NASA TECH BRIEF

Ames Research Center

Method for Evaluating Effectiveness of Dry Fire-Extinguishing Chemicals

The effectiveness of dry powdered chemicals for extinguishing fires can be evaluated by a method which is based on the observation that the powders cannot put out fires in a pure oxygen atmosphere. The method involves determination of the "oxygen index," that is, the upper limiting ratio of oxygen to oxygen-plus-nitrogen ($O_2/O_2 + N_2$) below which a specific dry chemical is capable of extinguishing a premixed propane-oxygen-nitrogen flame. The apparatus used in the method is a commercially available, powder-deposition type oxy-acetylene torch that has been modified to provide electronically timed operations and more uniform powder flow; the usual torch tips are replaced by a burner head with a pilot flame.

It has been observed that the torch flame can be reproducibly extinguished so long as extinguishment time is limited to about one second. If the flame is not extinguished within the first second after commencing powder injection, then the probability for such occurrence within the next half-second is less than 1 in 10, and within the last ½ second of a 2-second time period about 1 in 100.

Extinguishment data are plotted as oxygen index (O.I.) *vs.* the equivalence ratio (E.R.), which is the stoichiometric ratio of propane to oxygen. As an example, when data for oxygen flow rates are arranged in order of increasing O.I. *vs.* extinguishment success, it is found that a definite yes-no cutoff for 1-second extinguishment occurs in the case of sodium bicarbonate at O.I. = 0.33 and E.R. ≒ 2.8 in one run, at O.I. = 0.36 and E.R. = 2.8 in a second run, and O.I. = 0.39 and E.R. = 3.6 in a third run. In other words, extinguishment in one second or less always takes place with O.I. $<0.36 \pm 0.03$, and never seems to occur for O.I. >0.39. The examination of many data points indicates that this O.I. extinguishment limit is relatively insensitive to equivalence ratio. Also noted is that the oxygen flow rate must exceed 3300 cc/min for extinguishment success; rates up to 4500 cc/min (experimental limit) were used in the determinations.

Potassium bicarbonate is rated about twice as effective as sodium bicarbonate by Underwriter's Laboratories on the basis of pan-fire extinguishment tests. Qualitative agreement with this rating was obtained for several commercial products containing potassium bicarbonate, i.e., O.I. = 0.49, 0.49, and 0.47 *vs.* 0.36. Other dry chemicals which are reportedly superior to potassium bicarbonate (containing phosphate, nitroprusside, cryolite) were found to be little different than sodium bicarbonate; chromate-containing powders are apparently slightly more effective than sodium bicarbonate.

Note:

Requests for further information may be directed to:

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Reference: TSP 75-10027

Patent status:

NASA has decided not to apply for a patent.

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