CORROSION EVALUATION

R10526392

LVP-TK-00001 (LAW)
CAUSTIC COLLECTION TANK

ISSUED BY
RPP-WTP PDC

- Design Temperature (°F)(max/min): 180/50
- Design Pressure (psig): per Code
- Location: outcell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

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: 0.04 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- None

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Concurrence DMB
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
2	5/20/05	Update wear allowance based on 24590-WTP-RPT-M-04-0008	DLAdler	JRDivine	NA	APRangus
1	7/8/04	Change item number from VSL to TK Correct description Update design temp/pressure Incorporate new PCDS Information regarding inadvertent nitric acid addition Re-format references Add DWP note	DLAdler	JRDivine	APR	APRangus
0	3/6/02	Initial Issue	JRDivine	DLAdler	NA	SKirk

CORROSION EVALUATION

Corrosion Considerations:

The tank receives scrubbing liquid from LVP-SCB-00001. It will operate at about 140 to 150 °F and range in pH from 7 to 12 with a nominal value of 9.

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 are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Indications are that in the present system, the uniform corrosion rate is negligible.

Conclusion:
304L or 316L are acceptable for use in the stated conditions.

b Pitting Corrosion
Chloride is likely to cause pitting in acid and slightly alkaline solutions. Berhardsson et al (1981) suggest that at chloride concentrations of a few hundred parts per million, a temperature of 150°F would compatible with 316L. At the stated concentrations of 800 to 1900 ppm chloride and the given temperatures, pitting will be a strong function of pH. At the nominal pH or 9 or higher, 316L is satisfactory. Should the halide concentrations rise above nominal, the pH of the solution will need to be adjusted to at least 12.

If the solution will remain below about pH 7 for any length of time at 150°F, 6% Mo or better should be used. Phull et al (2000) note that 6% Mo is acceptable to about pH 5 and 150°F in high chloride environments. Lower pH values and higher temperatures would require Hastelloy C-22 or the equivalent.

Conclusion:
Localized corrosion, such as pitting, is a concern. However, 316L is satisfactory for the nominal halide concentrations, pH and temperature and assuming that the pH will be adjusted should the halide concentrations rise above nominal.

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

Conclusion:
Not believed likely 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 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. Berhardsson (1981) suggests that 316L is acceptable under these conditions up to a temperature of about 150°F.

Conclusion:
Under the normal operating environment, 316L is recommended.

e Crevice Corrosion
Although crevice corrosion is possible, the same alloy choices as for pitting are acceptable. Also 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.

g Microbiologically Induced Corrosion (MIC)
Typically, MIC is not encountered in operating systems.

Conclusion:
MIC is not considered a problem.

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

Conclusions
Not expected to be a concern.

CORROSION EVALUATION

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is unknown whether this will be sufficiently washed or whether residual acids or solids will be present. Because solids or acids and solids may be present, a 316L or better would be preferred.

Conclusion:
Vapor phase corrosion is not a concern.

j Erosion
Velocities 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:
Erosion is not a 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 a concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
At this time, nitric acid reagent is not available in this system.

Conclusion:
Not applicable.

CORROSION EVALUATION

References:

1. 24590-LAW-MKE-LVP-00004, *LAW Melters Offgas Caustic Scrubbers (LVP-SCB-00001) Process Conditions And Requirements*
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*
4. 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
5. CCN 088587, Meeting Minutes from 6/1/2004 meeting with the following purpose: LAW Caustic Scrubber pH Requirements to Address ICD-6 and Material Selection, by Scott Colby
6. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
7 Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
8. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
9. Phull, BS, WL Mathay, RW Ross, 2000, *Corrosion Resistance of duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Corrosion 2000, Paper 00578, NACE International, Houston, TX 77218
10. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158

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. Blackburn, LD to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Evaluation of 240-AR Chloride Limit*, August 15, 1991.
3 Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
4. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
5. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

