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EVALUATION OF THE ADA TECHNOLOGIES' ELECTRO-DECON PROCESS TO REMOVE RADIOLOGICAL CONTAMINATION

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ABSTRACT

A surface decontamination system featuring the use of ADA's electrochemical process was tested and evaluated. The process can be flexibly deployed by using an electrolyte delivery system that has been demonstrated to be reliable and effective. Experimental results demonstrate the effectiveness of this system for the surface decontamination of radiologically contaminated stainless steel.

INTRODUCTION

Approximately 50,000 gallons/year of hazardous, radioactive, acidic liquid waste is generated from various decontamination activities at the Idaho Nuclear Technology and Engineering Center (INTEC), located at the Idaho National Engineering and Environmental Laboratory (INEEL). The decontamination liquid waste is stored in large, underground tanks at the INTEC Tank Farm (TF). Discontinuing tank farm use and eliminating liquid waste generation is an INTEC goal.

At the INTEC, the chemical processes were typically decontaminated to remove high levels of radioactive contamination prior to repair work. However, the use of chemical decontamination has become undesirable because of restrictions on use of hazardous chemicals and INTEC waste handling issues. In addition, the use of chemical decontamination methods usually results in the generation of large quantities of secondary liquid waste. The increased regulation and concern about secondary waste has caused many nuclear facilities to abandon many of their former chemical decontamination methods.

The Radioactive Liquid Waste Reduction (RLWR) group seeks to develop effective alternatives to high waste generating decontamination methods currently in use at the INEEL. For the past several years, the RLWR group and several commercial vendors

have tested various methods of decontamination in order to minimize the generation of liquid waste.

Two technologies, ADA Technologies' electrochemical coating method and Universal Ice Blast, Incorporated's (UIBI) ice blasting methods, were selected from a variety of different techniques offered in the commercial cleaning/decontamination arena. Tests were conducted with non-radioactive simulated contamination (SIMCON) coupons supplied by the INEEL, to demonstrate their respective technologies at their facilities. The results of the studies[1] show that both decontamination methods are very effective in removing contamination from the 'SIMCON II' coupons. Both of these decontamination methods clearly have their advantages and disadvantages. Because the equipment is easy to use and only needs minimum utility support, the electrochemical method was selected for performing further testing using radioactively contaminated materials at the INTEC. This report describes the results of this study. In addition, other decontamination tests were also conducted to evaluate the level of loose and fixed contaminant on the test article.

EXPERIMENTAL

The electrochemical cleaning technique developed by ADA Technologies is somewhat unique in the field of decontamination; it combines the best attributes of two decontamination techniques-electropolishing and strippable coatings. The system was designed to electrochemically dispense an electrolyte gel onto the contaminated article.

The system shown in Fig. 1 and 2 is designed to apply the ADA's proprietary electrolyte gel to a contaminated surface. The major components of the system are: power supply and electrolyte pump module, electrolyte and current supply tether, anode current terminal, scrub shoe, abrasive scrub pads, and electrolyte gel pack.

The system operates by creating a "sandwich" filled with electrolyte gel between a hand-held electrical terminal and an object or surface to be cleaned (Fig. 1). When electrical current is passed through the sandwich, contaminants and other materials on the object's surface strip off as a result of electrochemical reactions that take place and are encapsulated in the gel. During operation, the average current measurement of the sandwich was approximately 2 amps.

Gentle scrubbing action of the pad on the surface tends to stir up the electrolyte by bring fresh material into the interface and increasing the rate of contamination removal. Following passage of the electrical current, additional electrolyte gel is applied through the scrub pad and, using the scraper edge on the sole plate, spread into a relatively smooth layer of sufficient thickness to permit post-cure removal. After a period of time to permit curing (approximately 2 hours for 15-25 mil thick layer), the coating may be stripped away from the surface (Fig. 3).

