No F. R. Note No. 406
~~Research Programme~~ Objective

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

# THE USE OF A SUSPENSION OF FULLER'S EARTH IN WATER AS A PROTECTION AGAINST THERMAL RADIATION

by

I. C. Emson

## Summary

An investigation has been made into the effect of a suspension of fuller's earth in water in providing protection for structures subjected to thermal radiation.

A preliminary investigation has also been made using fuller's earth to stabilize foam.

July 1959

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Boreham Wood,
HERTS.

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## Introduction

During the course of a fire it is sometimes necessary to cool nearby structures which are being subjected to thermal radiation, so that they may not become involved. The normal method of doing this is to apply a jet of water, some of which may drain off leaving a film which must be evaporated before the temperature of the structure can rise above 100°C. Since the viscosity of water is relatively low, the thickness of film which can be deposited on a non-porous vertical surface is small - it may be less than 0.1 mm., depending on the surface - and any surplus water merely runs off.

During the course of large fires, it has often been found necessary to apply a continuous stream of water to nearby structures to replace that lost by evaporation and drainage. The area which can be covered by one operator is limited by the time it takes for the film to evaporate. If, however, a much thicker layer could be built up it might be possible for one operator to cover a larger area, thus effecting a saving in manpower.

To this end the effect of using a suspension of fuller's earth in water has been investigated. This mixture is thixotropic; when disturbed it has a viscosity similar to that of water and is as easy to pump, but after being deposited on a surface it reverts to its normal jelly-like consistency which allows a thicker layer to be built up.

The times for which both water and a fuller's earth suspension will keep the temperature of a steel plate below 100°C when subjected to a constant intensity of heat radiation have been compared.

A preliminary investigation has also been made to determine the effect of fuller's earth as a stabilizer for foam.

## Experimental procedure

The tests shown in table I were made on plates cut from 18 s.w.g. flat steel sheet, the surface of which had a thin coating of scale which was easily wetted. A 26 s.w.g. $T_1 - T_2$ alloy thermocouple was silver soldered centrally to one face of each plate and its output was recorded automatically. A continuous record of temperature was thus obtained during each test.

A 4 in. square plate was mounted vertically on a sliding framework which could be moved in front of a 1 ft square gas-fired radiation panel, the incident intensity of radiation from which was 0.75 cal/cm$^2$/sec.

Table 1

Tests made using 4 in. square plates

| Protection used | When applied | Position of thermocouple |
|---|---|---|
| None | - | Unexposed face |
| Water | Application stopped before exposure to panel | " " |
| Fuller's earth | " " " " " " | " " |
| " " | " " " " " " | Exposed face |
| Water | Application stopped after exposure to panel | Unexposed face |
| Fuller's earth | " " " " " " | " " |
| Water | Applied for 10 seconds after exposure to panel and equilibrium temperature reached | Exposed face |
| Fuller's earth | " " " " | " " |

It was considered possible that a 4 in. square plate might not provide sufficient distance for the fuller's earth suspension to regain its original viscosity before reaching the bottom of the plate. Accordingly, a further investigation was made on 18 in. square x 16 s.w.g. steel plates, subjected to the same intensity of radiation as before from a 3 ft. square radiation panel. Temperatures were recorded by a thermocouple fixed to the centre of the unexposed face. Two tests were made, one using water and the other using a suspension of fuller's earth in water, each applied for 10 seconds after the plate had reached an equilibrium temperature. In a third test a fuller's earth suspension was sprayed onto a cold plate, after which it was moved in front of the radiation panel.

From the temperature records obtained, the times during which the temperature of the plate remained below 100°C were measured.

To examine the effect of fuller's earth on the stability of foam, the drainage times of mechanical foam made with a suspension of fuller's earth were measured. 10 c.c. of liquid foam compound were added to 200 c.c. of water containing various percentages of fuller's earth, and the mixture was stirred vigorously by hand. The times taken for 100 c.c. of liquid to drain were recorded.

Results of tests

The results of the tests made on 4 in. square and 18 in. square plates are given in Table II. In Table III the drainage times of foam made with foam compound and various percentages of fuller's earth suspensions are given.

Although no quantitative measurements were made, it was observed that while foams made with suspensions containing up to 3 per cent of fuller's earth were rather stiff, that made with an 8 per cent suspension was quite fluid and occupied about half the volume of the previous foams. It was possible to pour it onto a petrol surface over which it spread easily. When poured onto a surface of burning petrol it appeared quite stable and showed no tendency to break down quickly.

Table II

Times during which temperature of plate was below 100°C

| Protection and Application | 4 in. square plate | | 18 in. square plate |
|---|---|---|---|
| | Thermocouple on unexposed face | Thermocouple on exposed face | Thermocouple on unexposed face |
| Plate alone | 8 sec. | - | - |
| Water, application stopped before exposure to panel | 14 sec. | - | - |
| Fuller's earth, application stopped before exposure to panel. | 30 sec. | 33 sec. | 48 sec. |
| Water, application stopped after exposure to panel | 18 sec. | - | - |
| Fuller's earth, application stopped after exposure to panel | 26 sec. | - | - |
| Water, applied for 10 sec. after exposure to panel | - | 12 sec. | 23 sec. |
| Fuller's earth, applied for 10 sec. after exposure to panel | - | 53 sec.[*] | 48 sec. |

[*] During this test an exceptionally thick layer of suspension was built up around the thermocouple wires resulting in a greater time below 100°C than might otherwise have been the case.

Table III

Drainage times of foam

| Percentage of fuller's earth | Time for 100 cc to drain |
|---|---|
| 0 | 2 min. 22 sec. |
| 1 | 1 min. 45 sec. |
| 1½ | 12 min. 20 sec. |
| 2 | 10 min. 3 sec. |
| 2½ | 23 min. 23 sec. |
| 3 | 25 min. 34 sec. |
| 8 | No drainage during 30 min. |

## Conclusions

This investigation has shown that when a suspension of fuller's earth in water is sprayed onto a vertical steel plate and subjected to a constant intensity of radiation, the thickness of the film deposited is such as to keep the temperature of the plate below 100°C for about twice as long as the time due to a film of water alone. Since there is likely to be no scaling factor, an increase in time of the same order of magnitude might be expected in practice when the surface of a structure is being subjected to radiation from a fire. It is considered unlikely, however, that an increase in time of this magnitude during which a structure is protected would be sufficient to be of such practical advantage as to outweigh the complications involved in the use of the material.

A preliminary investigation indicates that fuller's earth may be of use in producing a stable, fluid foam, although further tests are needed to assess its value quantitatively.

Mr. Thorne

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