid. The recovered nitric acid is stored in the Cs evaporator recovered nitric acid vessel CNP-VSL-00004. During elution, nitric acid is pumped from the storage vessel by the Cs IX feed pump, through the feed cooler, and distributed into the system CXP ion exchange columns.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.