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THE RELATIVE FIRE HAZARDS OF SODIUM CHLORITE - SODIUM SULPHATE MIXTURES

by

K. N. Palmer

Summary

The fire hazard of sodium chlorite - sodium sulphate mixtures has been investigated; such mixtures are used in an electrolytic process for the preparation of chlorine dioxide for the bleaching of flour. In the experiments the salts were mixed with combustible (sawdust or flour) and formed into small trains, combustion was then initiated by a glowing cigarette end. It was found that the commercial mixture (chlorite:sulphate::1:2) presents a great fire hazard when mixed with a combustible; the hazard remains appreciable even when the proportion of chlorite in the mixture is reduced by half. Strict safety precautions are recommended for industrial premises using mixtures containing sodium chlorite.

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Fire Research Station,
Boreham Wood,
Herts.

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Introduction

This investigation arose from a request by the Fire Offices Committee for information concerning the fire hazards involved in the use of sodium chlorite - sodium sulphate mixtures, in particular a mixture containing 1 part chlorite (NaClO_2) to 2 parts sulphate (Na_2SO_4). This latter mixture is used in an electrolytic process, in aqueous solution, in the production of chlorine dioxide (ClO_2) for the bleaching of flour ⁽¹⁾ ⁽²⁾. As chlorine dioxide is unstable and reactive it cannot be manufactured and transported in bulk but must be prepared immediately before use; for this the sodium chlorite is either electrolysed or decomposed by the action of chlorine:



The chlorine dioxide readily decomposes, with explosive violence, and should always be diluted with air to a partial pressure of 30 mm. Hg or less. ⁽²⁾

A detailed account of the properties of chlorites has been published, together with a description of methods of preparation; ⁽³⁾ a summary of this work is given here. Chlorites are manufactured from chlorine dioxide, which may be produced from the decomposition of a chlorate (such as NaClO_3). The chlorine dioxide is then either absorbed in a peroxide solution:



or is passed over a reducing agent such as carbon, before absorption in alkali, to avoid the formation of uneconomic amounts of chlorate by-product. Commercial grade sodium chlorite always contains both chloride and chlorate as impurity.

The oxidising properties of sodium chlorite have been investigated particularly with regard to its use as a bleaching agent. The chlorite (NaClO_2) is less stable than the chlorate (NaClO_3) but more stable than the hypochlorite (NaClO); thus on heating to 175°C it decomposes:



Sodium chlorite is known to react violently with combustibles such as sulphur and also with acids (yielding chlorine dioxide). However, the reduction in the fire hazard of sodium chlorite caused by the addition of sodium sulphate was not known, and this is the subject of the present investigation.

In the main series of experiments the increase in the rate of combustion of sawdust caused by addition of chlorite-sulphate mixtures was taken as a measure of the fire hazard. A second series of experiments was carried out using plain flour instead of sawdust in order to test the principal conclusions; flour was not suitable for the main series as it did not itself sustain smouldering in still air, owing to decomposition and partial liquefaction caused by the igniting source.

Experimental

Materials The sawdust used in the main series of experiments was of elm, sieved through a 12 B.S. screen; the other experiments were upon ordinary plain flour of small particle size. The sodium chlorite was of commercial grade and was stated to be of 80% purity; the sodium sulphate was of B.P. standard and was anhydrous.

Procedure The finely divided salts were weighed out separately and then well mixed with a weighed amount of combustible. The resulting mixture was then formed into a small train (1.7 cm in depth and 5.1 cm in width) with a metal nozzle, and laid upon an asbestos sheet. Combustion was initiated by placing a glowing cigarette end upon one end of the train, and the time of travel of the combustion zone was then measured over a distance of 10 cm. All experiments were under still air conditions.

Results The main series of experiments was carried out using clean sawdust as combustible, the results are given below in Table 1.

Table 1

The combustion of sawdust trains containing sodium chlorite-sulphate mixtures

Experiment number	Relative weights of			Character of the combustion	Time of travel of combustion zone sec/cm
	sawdust	chlorite	sulphate		
1	1	1	0	Vivid and intense flaming	0.5
2	3	1	0	Intense flaming	2.2
3	3	1	2	Flaming	7.7
4	6	1	5	Smouldering with occasional flashes of flame	192
7	1	1	5	Smouldering with frequent flashes of flame	50
6	1	0	0	Smouldering, no flame	228

Demonstration photographs of experiments 1, 3 and 7, are shown in Plates 1-3.

