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EFFECT OF LIQUID SODIUM ON
THERMAL INSULATION SPECIMENS

By

M. Tarpinian

I. Purpose

The thermal insulation around the SRE must be installed with certain contingencies in mind. Since this layer of material is the last barrier to any large sodium leak, it is desirable for the material to have some delaying action on the escaping sodium. With this condition in mind, a simple procedure was effected to determine the action of liquid sodium on various specimens from the standpoint of deterioration and loss of mechanical strength.

II. Apparatus

Two tanks formed from mild steel pipes, 4 inches in diameter, were fitted with vacuum-tight flanges. Into each flange a compound gage was inserted with the necessary vacuum and gas fittings. Heater wire was wrapped around the tanks; chromel-alumel thermocouples were peened into the tank walls for temperature control. Both tanks were insulated with standard pipe insulation. To prevent specimens from sticking to the tank walls after cooling of the sodium, tiered racks were built with space for three specimens on each rack. Thus, a run was made simultaneously on six specimens. An overall view of the apparatus is shown in Fig. 1.*

III. Procedure

The specimens of rigid type insulation were cut from standard size pieces into cylinders about 3 inches in diameter and in thicknesses of 1 to 2 inches depending on the thickness of the standard pieces. The loose materials were made up into paste with water and formed into 3-inch diameter samples about 2 inches thick. These were cured at 1000° F for 6 to 8 hours. Into the top of each specimen was gouged a hole about 1/2 to 3/4 inch deep and about 2 inches across.

* Only Figs. 33, 35, 36 and 38 are included in this memo. Complete set of figures in Group 23 office.

Previous to loading, the tanks were flushed with argon. Then the racks were loaded with the specimens with a 1-1/2 inch cube of sodium placed in the cavity of each sample. After lowering and sealing the racks in the tanks, the argon was pumped out and the heaters turned on. The temperature was maintained around 950° F for 1-3/4 hours, and allowed to cool slowly. During the heating-up process the tanks were isolated from the vacuum pump to allow a check on any gas generation as indicated by the compound gages. Upon cooling, the specimens were removed for photographic study, and in some cases given an alcohol bath to dissolve out the sodium.

IV. Results

1. Johns-Manville Suprex Paste (Figs. 2-6)

This material is composed of asbestos fibers and calcined diatomaceous earth. After the sodium test, both specimens remained intact and showed little penetration by sodium. The color was gray where the sodium came in contact with it; however, the unaffected portions retained the white color. Mechanically there was little change, the specimen being about as flaky as before.

2. Johns-Manville Brick 1620 (Fig. 7)

This is a lightweight porous clay brick with a yellow color. The sodium was readily absorbed resulting in complete disintegration of the specimen. After an alcohol bath only a black sludge was left.

3. Johns-Manville Brick C-16 (Fig. 8)

The chief ingredient is calcined diatomaceous earth. This specimen showed thorough penetration by the sodium and complete destruction, with a residue of black sludge after an alcohol bath.

4. Eagle-Pitcher Oil Treated Mineral Wool (Figs. 9-11)

Even though there was considerable sodium penetration and considerable charring, the wool was mechanically intact. The wire mesh, however, had been destroyed.

5. Johns-Manville Sil-O-Cel C-3 with Atlas Lumnite Cement (Fig. 12-14)

The Lumnite cement (calcium aluminate) was mixed with Sil-O-Cel C-3 (calcined mineral celite in a ratio of 4 parts Sil-O-Cel to 1 part cement. Although penetration was slight, there was evidence of embrittlement throughout the specimen. The color changed from a whitish-pink to a dark gray, probably due to vapor penetration.

6. Johns-Manville Superex Block (Figs. 15-16)

The composition is the same as Superex paste. However, it was vigorously attacked, causing large cavities throughout the specimen. A very hard glassy substance was formed, which could not be sectioned with a hack saw. The color changed from white to black with dark glassy slivers.

7. Johns-Manville Sil-O-Cel, Course Grade (Figs. 17-19)

This mixture was made from 4 parts Sil-O-Cel (mineral celite) and 1 part Atlas Lumnite cement. Embrittlement followed exposure, with a change of color from pink to gray.

8. Johns-Manville Sil-O-Cel Brick C-22 (Figs. 20-22)

This specimen (calcined diatomaceous earth) was very badly attacked, becoming crumbly on the surface and brittle on the inside.

9. Johns-Manville C-16 with Sil-O-Cel Mortar (figs. 23-25)

The mortar is a mineral celite. After the brick was cut in half, it was cemented together with the mortar, and the entire surface and sides were plastered with it. The mortar was completely destroyed, with halves falling apart upon removal from the tank. The specimen fell apart into a sludge after an alcohol bath.

10. Johns-Manville Sil-O-Cel Powder (Figs. 26-28)

A mixture of 4 parts Sil-O-Cel powder (mineral celite) and 1 part Atlas Lumnite cement, this specimen showed no great superficial attack; however, the sectioned specimen showed deep penetration with a tendency to crumble. Color changed from pink to black.

11. Johns-Manville LK-61-Aerogel (Figs. 29-32)

The manufacturer did not divulge the composition of this material. It has a pink color and a texture similar to that of Superex Block. It was severely attacked, being very powdery to the touch. The specimen turned black throughout.

12. Superex Block, Cured (Figs. 33-35)

Preliminary to exposure to sodium, this specimen was cured for 12 hours at 1000° F resulting in a change of color from white to salmon pink. After exposure the sample was similar to Superex paste in mechanical properties; however, unlike the paste, this block turned gray throughout. Absorption of the sodium was complete.

13. Johns-Manville Thermoflex (Figs. 36-38)

Alumina and silica are the chief ingredients of this material. The texture is similar to that of mineral wool. In fact the two materials showed identical aftereffects, except that thermoflex showed even less sodium absorption; the sodium remained puddled in the cavity, as shown by the last photograph.

In no case was the buildup in pressure greater than 15" of Hg (about 7-1/2 psi). This occurred with three specimens in one tank.

V. Conclusions

Every type of material tested showed attack in varying degrees. Many specimens which had been cured at 1000° F, with no color change, did show drastic changes at 950° F due to the action of sodium.

The materials showing the least disintegration and greatest preservation of mechanical properties were Superex paste and Eagle-Pitcher mineral wool. It should be noted that the uncured Superex Block did not hold up as well as Superex paste, presumably due to the presence of water of crystallization; and that after curing, the results were similar to that of the paste. The refractory clays showed the greatest degree of destruction (J. M. Brick 1620).

The time element is of vital importance, since a long period of contact with liquid sodium would presumably result in complete destruction of every specimen tested.

Distribution: SRE
W. Sanders
M. Tarpinian

JOHNS-MANVILLE
SUPEREX
BLOCK
HEATED TO 1,000°F FOR
12 HOURS

1-m

Figure 33

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UNCLASSIFIED

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JOHNS-MANVILLE
SUPEREX
BLOCK
HEATED TO 1,000°F
FOR 12 HOURS
I-M

Figure 35

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JOHNS-MANVILLE
THERMOFLEX

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Figure 36

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JOHNS-MANVILLE
THERMOFLEX
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Figure 38

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