THERMAL INSULATION

from

ARMSTRONG CORK COMPANY
LANCASTER, PENNSYLVANIA 17604

SERIAL NO. 18080

FEBRUARY 27, 1968

FM

FACTORY MUTUAL ENGINEERING CORPORATION

1151 BOSTON-PROVIDENCE TURNPIKE, NORWOOD, MASS. 02062

FACTORY MUTUAL ENGINEERING CORPORATION

1151 BOSTON-PROVIDENCE TURNPIKE, NORWOOD, MASS. 02062

18080

February 27, 1968

THERMAL INSULATION

from

ARMSTRONG CORK COMPANY
LANCASTER, PENNSYLVANIA 17604

I ABSTRACT

At the request of the Armstrong Cork Company, a fire test was conducted on their Armaspray-16 high temperature insulation. Insofar as practicable, the test was conducted in accordance with ASTM C-411 specification, "Hot-Surface Performance of High-Temperature Insulation".

Exposure to a hot-surface of 1600°F for a total of 96 hours had no apparent adverse physical effects on the insulation.

Insulating qualities of the sample were not evaluated.

II DESCRIPTION

A. Sample

Armaspray-16 insulation is a blend of mineral wool and asbestos fibers with inorganic binders and is the sponsor's standard insulation. Density, after drying, is 10-14 lb per cu ft. It is applied by spraying on potentially hot surfaces to the desired thickness.

The sample tested was prepared by the sponsor in accordance with the requirements of the test standard noted in Section I. It consisted of a horizontal section of insulation 24 in. x 36 in. sprayed to a thickness of 6 in. within a frame of insulating fire brick and mounted on a horizontal 3/16 in. thick steel plate. See Appendix A. This plate, supporting the insulation, became the hot-surface when the sample was placed over the open furnace. Temperatures at the bottom face of the insulation were recorded by five thermocouples peened into the top surface of the steel plate and located as shown on Appendix B.

B. Furnace

A horizontal, rectangular, gas-fired furnace received the sample as its top closure. The firing chamber was 36 in. long x 18 in. wide x 12 in. deep. See Appendix A.

III TEST PROCEDURE

The test was a modification of the ASTM C-411 specification, "Hot-Surface Performance of High-Temperature Thermal Insulation". Its purpose is to determine performance of thermal insulations when exposed to hot-surface conditions.

The standard requires a 96 hour continuous exposure after the desired operating temperature is reached. The test sponsor requested an intermittent test procedure on the basis that this more closely paralleled the intended use of the insulation.

Following this guideline, the furnace was fired daily during normal working hours for 18 days. Each day the 1600°F test temperature, requested by the sponsor, was reached gradually after furnace light-off. Average exposure time per day at 1600°F was 5 hours 30 min. Hot-surface temperatures were maintained at 1600°F average and no single thermocouple fell more than 25°F below the end point temperature, as required by the Standard.

Within one hour of initial firing, all five of the previously installed thermocouples failed. Since peening in another set could not be accomplished without destroying the sample, the following procedure was followed as an expedient. Undersized holes were drilled through the insulation adjacent to the original thermocouple locations, and rigid-probe thermocouples were inserted. These were weighted at the top to maintain continuous contact with the steel plate.

Due to the consistency noted in recorded temperatures throughout the balance of the test, it is judged the expedient accurately monitored temperatures achieved on the surface of the steel plate in contact with the insulation.

For further discussion see Section V-C.

IV TEST LOG

No changes were noted in appearance of sample during the complete test period.

1st Day: Thermocouples failed within the first hour of operation. These were replaced as described in Section III.

2nd Day: Deflections of the steel plate upwards during pre-heat period reached a maximum of 7/8 in. at 30 min. An irregular crack 14 in. long x 1/8 in. wide developed on the surface of the sample 20 in. from the flue end. This crack, caused by deflection of the steel plate, closed within 20 min. and no further cracks developed during the 96 hours test.

Deflection toward the fire during the next hour returned the plate to its original position. A maximum deflection of 1/8 in. toward the fire occurred at 4 hours into the test.

Time accumulated; 5 1/2 hours.

3rd to 12th Days: Deflection readings decreased daily to where 1/8 in. in either direction was the maximum recorded at the end of the test.

