NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT | **NBS REPORT**

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NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

MECHANISMS OF FIRE IGNITION AND EXTINGUISHMENT

1. SUMMARY

Scaling factors have been determined relating the efficiency of dry powders of varying chemical composition in extinguishing fires of n-heptane in 1-, 6-, and 10-in. and 2-ft diameter containers. The same factors appear to apply equally well to the results on fires up to 13 ft^2 reported by Neill. A mechanism of inhibition based on ionic reactions is outlined and its application to the study of dry powders is discussed.

2. EXTINGUISHMENT BY POWDERS

The consolidation of results into final form, as mentioned in the Fifth Progress Report, showed the necessity for filling in some additional information and it was thought to be desirable to hold up the report for incorporation of results on 2-ft diameter fires. The final report will show that the rate of application of dry powder of a particular chemical composition is almost proportional to the area of the fire. Sodium bicarbonate, potassium bicarbonate, potassium oxalate and potassium iodide were studied, each giving a different efficiency, but all related in very nearly the same way to the area of the test fire. The results of R. R. Neill, Naval Research Laboratory Report 5183, on test fires up to 13 x 13 ft can be plotted on the same curves. The significance of this work is that comparative tests of dry powder extinguishing agents can now be made on small laboratory test fires with some degree of confidence that the results will also apply to full-scale fires.

3. [illegible] REACTIONS

The work on mechanisms of extinguishment started on this project was transferred to an NBS project at the beginning of last fiscal year. A paper has been submitted to the NBS Editorial Committee covering the results of some preliminary studies of ionic processes in flames. Some of the conclusions, without the supporting evidence, are presented here as background for new work to be undertaken on this project. This paper presents evidence that, in a flame, the following three ionic processes are important:

$$\text{Fuel} \xrightarrow{O_2} (\text{ion}^+) + e \quad (1)$$

$$e + O_2 \longrightarrow O_2^- \quad (2)$$

$$O_2^- + (\text{ion}^+) \longrightarrow \text{Products} + O_2 \quad (3)$$

where e = an electron

The indications are that, in lean flames, reaction (1) is rate controlling, while in diffusion and rich flames, reaction (2) and the diffusion of oxygen into the reaction zone are rate controlling. Reaction (3) is rapid under any conditions.

Inhibition can be accomplished, in the proposed mechanism, by interference with any of the three reactions. It is shown that compounds which have a large cross section for capture of electrons of the range of energies found in flames are also effective extinguishing agents. The relationship between the effectiveness of a dry powder and its surface area points to an adsorption phenomenon of some sort. The fact that dry powders emerging from a flame are charged negatively points to adsorption of either electrons or O_2^- ions.

An investigation is being started on this project of the number of charges acquired by dry powder particles and its relationship to chemical constitution. It is also of interest to determine whether the charges are retained more or less permanently, and to find an explanation for the observed fact that powders having low decomposition temperatures seem to be more effective extinguishing agents. This work is not much beyond the planning stage at the present time, but is expected to be actively prosecuted at an early date.