Innovative Process for Abatement of Mercury

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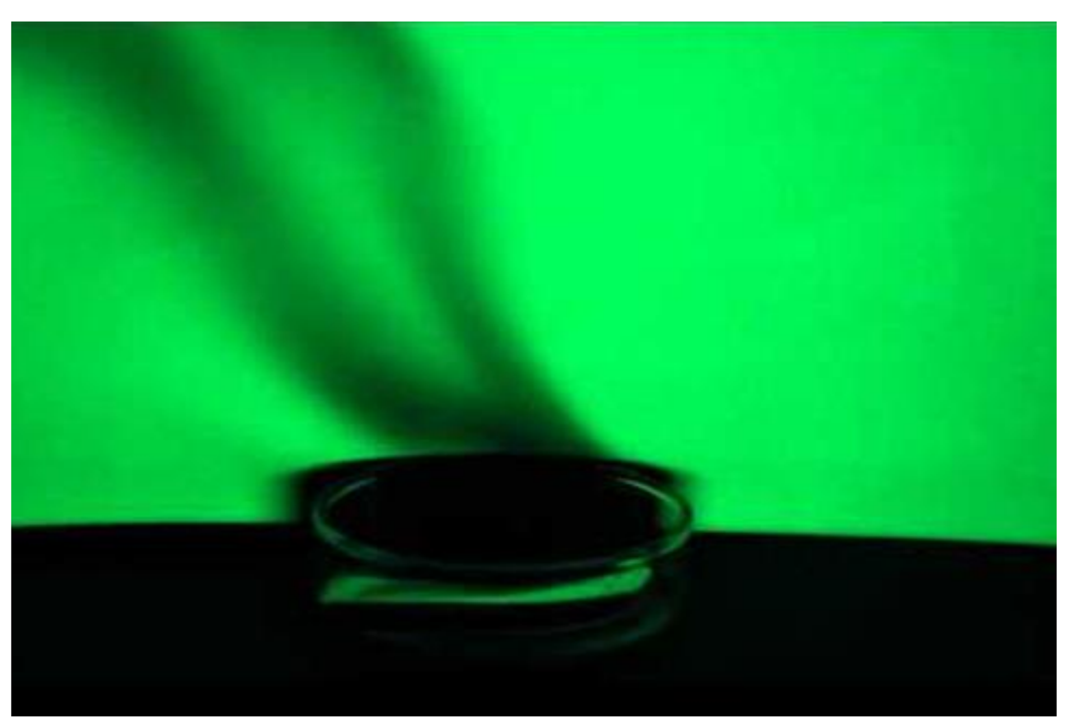
Introduction

Over the centuries, mercury has been used for game-changing innovations such as barometers, dental amalgams, and batteries; however, due to its toxicity, it has drawn the attention of environmentalists, policy-makers, and professionals in the health industry. The anthropogenic release of mercury can lead to mercury poisoning, which has been correlated with neurodegenerative processes.

In the case of a mercury spill, the current methods of decontamination include the use of a special mercury vacuum cleaner and/or mercury decontaminant. These are both very affordable and safe alternatives, but are not without their drawbacks. Mercury vacuums can be effective but can worsen the situation in some cases if it spreads the mercury vapor. This makes it a dangerous practice when dealing with porous surfaces such as concrete and granite. An ideal form of mercury decontamination would be one that keeps personnel at the lowest risk possible, contains the spill in lieu of potentially spreading it, doesn't produce any secondary waste, can be used for non-ideal situations, and makes the waste easier to dispose of.

Objectives

To contribute to the mercury decontamination initiatives that already exist, the goal was to develop a more effective method to minimize personnel exposure, reduce costs, and ease implementation.



Methodology

The innovative process being researched for mercury decontamination is the use of strippable coatings designed for radioactive contamination. To ensure that the process would reduce personnel exposure, an effective delivery mechanism is needed. The first step toward this goal was to evaluate how commercial-off-the-shelf (COTS) strippable coatings behave when sprayed. The list of the COTS coatings evaluated is displayed in the table below.

Product	Chemistry	Viscosity (cP)	Density (lbs/gal)
A: Stripcoat TLC Free	Acrylic	-	9.52
B: Encor 449	Acrylic	600	8.7
C: Carboset 441	Acrylic emulsion	40-125	8.93
D: DeconGel 1108	Acrylic	8,000-18,000	8.35-8.63

To take the mercury abatement component into consideration, specific additives that are known to treat mercury-contaminated surfaces were mixed into the coatings. The additives used included activated carbon and elemental sulfur. The specific mixtures are outlined below.

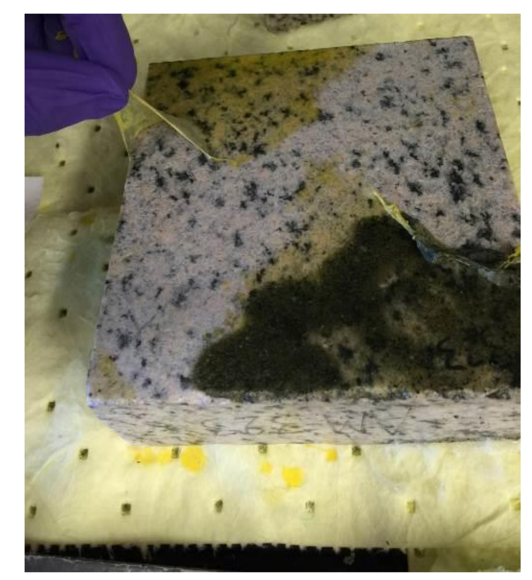
Solution 1	100 mL of Product
Solution 2	100 mL of Product+3.5g of AC+3.5g of ES
Solution 3	100 mL of Product+3.5g of AC
Solution 4	100 mL of Product+3.5g of ES