An additional experiment (number 5) was carried out upon a train composed of equal weights of sawdust and sodium chlorate (NaClO_3), for comparison with Experiment No.1. Intense flaming was again produced, the combustion zone travelling at a rate of 18 sec/cm.

The results of the experiments using flour as combustible are given below in Table 2.

Table 2

The combustion of flour trains containing sodium chlorite-sulphate mixtures

Experiment number	Relative weights of			Character of the combustion	Time of travel of combustion zone sec/cm
	flour	chlorite	sulphate		
8	1	1	0	Vivid and intense flaming	1.0
9	3	1	2	Smouldering with flashes of flame	20
10	1	1	5	Smouldering, no flaming	32

A photograph of experiment 9 is given in Plate 4.

Conclusions

1. The results of the main series of experiments, using sawdust as combustible, showed that the binary mixtures of sawdust and chlorite are very hazardous. The fire hazard of a 1:1 mixture is certainly equal to that of a similar mixture of sawdust and sodium chlorate, and would appear to be considerably greater. The addition of sodium sulphate to the sodium chlorite reduces the violence and speed of combustion of the trains to some extent, but the mixture chlorite : sulphate :: 1:5 (containing only half the amount of chlorite used in practice) still caused the trains to smoulder appreciably faster than sawdust alone. An additional hazard is the production of flashes of flame accompanying the smouldering.

2. The results obtained using flour as combustible were in agreement with those for sawdust.

3. In all the experiments described above combustion was initiated by a glowing cigarette end, the presence of sodium chlorite appeared to increase the ease of initiation. The transition from glowing to flaming combustion occurred spontaneously.

4. The experiments have shown that a 1:2 chlorite-sulphate mixture is very hazardous and that a half strength mixture (chlorite:sulphate::1:5) presents an appreciable hazard. Stringent precautions should, therefore, be taken in industrial premises where these mixtures are to be used. It is highly desirable that facilities for washing down should be made available in such premises and that all possible sources of ignition are excluded.

Acknowledgement Mr. M. D. Perry assisted with the experiments.

References

- | | |
|---------------------------------------|---------------------------------|
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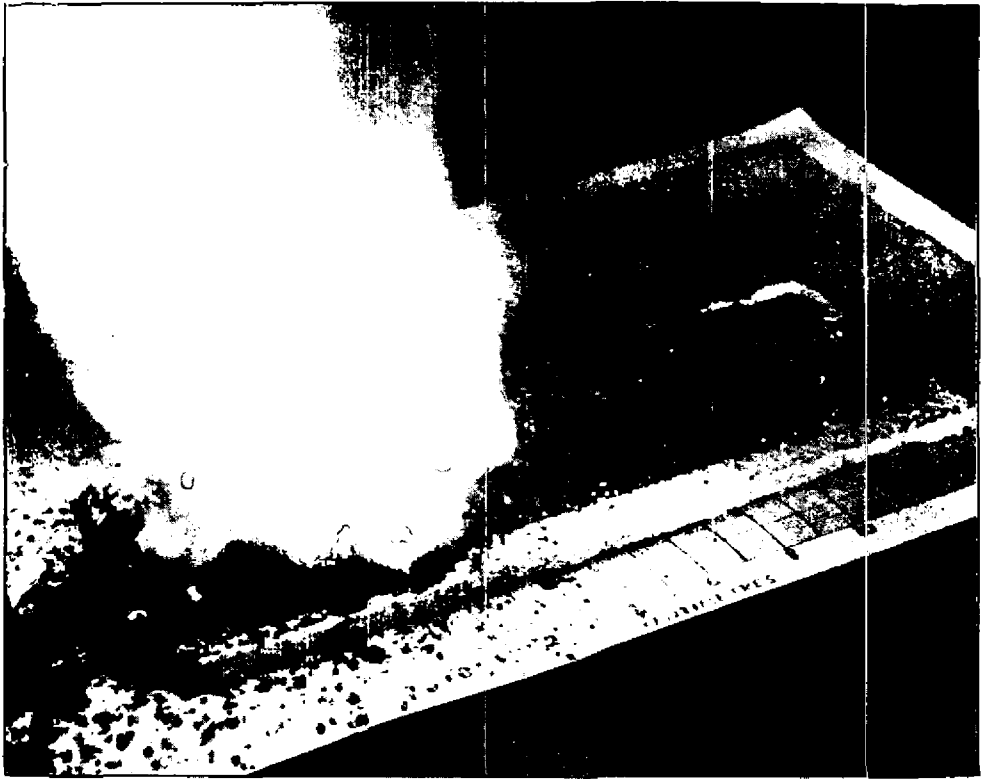


