VESSEL/TANK MATERIAL SELECTION DATA SHEET

R10082250

HOP-VSL-00903 & HOP-VSL-00904 (HLW)

SBS Condensate Receiver Vessel

- Design Temperature, max/min (°F): 165/40
- Design Pressure, max/min (psig): 15/FV
- Location: incell
- Anticipated 40 y radiation dose: gamma ≈$2x10^8$ rad, alpha ≈ $2x10^9$ rad
- PJM Discharge Velocity (fps) (max): 32
- Drive Cycle: 25 %

Offspring items

HOP-PJM-00001 – HOP-PJM-00003
HOP-PJM-00007 – HOP-PJM-00011,
HOP-VSL-00101A/B, HOP-VSL-00004A/B
HOP-VSL-00905A/B – HOP-VSL-00906A/B
HOP-RFD-0001A/B – HOP-RFD-0004A/B

ISSUED BY RPP-WTP PDC
INIT DATE 6/4/03

Operating conditions are as stated on sheet 5

Operating Modes Considered:

- normal operation at pH 1.3 (≈0.05M)
- vessel is at pH 1.3 and temperature reaches ≈165°F
- process conditions for HOP-VSL-00904 are identical to those for HOP-VSL-00903

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 N06022

Recommended Corrosion Allowance: 0.08 inch

Process & Operations Limitations:

- maintain agitation during operation
- develop lay-up strategy

Please note that source, special nuclear and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only

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5/31/03

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Corrosion Considerations:

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; C-22 or equivalent has a corrosion rate of about 75 mpy. The presence of Al^{+++} at the forecast ratio of Al^{+++}/F^- is expected to reduce the corrosion rate to near zero. However, because of the possibility of hot, though dilute, acid with a low Al^{+++}/F^- ratio, an alloy more corrosion resistant than the 300 series stainless steels, such as Hastelloy C-22 or equivalent, will be required.

Conclusion: Hastelloy C-22 or the equivalent is recommended to protect the vessel from off-normal conditions. Added protection by using a 0.08 inch corrosion allowance is recommended.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Normally the vessel is to operate at 122°F at a pH of 1.3. Extrapolating from Wilding & Paige (1976) data, 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. However, the temperature could approach boiling. Data from Phull et al (2000) imply that with these conditions, Hastelloy C-22 or equivalent will be needed as a minimum.

Further, 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 source of the water, being shorter for filtered river water and longer for DIW. Pitting has been observed in both cases, and is likely because residual chlorides are likely to remain. Pitting is less likely for the higher alloys such as Hastelloy C-22 or equivalent.

Conclusion:
Hastelloy C-22 or the equivalent is recommended.

c End Grain Corrosion
End grain corrosion only occurs in hot concentrated 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, the environment, and also 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. For the normal operating conditions, 316L would be satisfactory. However, with the proposed off-normal conditions where there will be a tendency to concentrate salts, Hastelloy C-22 or equivalent is required.

Conclusion:
Because of the normal operating environment as well as that which can occur during off-normal conditions, the minimum alloy recommended is Hastelloy C-22 or equivalent.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
The heat tint must be removed after construction if it is darker than straw yellow.

Conclusion:
Weld corrosion is not considered a problem for this system except as noted above.

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g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth – the average operating temperature is approximately correct but the pH is too acidic.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is expected to be a concern because of the frequent temperature cycles and the presence of vibration from the pulse jet mixers.

Conclusions
C-22 is anticipated to be sufficiently resistant for the design life.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be splashed with particles of waste. The region shall be sufficiently washed to prevent solids deposits.

Conclusion:
Not expected to be a concern.

j Erosion
Velocities within the vessel are expected to be low. The presence of PJMs in the vessels will create higher velocities near the nozzles but this has been reviewed and the determination has been made that the standard 0.080-inch corrosion allowance is sufficient to offset any possible effects of erosion.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No metal/metal contacting surfaces expected.

Conclusion:
Not expected to be a concern.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not expected to be 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.

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References:

1. 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
2. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
3. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
4. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho National Engineering Laboratory, Idaho Falls, ID

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1. Agarwal, DC, *Nickel and Nickel alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
2. 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
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. 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
5. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
6. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

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OPERATING CONDITIONS

Materials Selection Data

Component (Name/ID) SBS Condensate Receiver Vessel/HOP-VSL-00903
System HLW - HOP

Operations

Chemicals	Unit	Cold Startup	Normal Operation	Standby/Idle	Cleaning	Accident
		Note 3		Note 4	Note 5	
Aluminum	g/l		0.23			
Chloride	g/l		0.01			
Fluoride	g/l		0.08			
Hydroxide	g/l		0			
Iron	g/l					
Nitrate	g/l		3.56			
Nitrite	g/l		0			
TOC[Ψ]	g/l		0			
Sulfate	g/l		0.05			
Undissolved solids	g/l		3.61			
Particle size/hardness	µm (##)					
Other ($NaMnO_4$, etc)	g/l		0.4			
Carbonate	g/l		0			
pH (Note 1)	-		1.3			
Dose rate, α, β/γ (Note 2)	Bq/L		2.66E7, 7.37E10			
Temperature	°C		50			75, Note 6
Velocity	fps					
Vibration						
Time of exposure	#					

- % of total; ## - use Mho scale

Assumptions: Cannot be maintained during the 40 year design life

Notes
Note 1: Based on best engineering judgement.
Note 2: Excluding Tritium, Carbon-14 and Iodine-129.
Note 3: Assume same as for normal operation minus the radionuclides.
Note 4: Assumes same as normal operation.
Note 5: Assume Process H2O.
Note 6: Based on maximum SBS operating temperature (60C) + 15C allowance for off-normal event involving steam ejector use.

☒ Black Cell

☐ Flushing

Use maximum of 2 significant figures

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Dan Pfluger	MS4-B2		X						X	
Phil Peistrup	MS4-C1		X						X	

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