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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
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METHODS FOR ASSESSING SPONTANEOUS HEATING AND IGNITION HAZARDS
II. THE HEATING OF OILED FIBRE IN A MODIFICATION OF THE MACKEY TESTER

by

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Summary

It has been shown that there is an optimum rate of air supply for the spontaneous heating of a specimen of oiled fibre through which air is passed at a controlled rate. The tests were carried out in a modification of the Mackey Tester designed for the purpose.

Introduction

An account of the Mackey test has been given in the first note of this series [1]. Briefly, the Mackey test is used for assessing the liability to spontaneous heating and ignition of textile oils and it consists of a small-scale, accelerated, reproduction of the heating. The oil to be tested is spread on cotton sliver which is then supported in a water-jacketed oven, maintained at 100°C, and the temperature of the oiled cotton is observed by means of a thermometer inserted in the centre. If the temperature exceeds 200°C in two hours the oil is regarded as hazardous.

The water oven is a specially designed piece of apparatus with standard dimensions, and it is provided with a chimney system to maintain a current of air through the specimen chamber. It is known as the Mackey Tester. In Firth's 1934 Modification, which is used for the standard test prescribed by the Fire Offices' Committee [2], the chimney is steam-jacketed. It appears to be generally agreed that no positive control of the air circulation is necessary.

The supply of oxygen for the oxidation of the oil within the specimen of oiled fibre must depend on the convection and diffusion of air through the specimen. In so far as air convection through the specimen controls the rate of reaction and heating, the air convection and the temperature distribution within the specimen will be mutually dependent throughout the course of the heating. With a sufficiently copious ventilation of the specimen chamber the only independent variable which can control the supply of oxygen to the interior of the specimen will be the porosity of the specimen which, itself, depends on the packing density. It has been shown [1] that there is an optimum packing density for the self-heating of specimens consisting of linseed oil on jute in the Mackey tester, and it has been suggested that the existence of the optimum depends, at least partly, on eventual restriction of the air supply to the interior of the specimen as the packing density is increased.

An experimental study has now been made of the effect of air supply to the interior of the specimen on the course of self-heating in jute impregnated with linseed oil. For this purpose it was necessary to carry out tests under conditions which were different from those existing in the Mackey test itself where, as pointed out above, air supply and self-heating in the specimens must be to some extent mutually dependent. Thus, the specimens were enclosed in tubes through which air was passed at a known rate which was held constant in each test. A modification of the Mackey tester was designed for the purpose of carrying out these tests.

This work forms part of a study of the factors involved in spontaneous heating and ignition which has the object of defining the test conditions for assessing the relative spontaneous heating and ignition tendencies of different materials. The intention was to determine the effect of varying the air flow through the specimen for a number of different packing densities, but it was found that the variability of the maximum temperatures obtained in different specimens under given conditions was such that considerable replication of tests was necessary in order to obtain significant results. An attempt was therefore made to determine the causes for this variability.

Work on this subject is now suspended and the present note gives an account of the results so far obtained.

Experimental and results

(a) General

The fibre used was Daisee jute (*Corchorus olitorius*) which was cut into lengths of about 1 cm, mixed, and stored in tins.

Two samples of linseed oil were used. One was found to contain 10 per cent of white spirit and was used only in the tests in the steam-jacketed tube (section b).

The specimens of oiled jute were prepared by pouring a weighed quantity of the oil on to a weighed quantity of the jute in a porcelain dish, and mixing by alternate hand kneading and teasing out.

In previous Mackey tests on oiled jute [1] it was found that charring of the specimens was mainly confined to the portion of the specimen below the thermometer bulb. The smaller temperature rise in the neighbourhood of the thermometer was doubtless due to the appreciable thermal capacity of the thermometer. In the present work, therefore, a thermocouple of low thermal capacity was used; it consisted of a copper/constantan couple of 38 S.W.G. wire.

The air supply was obtained from a small aquarium aerator connected to a constant pressure by-pass of about 25 cm head of water, a needle valve, and a calibrated capillary flow gauge.

(b) Tests in steam-jacketed tube

Initially it was decided to study the effect of air flow, on the self-heating of the oiled jute, with the specimen packed in the centre (5 cm) section of a vertical tube of Pyrex 3·0 cm diameter and 30 cm long. The tube was jacketed and heated by steam at atmospheric pressure. The controlled air supply to the specimen was passed first through a preheater in the steam boiler and then into the lower end of the tube. The thermocouple was arranged with one junction inserted for 1-2 mm in the centre of the top surface of the specimen and with the other junction a few millimetres below the lower surface of the specimen.