Time accumulated to date; 63 hours.

13th to 15th Days: Increased sensitivity in thermocouple No. 8 noticed at light-off each day. Response to gas supply adjustments was rapid. Other thermocouples responded normally.

Time accumulated to date; 81 1/2 hours.

16th to 18th Days: At light-off, thermocouple No. 8 instantly recorded 300°F plus. All adjustments to gas supply for remainder of test resulted in instantaneous response from this thermocouple. Such reaction is indicative of flame impingement on the thermocouple. This was confirmed when the sample was removed from the furnace at the end of the test. For further discussion see Section V-A.

Time accumulated at end of test; 96 hours.

V DISCUSSIONS AND OBSERVATIONS

A. Steel Plate

At the end of the test, the steel plate had deteriorated due to scaling creating an opening approximately 1 ft. x 3 ft. in area. See Appendix C. This erosion was a result of a combination of the heat cycling and excess unburned oxygen in the furnace which accelerated oxidation.

Comparison of temperature recorded charts indicates the plate thickness was reduced to a thin layer of steel under thermocouple No. 8 during the 13th, 14th and 15th days. The last trace of steel apparently dropped into the furnace after flame-out on the 15th day. This allowed flame impingement on thermocouple No. 8 when the furnace was fired on the 16th day, resulting in the instantaneous responses noted in Section IV.

B. Insulation

The insulation retained dimensional stability throughout the test. After removing the brick edging, the insulation was noted to have turned orange-brown in the lower half of its 6 in. thickness. The sample was cut into quarters and the color shift was noted to be in three distinct horizontal bands. The bottom band was a deep brown. The second and third bands were successively lighter shades of brown. The fourth, or top band retained its whitish coloring.

The darkest discoloration occurred above the void in the steel plate. A small amount of insulation (less than 1 in. of thickness) dropped into the furnace as a result of the severe heating in this area. The surface thus exposed easily crumbled, to an additional depth of approximately 1/2 in., when touched.

Effectiveness of the inorganic binders was tested during the final three days of the test. Periodic application of an open flame to the top surface of the insulation failed to ignite the material or any gases driven off by the heating.

Surface temperatures of the insulation rose slightly above ambient, but were not objectionable to the touch over prolonged periods.

C. Thermocouples

The rigid-probe thermocouples substituted as described in Section III functioned properly throughout the test. No evidence of excessive heat loss or damage to the sample was noted as a result of the expedient.

Upon examination after the test period, only one of the original thermocouples could be located. Peening appeared to be satisfactory and securely anchored. However, this anchorage, in conjunction with the firm bond between leads and insulation, may have induced excessive stresses resulting in breakage of the leads as the steel supporting plate deflected downwards.

VI CONCLUSIONS

After 96 hours of intermittent testing, including the potentially destructive effects of the flame on the unsupported underside, the sample remained in place. There were no measurable dimensional changes. There was no evidence of delamination or tendency to disintegrate except as noted in Section V-B.

Exposure to a hot surface temperature of 1600°F for the stated period had no apparent adverse physical effects on the insulation.

