SODIUM REMOVAL AND CLEANING
OF REUSABLE HARDWARE

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Sodium Removal and Cleaning
of Reusable Hardware

by

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GENERAL

There are a number of ways in which sodium contaminated articles may be cleaned for reuse. The method utilized is dependent on a number of factors; namely, the size of the article, degree of cleanliness required, and geometrical configuration, to name a few. Large articles such as pipes and large valves can be effectively cleaned by totally immersing them in a hot oil bath. The parts are usually placed in a wire mesh basket and lowered into the hot oil. The basket is agitated every hour or so and the liquid sodium flows out of the pipes or valves and sinks to the bottom of the tank. The oil covering prevents sodium reactions with the atmosphere. After visual inspection indicates that the sodium has been removed, the parts can then be taken from the hot oil and cleaned further with saturated steam. This method is recommended for cleaning radioactively contaminated parts, since the oil can be disposed into barrels and treated as contaminated liquid waste.

Large pipes that are not filled with solid sodium, but only have residual traces, may be effectively cleaned by placing them in a vice attached to a heavy metal table in an approved open area and applying saturated steam to them at about fifty pounds pressure. This should be followed with a liquid water rinse.

Small tubes, valves, specimens, etc. may be cleaned in an inert atmosphere box using a mixture of steam and nitrogen applied under low pressure through a nozzle. There is no assurance, however, that all of the sodium in relatively inaccessible areas has reacted. Also an inert atmosphere box and associated piping are costly. Another disturbing possibility is the chance of losing the inert atmosphere and creating a secondary reaction, such as a hydrogen explosion.

DOWANOL-EB NEUTRALIZATION OF SODIUM

A practice which has received some attention is the use of commercial solvents with an alcohol base to react with the sodium and remove it from contaminated parts. Frequently, the reaction rate is not controllable within acceptable limits, and a scum is left which is difficult to remove. Since data for this method of cleaning is generally unavailable, extensive tests were conducted by the staff of Nuclear Metallurgy in the 321-A Creep Facility, and it was found that a commercial solvent (Dowanol-EB), manufactured by the Dow Chemical Company, gives extremely good results. The reaction of the Dowanol-EB and the sodium is slow, but predictable, and there is no scum left on the part being cleaned. The end product of the reaction is the spent Dowanol-EB and a soft residue which is easily removed by rinsing with water. Sodium reaction goes to completion, even in hard-to-get-at places such as screw threads, fittings, and inside valves.

The tests were conducted in a large, high bay area with adequate ventilation. The hydrogen which was generated bubbled up through the Dowanol-EB at the rate of five or six bubbles per second. This slow rate allowed no chance of a hydrogen accumulation and subsequent explosion. The reaction interface between the metallic sodium and the Dowanol-EB advances smoothly at a rate of approximately

one twenty-fourth inch per hr in fresh Dowanol-EB. When Dowanol-EB which had been standing in an open beaker for one week was used, the moisture absorbed from the atmosphere speeded the reaction rate to about 1 in/hr; however, the reaction was under complete control and the temperature rise of the containment beaker was small.

The procedure for cleaning a sodium contaminated article begins by placing the part in a metal container and just covering the part with Dowanol-EB. The cleaning operation should be conducted in a ventilated hood or well ventilated room. After 24 hrs, the reaction is usually found to be complete and a white residue is left in the bottom of the container. To insure complete reaction, add about 10 ml of water to the fluid. If any bubbles are observed, wait until they cease and then add an additional 10 ml of water. Continue this procedure until the resultant mixture is 50 percent water or all bubbling has ceased. At this point, remove the part and totally immerse it in water to remove all traces of the residue. The part can then receive a final cleaning rinse in absolute ethyl alcohol. The spent Dowanol-EB and reaction residue can be safely flushed down a sink, since the Dowanol-EB is completely miscible in water. The tap should be running during flushing to insure good dilution.

Another method of Dowanol-EB cleaning was successfully used to remove sodium from the surface of test elements contained in a large capsule illustrated in Figure 1. Dowanol-EB was introduced into the capsule through the bottom and allowed to flow up and around the test rod and specimens until it reached a point just above the uppermost part of the test rod. The level was observed at the transparent Tygon transfer tube. Helium was then introduced into the bottom of the capsule at a slow purge rate and allowed to bubble up and around the specimens. This counterflow action assisted the Dowanol-EB in getting at all areas of the specimens, decreasing reaction time

and insuring complete sodium removal. The helium also served an additional function of sweeping out toxic gasses and hydrogen which had been generated. The gasses exited through a valve at the top of the capsule to a gas washing bottle containing kerosine for a bubbler, thus preventing back flow of the gas. Three gallons of Dowanol-EB was used in the reaction process and two gallons were used for flushing the residue. Reaction was completed in about 24 hrs, as noted by the absence of bubbling in the bubbler when the helium purge was secured.

PRECAUTIONS

Dowanol-EB has a flash point of 165°F, and requires proper safety measures for handling and storing. It is also moderately poisonous on inhalation, and is readily absorbed through the skin. In both instances, the material is capable of producing degradation of the blood when the threshold value of 50 ppm is exceeded. Consequently, good ventilation and skin protection are necessary.

RESULTS

Figures 2 through 4 illustrate the cleaning effectiveness of the Dowanol-EB method. Figure 2 shows two, 1/2-in ID, 6-in long capsules which were filled to within one inch of the top with sodium and welded closed. Two, 1/16-inch holes were drilled as shown, and the capsules were then totally immersed in Dowanol-EB for cleaning by the previously described method. Upon completion of the reaction, they were cut open. The very small amount of residue remaining inside the capsule was easily flushed out with water.

Figure 3 illustrates a 1/2-inch ID, 2-in long tube, which was completely plugged with sodium. The ferrule was also covered with sodium oxide. After 24 hrs immersion in Dowanol-EB without water addition, the tube exhibited no traces of sodium or sodium oxide. Oxide was even removed from under the ferrule which turned easily on the tube after cleaning.

Figure 4 is a photomicrograph of the surface of a 304 SS plate which was polished to a yellow diamond finish and then subjected to molten sodium. After sodium exposure, the plate was immersed in a beaker of Dowanol-EB, and allowed to react totally. The photomicrograph shows no evidence of attack of the previously polished surface.

CONCLUSIONS

1. Dowanol-EB provides a safe and flexible method for cleaning reusable parts contaminated with sodium or sodium oxide.
2. Experimental tests reveal that the reaction rate of sodium with Dowanol-EB can be regulated by water additions and that the end products, liquid and residue, can be readily dissolved and flushed with water.

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FIGURE 1
Schematic for Removing Residual Sodium from Fuel Rod and Specimens
with Dowanol (EB)

FIGURE 2: Sodium Filled Capsules Which were Cleaned by
Using Dowanol (EB)

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FIGURE 3: Sodium Filled Tube and Heavily Sodium Oxide Covered Ferrule After Cleaning by Using Dowanol (EB)

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FIGURE 4: Polished Stainless Steel Plate Showing No Attack
by Dowanol (EB) Cleaning Process

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