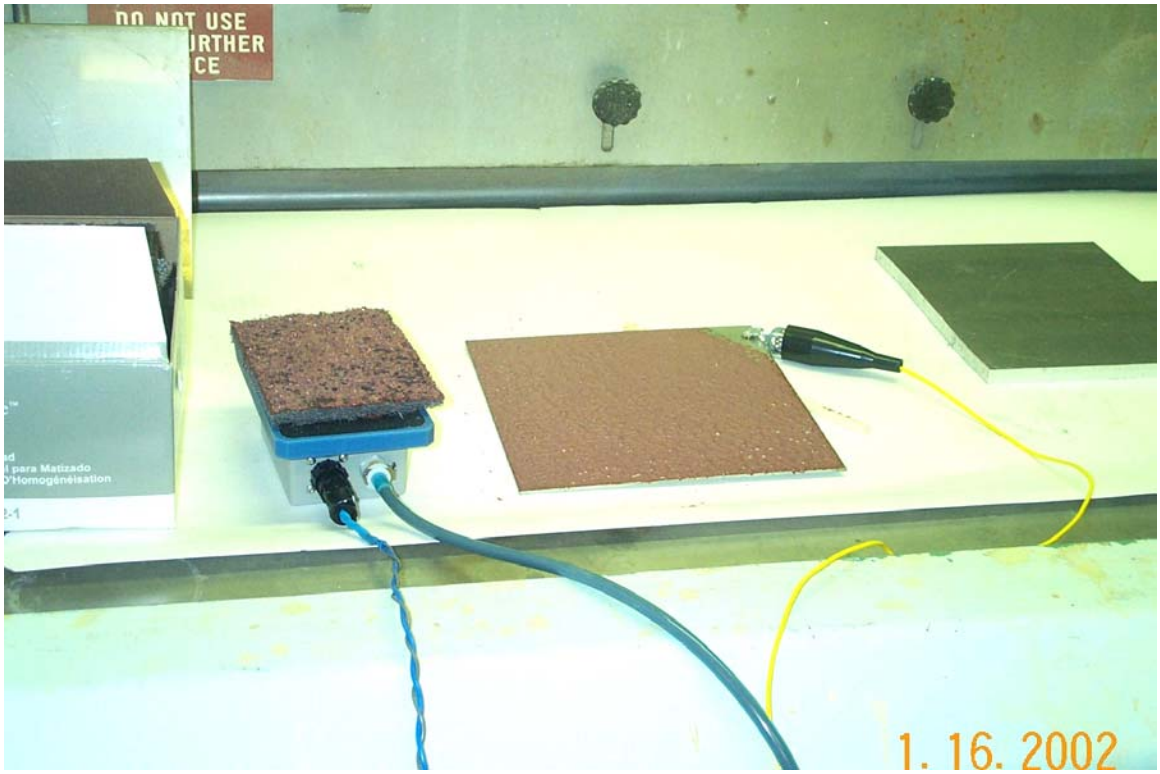

Fig. 1. Scrubbing shoe and electrode setup.

Fig. 2. ADA Electro-Decon System.

Fig. 3. Electrolyte coating being stripped away from the surface.

Test Articles and Radioactivity Measurement

Two radioactive contaminated materials were used for this study. Both test articles were previously used in CPP-666 fuel storage basins at the INTEC, as a criticality barrier. The stainless steel material has a dimension of 14”x14”x3/8”. A hand held Geiger counter (Ludlum measurements) with a 2” diameter probe head and a RO-20 radiation dose analyzer (Eberline) were used to measure the surface radioactivity, before and after decontamination. The probe/heads of both analyzer were positioned approximately ¼” away from the flat surface during radioactivity measurement. Filter paper swipe samples were also collected to provide an estimate of the level of loose contaminant on the test article, before and after being decontaminated.

RESULTS & DISCUSSION

Of the two test articles evaluated for this study, both pieces have shown that one side has consistently higher initial readings (Side 1) than the other side (Side 2), based on results of radioactivity measurements by direct scans. Without removing any contaminant from the test articles, the sides with high initial contamination were decontaminated by the ADA Electro-Decon method. A total of approximately 10 minutes was used to apply the electrolyte gel, moderately scrub the surface, and pass current through the interface.

Table I lists the results of a radioactivity survey on the sample surface of both criticality barriers before and after decontamination. It shows that more than 80% of the initial gross radioactive contaminant was removed. The swipe samples collected from the sample surface were below the detectable limit after the initial decontamination. It is very likely that all loose contaminants and portion of the fixed contaminant on the criticality barrier surface were removed. To evaluate the effectiveness of electrochemical decontamination on fixed surface contamination, the test was repeated on the previously decontaminated surface of the first test article, further reducing the surface radioactivity from approximately 8000 dpm/100 cm^2 to approximately 4000 dpm/100 cm^2. This suggests some contaminants in this section of the plate were strongly fixed to the test article. The contamination distribution profile on the original criticality barrier was not known, but the major contaminants were determined to be ^{60}Co and ^{152}Eu, based on swipe sample analyses.

Table I. Radioactivity on criticality barrier surface (Side 1) from electrochemical decontamination.