CORROSION EVALUATION

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Caustic Scrubber (LVP-SCB-00001), Caustic Collection Tank (LVP-TK-00001)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l	8.64E-01	1.87E+00			
Fluoride	g/l	2.21E+00	4.78E+00			
Iron	g/l					
Nitrate	g/l	3.84E+00	8.28E+00			
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt %					
Other (Pb)	g/l					
Other	g/l					
pH	N/A					
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-LAW-3YD-LOP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: LVP17
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-LAW-M6-LVP-00002, Rev 0
PFD: 24590-LAW-M5-V17T-00011, 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. Normal inlet offgas temp is 560 °F maximum unquenched inlet offgas temp is 1025 °F per 24590-LAW-MKD-LVP-00011, Rev C.; caustic scrubber blowdown 142 °F to 149 °F (24590-WTP-M4C-V11T-00005, Rev A).

Assumptions:

Note 3: Tank has a nominal pH of 9 (24590-LAW-MKE-LVP-00001). Should high halides, greater than 0.3 g/l (CCN 088587), be detected in the scrubber upstream, the pH will be raised to 14.

6.4.9 Caustic Scrubber and Caustic Collection Tank (LVP-SCB-00001, LVP-TK-00001)

Routine Operations

The caustic scrubber (LVP-SCB-00001) further treats the offgas by removing acid gases such as SO_x and CO_2. It also provides offgas cooling.

The offgas stream enters the bottom side of the scrubber and flows upward through a packed bed. The offgas flows countercurrent to the scrubbing liquid, which is introduced through a distributor at the top of the packed section of the column and flows downward through the packing media. Contaminants in the offgas stream are absorbed into the liquid.

The offgas is cooled through the scrubber by evaporation of scrubbing liquid and exits at nearly 100 % relative humidity. The scrubbing liquid drains into the caustic collection tank (LVP-TK-00001). This liquid is recirculated to the top of the column using the caustic scrubber recirculation pumps (LVP-PMP-00001A/B)

The vessel is fitted with radar type liquid level instrumentation. Density, temperature, and flow are measured on the recirculation line. Capability for sampling the vessel is provided using a tap from the recirculation pump line. The vessel is vented to the room. The caustic collection vessel (LVP-VSL-00001) overflows to the berm around the vessel.

Water is added directly to the vessel at a rate sufficient to maintain a specific gravity in the scrubbing fluid consistent with a maximum of 10 % dissolved solids. Suspended solids are not expected.

Offgas from the caustic scrubber is environmentally monitored (stack discharge monitoring [rad and non-rad] system [SDJ]) then released via the stack.

Non-Routine Operations that Could Affect Corrosion/Erosion

- The caustic scrubber has provisions for process water addition for startup and to provide makeup water as necessary. A spray wash ring is also provided for washdown during maintenance periods.
- If the caustic scrubber needs maintenance, a bypass line is provided to allow continued operation of the main offgas system after the melters are idled.
- **Loss of caustic flow to the collection tank** - Loss of caustic flow results in decreased pH of the scrubber bottoms. If the problem can be resolved readily, the scrubber column can continue operating, since the pH decreases slowly. If the problem is more serious, the melters are idled and the caustic scrubber bypass is activated until caustic flow is reestablished.
- **Loss of recirculation pumps** - Loss of recirculation results in the inability to remove acid gases and iodine. An installed spare pump is provided to quickly restore flow to the column.
- **Plugging of packed bed** - If the pressure drop across the packed bed increases beyond a normal range, the melters are idled, the column is bypassed, and the bed is flushed to remove deposits. If this is not effective, the melters are idled, the bypass opened, and the bed replaced.
- **Caustic collection vessel overflow** - The vessel overflows to the berm around the tank. The berm drains to the plant wash vessel (RLD-VSL-00003).

CORROSION EVALUATION

- **Solids buildup in the caustic collection vessel** - Minimal solids are expected in the caustic collection vessel. When not transferring to the PT facility, the transfer pumps recirculates back to the collection tank. Caustic is injected into the pump suction to maintain the correct pH in the tank. Any solids are removed from the vessel, and the liquid is transferred to the PT facility.
- **Loss of transfer pump** - If the primary pump fails, the backup pump is activated and operated while the failed pump is replaced.