An Improved Polymer-Based Hydrogel for Decontamination of Hard Assets

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ABSTRACT

Strippable coatings have been employed with mixed degrees of ease and efficacy over the last two decades. A new, zero-prep, non-toxic, minimum-odor hydrogel was tested on various material surfaces contaminated with uranium. The gel dries to a durable coating that provides improved ease of removal as compared to other coatings. The gel showed favorable performance on flat and textured surfaces containing grooves, pits, and joints with decontamination factors (DF) up to 50 for surfaces with high levels of alpha contamination. Of particular note was the ability of the gel to penetrate into joints and crevices and maintain its cohesiveness upon removal. The gel was applied on a typical fiber expansion joint in a concrete floor with initial activity of 24,400 cpm/100 cm^2. After removal, the residual contamination level was 480 cpm/100 cm^2, for a DF of 50 after a single application (98% removal). Materials tested included coated concrete, floor joint filler, painted steel stairs, unpainted wood, oxidized steel, and urethane glass. Loose and fixed surface contamination levels were determined to further evaluate the gel for removal of fixed contamination. Masking tape was applied to surfaces adjacent to the test surfaces which improved the dried gel removal. Loose contamination fractions were determined to be negligible, with tape DF values in the 1 to 1.07 range, i.e., essentially no loose contamination. These results indicated that the majority of contamination removed by the gel with high DFs was not simply loose particulate, but fixed in the surface. Some lower DFs were attributed to 90% humidity conditions, damp porous concrete, and incomplete cure time. Testing is planned to further evaluate high-humidity conditions and improved curing.

INTRODUCTION

DECON 188 strippable coating was tested on uranium contamination to determine the decontamination factor (DF) for the material on multiple surfaces. DFs were determined for the different surfaces.

Procedure:

An Eberline E600 meter (serial number 1348, calibration due June 2, 2007) was used with a 100 cm^2 SHP 380 alpha scintillation probe (serial number 924, calibration due June 3, 2007) in alpha scaler mode for these tests. One minute static counts were used. The probe was positioned and a permanent marker was used to draw around the outside of the probe to provide a reproducible geometry for subsequent measurements. Masking tape was positioned along the marker lines to define the area to be tested. DECON 188 was painted over the entire area with a one-inch foam brush, and overlapped on the masking tape to make the coating easier to remove. Masking tape was not used in some areas.

Conditions:

The temperature was 82^o F with humidity estimated at 90% (it was misting outside). The test was conducted inside the building. The air circulation system for the building had not been running in the past few days but had been turned on the morning of the test. It had been operating for about 1.5 hours before the testing started. The temperature of the floor was not measured, but was noted to be cooler than room temperature, possibly causing condensation on the floor.

TESTING

Initially, five spots were picked on the concrete floor and the contamination levels were determined. The mean and standard deviation were calculated. The initial total contamination mean was 482 +/- 21 (see Table 1). After decontamination the mean contamination was 366 +/- 40. These five spots were originally to be used for the curing time experiment, but due to humidity the required curing time was too long for the one-day experiment to be practical. The curing time on the floor was over 4 hours so only one spot received a second application. The second application was dried with a heated air gun along with some of the original areas. It is suspected that the floor was cold and had condensation and/or moisture trapped in it due to the common practice of mopping. The condition of the floor was coated concrete with numerous visible pits made when drums (weighing approximately 1800 pounds) were placed on the floor at an angle. The DECON 188 material worked well into the grooves and pits in the floor.

Table 1 - Floor Decontamination Factor Determination

cpm/100 cm^2	1	2	3	4	5
Initial level	468	465	468	495	513
First decon	381	354	306	374	414
Second decon	360				
DF	1.2, 1.1	1.3	1.5	1.3	1.2
DF %	19% 6%	24%	35%	24%	19%

Other areas of the floor were tested where contamination was greater. One area tested showed initial total contamination of 1,899 cpm/100 cm^2. After putting masking tape down and removing it the contamination level was 1,920 cpm/100 cm^2. Although the contamination seemed to increase in this case, this was believed to be due to removal of a dust layer that was attenuating the alpha contamination. Another layer of tape was used to perform decontamination and the level after removal of the second tape press was 1,956 cpm/100 cm^2. DECON 188 was placed over the area and allowed to cure. After removal of the DECON 188 the contamination level was 1,345 cpm/100 cm^2, which is a DF of 1.5 or 31%.

Another test was performed on diamond plate stairway tread. This area was posted as a "high contamination area" and had significant foot traffic over the years. One patch had an initial contamination level of 5,620 cpm/100 cm^2. Another patch right next to the initial one had an initial contamination level of 5,570 cpm/100 cm^2. For one patch decontamination with tape brought the level down to 5,470 cpm/100 cm^2. The other patch was not decontaminated and DECON 188 was applied to both. The final contamination level was 3,440 cpm/100 cm^2, for the patch on the left for a DF of 1.6 or 37%. The patch on the right had a final activity of 3,690 cpm/100 cm^2, for a DF of 1.5 or 34%.

