THE EFFECTS OF CONTAMINANT AGING ON DECONTAMINATION EFFICACY FOR RAPID REMEDIATION OF CONCRETE SURFACES

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BACKGROUND/MOTIVATION

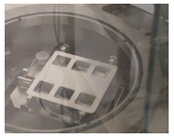
- Understanding the relationship between contaminant aging and decontamination efficacy is imperative for effective remediation following a large-scale nuclear contamination event
- Two minimally-destructive decontamination options for concrete surfaces are washing down structures using low pressure (e.g., via fire fighting equipment) or pressure washers
- Far-field contamination analysis has shown radionuclides are encapsulated in silica-like particles sized 0.5 – 3 µm and soluble contaminants
- Because contaminant form influences contaminant fixation, this work measures decontamination efficacy for soluble and particle contaminants on concrete

Field-demonstration of the Integrated Wash Aid Treatment Emergency Reuse System

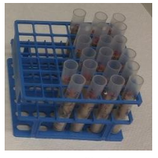
METHODS

- Low-porosity concrete samples were contaminated with soluble Cs-137; 0.5 µm spherical silica particles tagged with Gd-153; and 2.0 µm spherical silica particles tagged with Eu-152
- Contamination aged either with or without simulated rainfall every 2 - 4 days and up to 60 days in 55% -75% relative humidity and 20°C
- Samples were decontaminated with 0.1M KCl either pumped across the coupon face at 100 mL/min for 15 minutes or applied using a pressure washer and a 5 mm/sec linear cleaning rate
- Depth profiles of aged, but not decontaminated, samples were created by measuring activity in surface layers removed using 100 grit sand paper
- Removal depth was calculated from the removed mass per layer and sample density
- Decontamination experiments were performed in quintuples and depth-profiles in duplicates

Flow decontamination setup

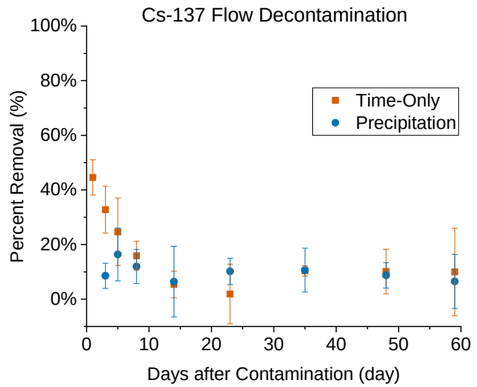


Pressure Washing Sample Holder



Depth profile layers

DECONTAMINATION RESULTS

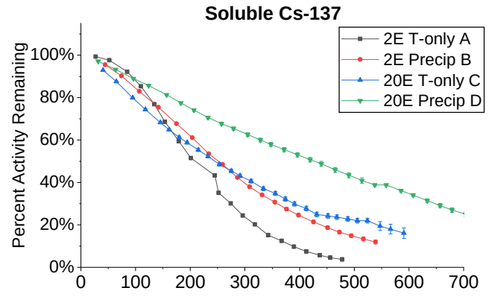


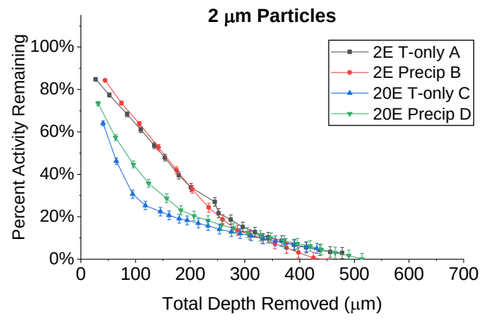
- Pressurized washing of cesium-contaminated concrete yielded 0-20% removals consistently.

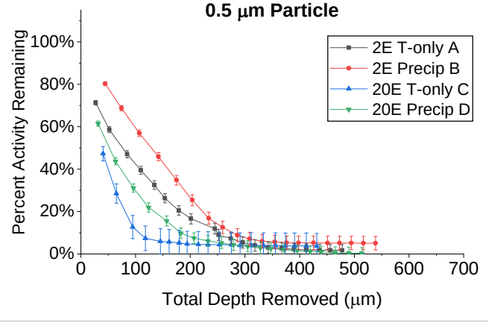
- Pressure washing effectively removed particle contaminants
- Flowing solution across the coupon face was likely ineffective at removing particles because particles localizing in surface depressions, limiting exposure to fluid bulk velocity
- The 0.5 µm particles showed similar behavior to 2 µm particles except:
  - Relatively low removals (35%-70%) were observed for high pressure washing at two aging conditions

SELECT DEPTH-PROFILE RESULTS

- Depth profiles measured for 34 samples
- Line roughness measurements from one sample suggest an approximate height range of 300 µm, distorting profiles
- Observations on surface roughness and aggregate exposure by layer were made throughout testing
- 2E and 20E indicate two and twenty rainfall events before depth profile measurements respectively (5 or 60 days)







CONCLUSIONS

- Soluble Cs-137 removal becomes insignificant (<10% removal) within the first ten days of contamination in moderate humidity environments
- The majority of soluble Cs-137 is located in the upper 1 mm of contaminated concrete after 60 days of aging, regardless of precipitation events
- Elevated humidity, rather than the precipitation, appears to facilitate soluble Cs-137 subsurface migration
- Particulate contamination can be readily removed by low-pressure washing.
- At standard operating conditions, flowing solution across a contaminated surface is ineffective at removing micron particles from concrete
- Most observed particle subsurface penetration was likely caused by sample roughness

NEXT STEPS

- Determine best method to correct for surface dipping/roughness in depth profile tests
- Measure how penetration depth changes over time for concrete and cement samples of different porosities
- Incorporate decontamination results into simulations of decontamination logistics to estimate observed decontamination efficacy
- Determine removal depths of different pressure washer configurations to provide optimal guidance for responders depending on contaminant(s) and aging conditions

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