SMK/mtd

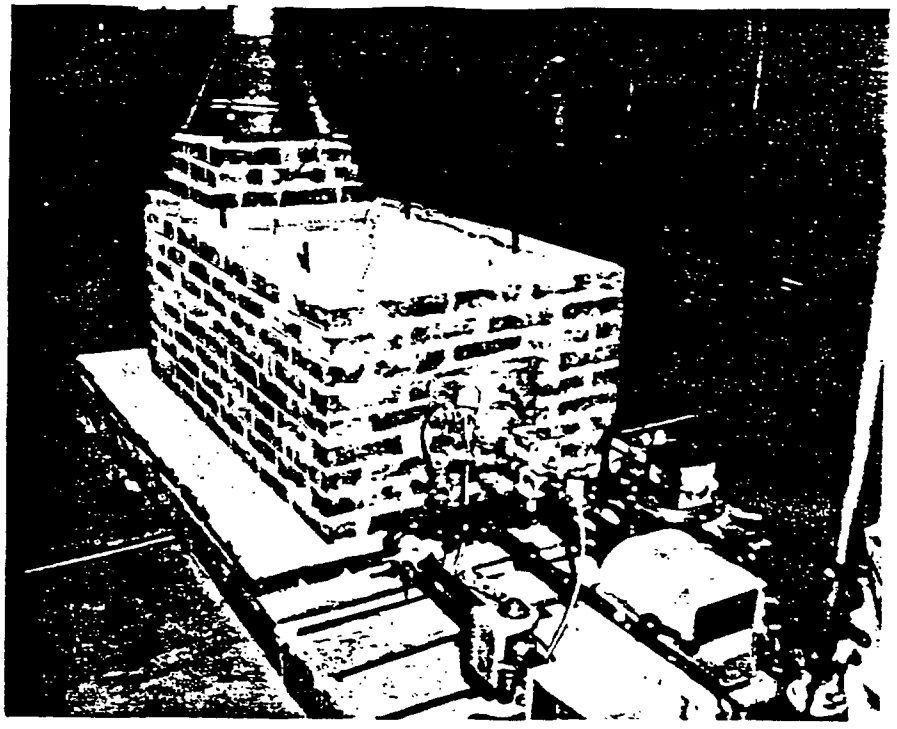
TESTS BY : J. E. Beauregard
S. M. Knight

REPORT BY : S. M. Knight

ATTACHED : Appendices A, B, C.

ILLUSTRATION 1

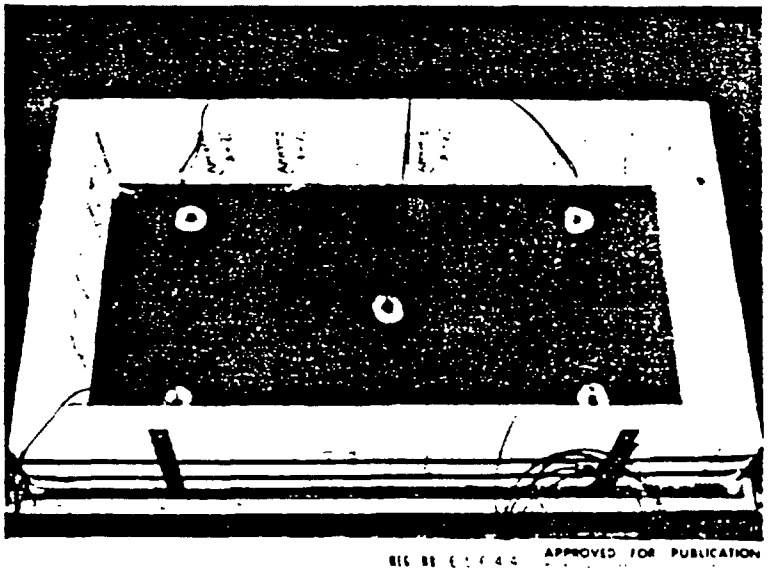
GAS FIRED FURNACE



(1715-1)

ILLUSTRATION 2

THERMOCOUPLE LOCATIONS IN STEEL PLATE BEFORE PLACING INSULATION



(1715-11)