The DECON 188 material was tested on two pieces of wood, one a rough wood pallet and the other planed wood. Neither were painted. For the wood pallet the initial activity was 192 cpm/100 cm^2, after application of the DECON 188 and removal the activity was 39 cpm/100 cm^2. This gives a DF of 4.9 or 80%. The planed wood started at 168 cpm/100 cm^2 and after decontamination read 36 cpm/100 cm^2 for a DF of 4.7 or 79%. It should be noted that the DECON 188 took considerably longer to cure on the wood; it penetrated the porous pallet wood well and was effective in cleaning the wood from dirt.

Bare oxidized steel metal (some rust) was tested. The initial contamination level was 2,640 cpm/100 cm^2. The application of DECON 188 to this surface dried quite quickly as compared to the floor due to more air movement around the test area. This made the removal of the DECON 188 very easy and exposed the surface down to bare metal. Post removal activity was 742 cpm/100 cm^2 for a DF of 3.6 or 72% (see Figure 1).

Figure 1 - Oxidized steel after decontamination

One area of the floor used for machining uranium bore greater contamination. The bare floor initially was 9,420 cpm/100 cm^2, after one tape press removal it was 8,500 cpm/100 cm^2, after the second tape press removal it was 8,800 cpm/100 cm^2, and after the DECON 188 the activity was 357cpm/100 cm^2, for a DF of 24.6 or 96%. A joint in the concrete was tested also where the joint material was the typical felt used in cold joints. The DECON 188 was aggressively applied into the joint as part of the 100 cm^2 area covered. The initial activity was 24,400 cpm/100 cm^2, and the post decon level was 480 cpm/100 cm^2, for a DF of 49.9 or 98%.

Painted concrete block with a textured finish was tested for the ability of DECON 188 to form to the shape of a rough surface. The initial activity was 180 cpm/100 cm^2, and the final activity was 63 cpm/100 cm^2, for a DF of 2.9 or 65%. Figure 2 shows the removed DECON 188 and how well it conformed to the textured surface.

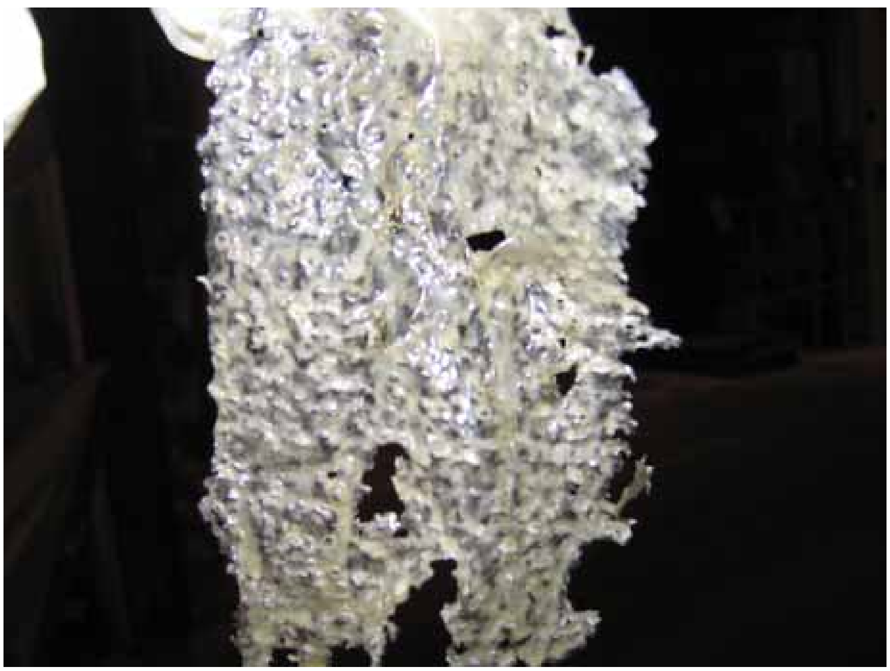

Figure 2 - DECON 188 removed from textured surface

CONCLUSIONS

The results of this testing are summarized in Table 2. It may be observed that the DFs are significantly higher for certain surfaces. The dampness of the floor first tested is believed to have contributed to the low DFs for that surface. The material performs better than tape decontamination and can be used without the need for any prior decontamination activities. It is believed that if DECON 188 was left on these surfaces for 24 hours or more, it would have been easier to remove, and have yielded higher DFs. This test, even with forced air drying, shows favorable performance. The effects of surface moisture on optimum cure time and DF should be further documented, as well.

Table 2 - Summary of results

Material	Activity prior to DECON 188 (cpm/100 cm^2)	Final activity	Decontamination factor	Decontamination percentage
Floor	1,956	1,345	1.5	31%
Stair tread – L	5,470	3,440	1.6	37%
Stair tread – R	5,570	3,690	1.5	34%
Rough wood	192	39	6.0	80%
Planed wood	168	36	4.7	79%
Oxidized steel	2,640	742	3.6	72%
Floor	8,800	357	24.6	96%
Floor joint	24,400	480	49.9	98%
Plexiglas	57	24	2.4	58%
Textured concrete block	180	63	2.9	65%

This improved decontamination agent shows great promise for good decontamination factors and ease of application and removal. Several of the previous problems with removable coatings have been overcome to improve performance. A series of tests may be considered for comparison with traditional means of decontamination, i.e. masslin, soap solutions, other strippable coatings, and mechanical decon techniques such as plastic/water/CO_2 blasting, spalling, and scabbling. The material should also be evaluated as a pre-applied preventative coating that is removed following radiological activities. These tests are under way.