PLATE.1. EQUAL WEIGHTS OF SAWDUST AND
SODIUM CHLORITE

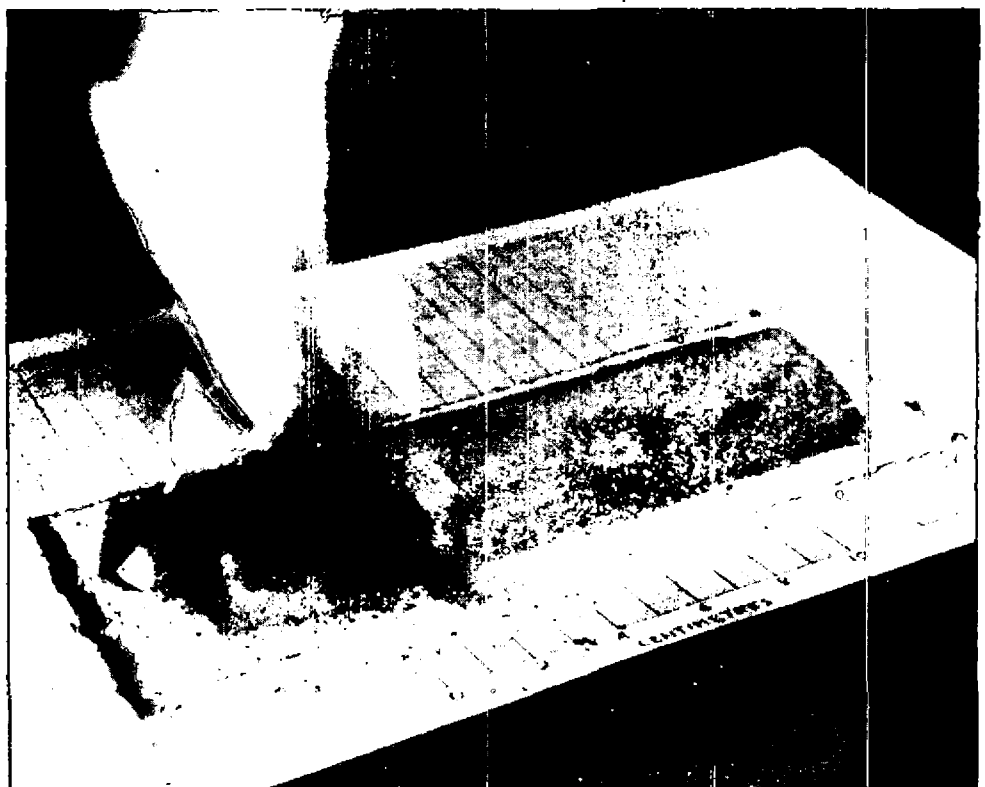


PLATE.2. EQUAL WEIGHTS OF SAWDUST AND
A 1:2 MIXTURE OF SODIUM CHLORITE
AND SODIUM SULPHATE

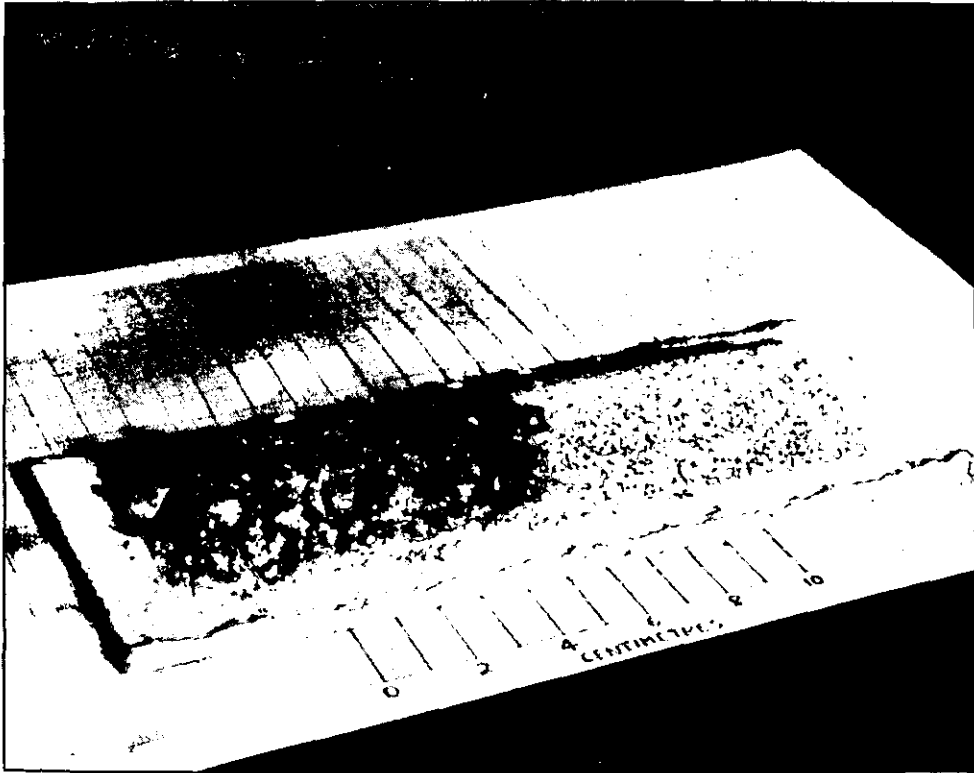