Radioactivity Measurements		Test Article 1	Test Article 2
Pretest			
Direct Scan	Geiger Counter ($\beta\gamma$,dpm/100 cm^2)*	50,000	45,000
	Surface Dose (mR)	1.5	1.0
Swipe Sample (dpm/100 cm^2)	$\beta\gamma$**	13,900, 11,100	18,200, 11,500
	α**	230, 160	310, 200
After 1st Decontamination			
Direct Scan	Geiger Counter ($\beta\gamma$, dpm/100 cm^2)*	8,000	6,000
	Surface Dose (mR)	<0.1	<0.1
Swipe Sample (dpm/100 cm^2)	$\beta\gamma$	<1,000	<1,000
	α	<20	<20
% Removal	$\beta\gamma$ (dpm/100 cm^2, direct scan)	84	87
After 2nd Decontamination			
Direct Scan	Geiger Counter ($\beta\gamma$, dpm/100 cm^2)*	4,000	NA
	Surface Dosage (mR)	<0.1	NA
Total % Removal	$\beta\gamma$ (dpm/100 cm^2, direct scan)	92	NA
* Peak reading of the test article surface, fume hood floor has background of 3000 dpm/100 cm^2. ** Samples from different locations of test article.			

Comparison with Other Common Methods

At the INTEC, Windex window cleaner is one the most commonly used methods to remove the loose radioactive contaminants. This cleaner was sprayed onto the backside

of a previously decontaminated part and followed by wiping with paper towels. Bartlett TLC Stripcoat is another popular material to remove the surface contaminants in the nuclear industry. A thin layer of strip coat (~ 10 mil) was applied to the contaminated surface on the backside (Side 2) of the other decontaminated part; the material dried in 2-3 hours and was easily strip off. Both techniques were evaluated in this study to compare their relative effectiveness versus the Electro-Decon process.

By turning over the test articles, decontamination tests were conducted on the other side (side 2) of both criticality barriers. The surfaces (side 2) of both test articles have lower initial radioactive readings (versus side 1), probably due to side 2 of sample plates facing downward when in the CPP-666 basins. Accumulation of radioactive species is less likely for the downward facing plate surface.

Table II lists the radioactivity measurements of the test articles, before and after decontamination by Windex and Stripcoat methods. Obviously, Bartlett stripcoat is more effective than Windex cleaner to remove radioactive contaminants from the criticality barrier, but neither was as effective as the ADA electrochemical method.

Table II. Radioactivity of criticality barrier (side 2) by other decontamination methods.

Radioactivity Measurements		Test Article 1 (Windex)	Test Article 2 (Bartlett Strip Coating)
Pretest			
Direct Scan	Geiger Counter ($\beta\gamma$,dpm/100 cm^2)*	16,000	20,000
	Surface Dose (mR)	0.5	0.5
Swipe Sample (dpm/100 cm^2)	$\beta\gamma$**	1,160, 1,200	<1,000
	α**	39, <20	<20
After Decontamination			
Direct Scan	Geiger Counter ($\beta\gamma$, dpm/100 cm^2)*	13,000	9,000
	Surface Dose (mR)	NA	NA
Swipe Sample (dpm/100 cm^2)	$\beta\gamma$	<1,000	<1,000
	α	<20	<20
% Removal	$\beta\gamma$ (dpm/100 cm^2, direct scan)	19	55
* Peak reading of the test article surface, fume hood floor has background of 3000 dpm/100 cm^2. ** Samples from different locations of test article.			

CONCLUSIONS

This report demonstrates that the ADA Electro-Decon process is easy to use and can be highly effective in removing both the fixed and smearable radioactive contaminants from a metallic surface. It combines airborne contamination control and encapsulation properties of strippable coatings, with minimum secondary waste generation. Further decontamination can be achieved by repeating the process on a contaminated area.

There are no RCRA hazardous constituents in the electrolyte gel. For those items which carry RCRA codes, the waste generated from the electro-decon decontamination process will not pick up listed waste codes if the contaminated item has been flushed/wiped with water or nitric acid (to reduce its radioactive level). Otherwise, all the waste generated from ADA electro-decon process may carry the same listed waste codes as the contaminated items. Any mixed, low level waste would be stabilized and disposed at an approved site consistent with other mixed waste such as personnel protective equipment (PPE).

ACKNOWLEDGMENTS

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REFERENCES

1. R. L. Demmer and S. K. Janikowski, *Evaluation of Two Commercial Decontamination Systems*, INEEL/EXT-01-01013, August 2001.