PLANT ITEM MATERIAL SELECTION DATA SHEET

ISSUED BY
RPP-WTP PDC

R10592511

HDH-VSL-00002 & HDH-VSL-00004 (HLW)
Canister Decon Vessels

- Design Temperature (°F) (max/min): 225/40
- Design Pressure (psig) (internal/external): 15/atm
- Location: out cell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached sheets 6 and 7

Operating Modes Considered:

- The tank is filled with the acidic decontamination solution at 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 R50400

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

Process & Operations Limitations:

None identified

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This bound document contains a total of 7 sheets.

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Canister decontamination vessels hold the filled canister and the ceric nitrate solution during decontamination. Heating and cooling coils are used to maintain the decontamination solution at 149 °F. After the decontamination solution is drained from the vessel, spray rings rinse the canister with nitric aid and demineralized water.

a General Corrosion
Corrosion rates of 304 stainless steel in Ce-IV/nitric acid solutions depend on temperature, nitric acid concentration, and cerium concentration, but are typically about 350 mpy. Thus, the neat solution is good for decontamination of stainless steel but cannot be stored in stainless steel containers.

There are no published data on the dissolution rate of Ti-2 by $Ce(NO_3)_4/HNO_3$ solutions. However, Craig (1989) states that Ti is very resistant to nitric acid except that in the 20-70% concentration range (maximum at 45%), the corrosion rate is relatively high. The use of about 12% acid minimizes this. Corrosion is inhibited by Ti^{+4}, Cr^{+6}, and Fe^{+3} ions as well as by other oxidizing ions. Ce^{+4} is not mentioned. However, it is expected to behave similarly.

Zirconium, according to Craig (1989), can crack in concentrated nitric acid, such as might be present in condensed vapors. Consequently, it is not more appealing than Ti.

West Valley Nuclear Services has not examined their Ti-2 vessel for corrosion. However, they do not believe it has been a problem. The reason Ti was selected was that it was recommended by Battelle-Northwest (PNNL). PNNL recommended it because electrodes used in several earlier studies were Ti and had not visibly degraded.

Conclusion:
Ti appears to be an acceptable alloy although there are no published data, or known unpublished data, on the topic. Based on an examination of the chemical and electrochemical behaviors of Ti alloys and Ce^{+4} solutions, no problem appears to exist.

b Pitting Corrosion
No data are available. Ti is resistant to pitting in chloride solutions although the effects of a highly oxidizing medium, such as Ce^{+4}, with chloride are unknown. However, in this system, there should be no chloride except for that brought over with any ^{137}Cs contamination. According to Meigs (2000), this should amount only to 0.13 Ci of ^{137}Cs, equivalent to about 1.5 mg of Cs and therefore 0.4 mg of chloride. With approximately 800 L of solution, the chloride is expected to be about 0.5 ppb.

Pitting of the canister is not expected to be a concern because of the low chloride concentration, the high nitrate concentration, and the high general corrosion rate.

Conclusion:
Pitting of the canister is not considered a problem as long as the 304L meets specifications. Pitting of the Decontamination Vessel is not a concern.

c End Grain Corrosion
No published data, but not expected to be a concern.

Conclusion:
Not likely in this system.

d Stress Corrosion Cracking
Cracking of the canister is not a concern at the stated conditions because there is too much nitrate, too little chloride, and the uniform corrosion rate is too high. Work by Mackey (2000) showed post-decontamination cracking of the canister is not a concern.

No reports of cracking of Ti in this environment are known.

Conclusion:
Ti-2 is acceptable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting.

f Corrosion at Welds
West Valley reports no problems. Proper welding techniques will be required (H_2, O_2, or N_2 shall not be present in the welding cover gas).

Conclusion:
Weld corrosion is not considered a problem.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a problem except possibly in the coils and their entry point into the vessel – these lines will be used alternately for heating and cooling the acid and will undergo severe stresses. Design and material will accommodate this.

Conclusions
Proper design and material choice mitigates this concern.

i Vapor Phase Corrosion
West Valley has encountered no problems.

Conclusion:
Not expected to be 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:
Not expected to be 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
The canister is expected to be anodic relative to the vessel. The canister is purposely being corroded and so this state is acceptable. It is unknown whether hydrogen will be generated at the Ti surface. Because of the strong oxidizing nature of the solution, hydrogen, if present, is not expected to survive long enough to diffuse into the Ti.

Conclusion:
The hydrogen generation rate at the Ti-2 surface is not expected to be a concern.

PLANT ITEM MATERIAL SELECTION DATA SHEET

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
Vessels normally contain nitric acid and operate at a low pH.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

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. Craig, BD, Editor, 1989, *Handbook of Corrosion Data*, ASM International, Metals Park, OH 44073
4. Mackey, DB, Personal communication to JR Divine, 24 March, 2000
5. Meigs, R, Personal communication: to D E Larson, 22 March 2000, amount of soluble Cs on the canister.

Bibliography:

1. Bray, LA, 1988, *Development of a Chemical Process Using Nitric Acid-Cerium (IV) for Decontamination of High-Level Waste Canisters*, Battelle, Pacific Northwest Laboratory, Richland, WA 99352
2. Bray, LA, MR Elmore, KJ Carson, RJ Elovich, GM Richardson, and LD Anderson, 1992, *Decontamination Testing of Radioactive-Contaminated Stainless Steel Coupons Using a Ce(IV) Solution*, Battelle, Pacific Northwest Laboratory, Richland, WA 99352
3. Bray, LA and JR Divine Telecon, March 2000

PLANT ITEM MATERIAL SELECTION DATA SHEET

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Canister decon vessel (HDH-VSL-00002, HDH-VSL-00004)

Facility HLW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	1.15E-03	1.92E-03			
Chloride	g/l					
Fluoride	g/l					
Iron	g/l	7.39E-01	7.37E-01			
Nitrate	g/l	2.42E+02	2.42E+02			
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt %	5.45E-02	5.45E-02			
Other (Pb)	g/l	2.23E-04	1.69E-04			
Other(Cerium)	g/l	6.81E+01	6.81E+01			
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-HLW-3YD-HDH-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: HDH01, HDH05, HDH03, NAR21A/B
Off Normal Input Stream # (e.g., overflow from other vessels):
P&ID: 24590-HLW-M6-HDH-00001, Rev 1
PFD: 24590-HLW-M5-V17T-00006, Rev 4
Technical Reports:

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Tmin 40 °F, Tnorm 149 °F, Tmax 225 °F (24590-HLW-MVD-HDH-00006, Rev 1)
3. Approximately pH 0 to 0.5 (24590-HLW-M4C-HDH-00001, Rev A).

Assumptions

5.2.4 Canister Decontamination Vessel (HDH-VSL-00002, HDH-VSL-00004)

Routine Operations

The canister decontamination vessel is used to hold the filled canister and ceric nitrate solution during the decontamination process. High-pressure steam at 343 °F is supplied to raise the solution temperature from 68 °F to 149 °F and is held at 149 °F for 6 hours during the decontamination process. Heating and cooling coils maintain the temperature of the liquid at 149 °F. The nitric acid solution is drained from the vessel. Spray rings will rinse the canister with nitric acid and demineralized water. The canister is then removed from the vessel.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.