PLATE.3. EQUAL WEIGHTS OF SAWDUST AND 1:5 MIXTURE OF SODIUM CHLORITE AND SODIUM SULPHATE

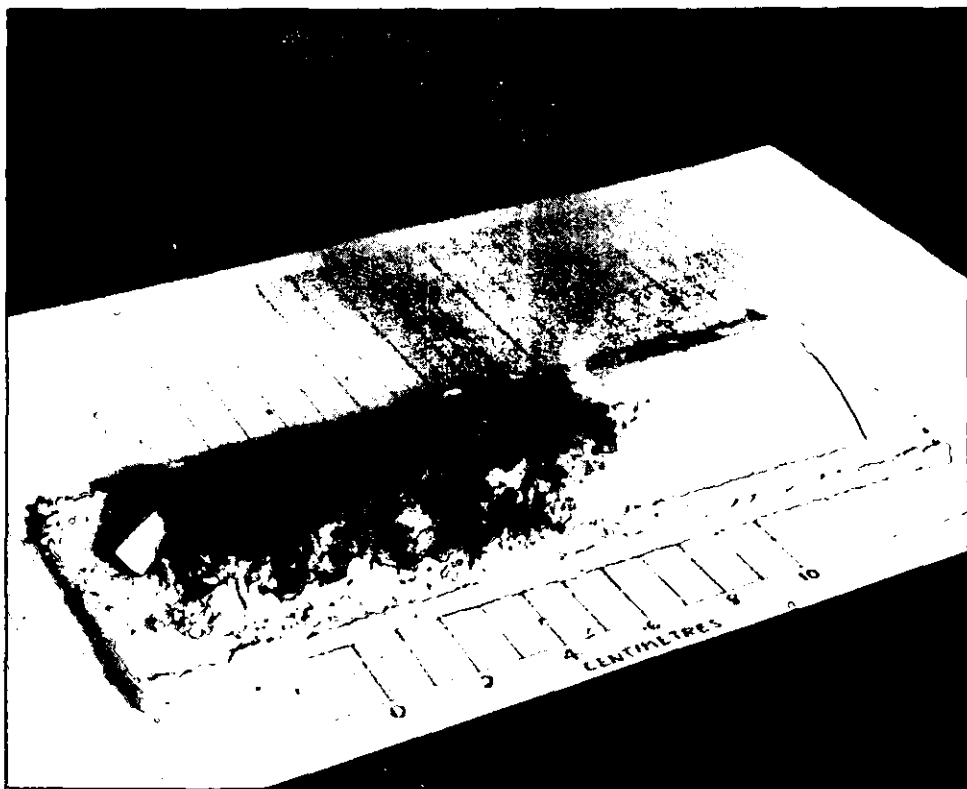


PLATE.4. EQUAL WEIGHTS OF FLOUR AND A 1:2 MIXTURE OF SODIUM CHLORITE AND SODIUM SULPHATE