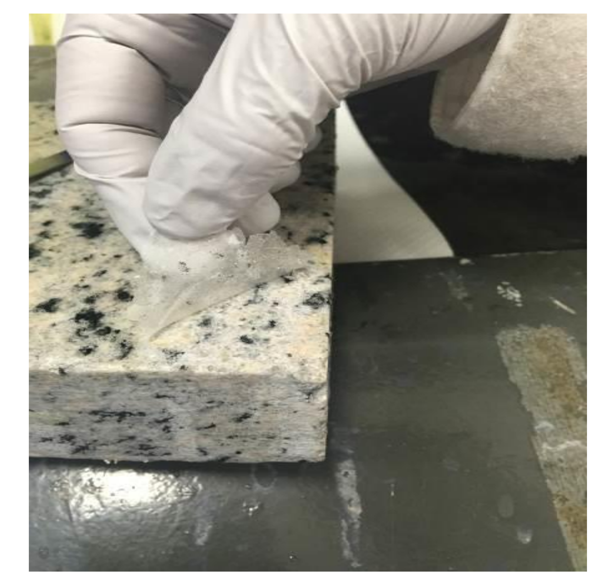
Using the 16 different combinations of solutions, the characteristics evaluated included how sprayable the solution was and the quality of the cure. Each combination was sprayed onto concrete and granite substrates.

Results

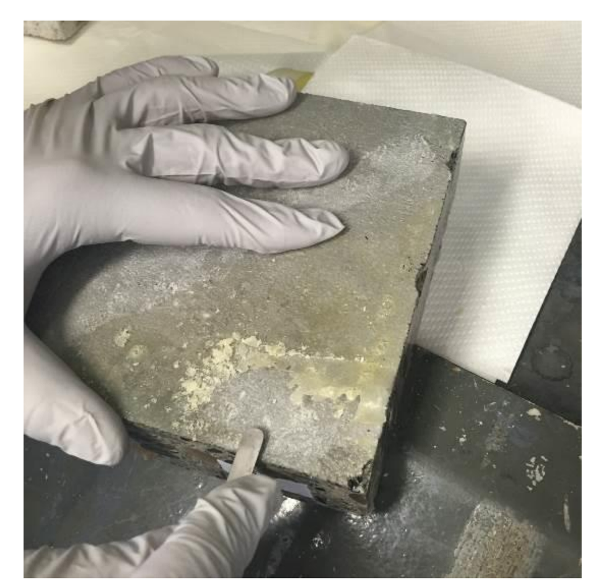
The results varied tremendously among the 16 different solution combinations. In some cases, the addition of the activated carbon and/or elemental sulfur caused the solution to become brittle and no longer strippable. In other cases, the mixture was more successful, allowing the solution to be strippable.

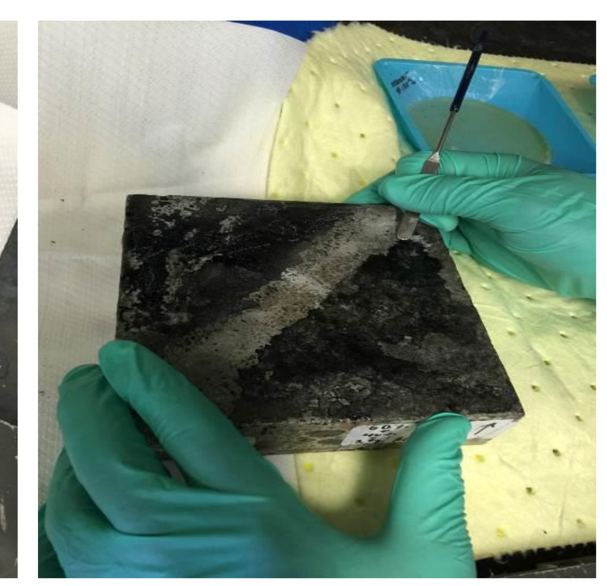
The samples shown below were successfully peeled off from the substrate. The image on the left displays solution 1 and solution 2 of Product A being stripped and retaining an elastic form.





On the other hand, the samples shown below were either almost totally absorbed by the concrete surface or eliminated their tensile integrity due to a conflict in the chemistry.





A few of the challenges encountered included logistic issues with the spray bottle used to generate the coating mist, the porosity of the substrates, and the granular form of the additives. All of these, in one way or another, hindered the results and progress moving forward.

Conclusions

The research conducted during the summer 2015 internship at Idaho National Laboratory helped advance the progress of technologies that are designed for the abatement of mercury and other hazardous substances. As the early stages of trial and error are complete, progress towards quantifying the results will be made.

Future Work

Additional considerations are required to advance this research. First, a more advanced commercial sprayer, particularly one that is capable of including a larger pressure gradient, is needed to generate the force to atomize the thicker solutions. Second, using other substrates that are not as porous, such as steel or other metals, would not interfere with the coating thickness and thus, provide more consistent results. Third, instrumentation to measure the coating thickness would complement the substrate substitution. Finally, incorporating a contaminant component to test the effectiveness of the solutions would ultimately be essential to substantiating the results.

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