ILLUSTRATION 3

THERMOCOUPLE LOCATIONS

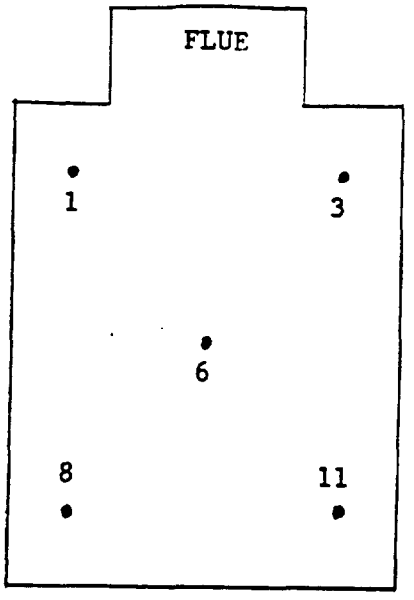


ILLUSTRATION 4

APPEARANCE OF UNEXPOSED SURFACE AT END OF TEST

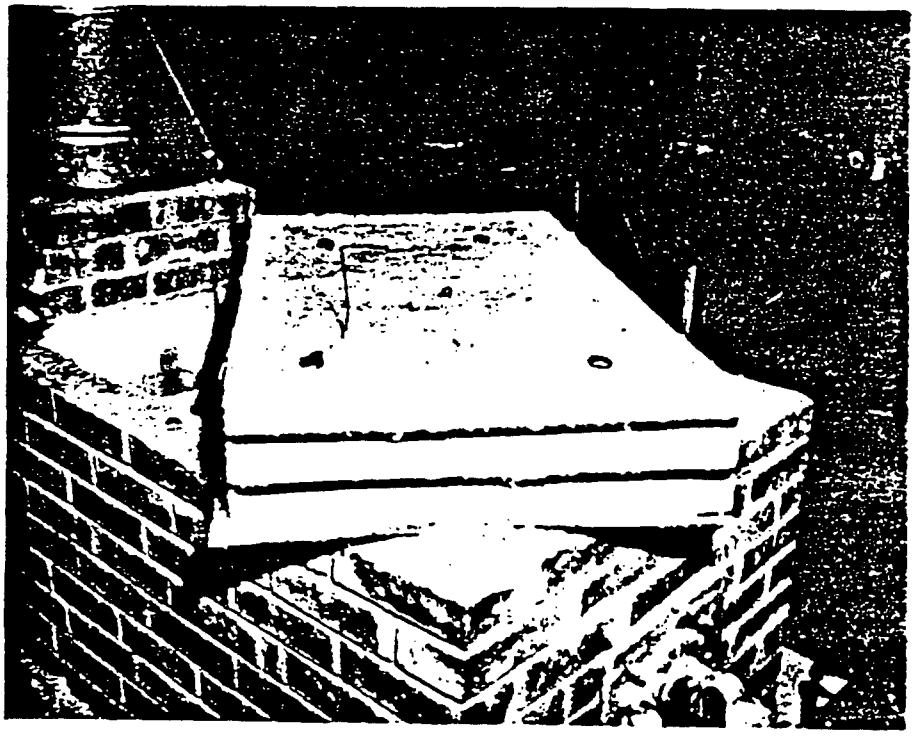
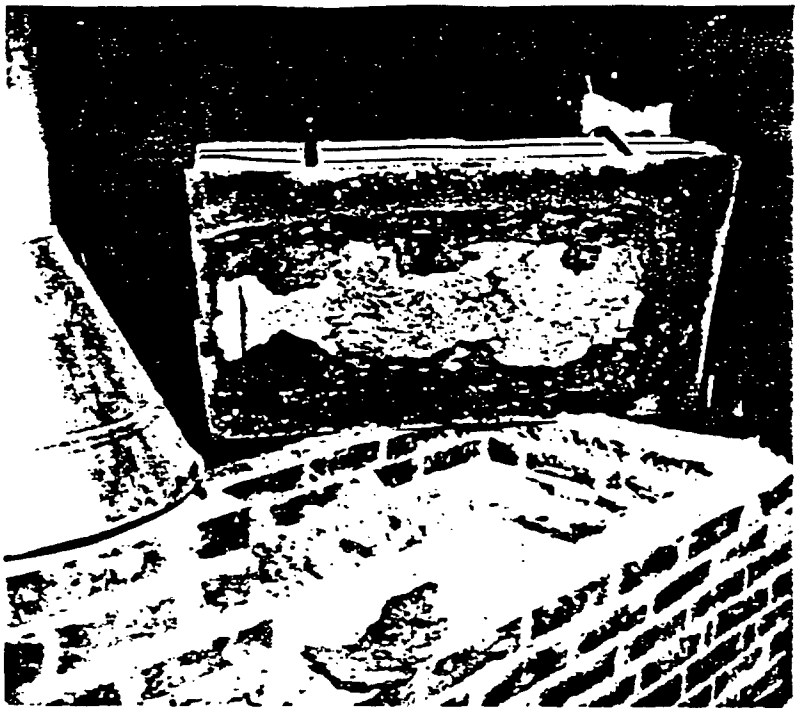


ILLUSTRATION 5

APPEARANCE OF STEEL PLATE
AT END OF TEST



(1715-6)