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Flame Retardant Paint Treatment of Some Tropical Timbers

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Abstract: Two different paints, emulsion and gloss, were treated with borax. Application of different concentrations of the paints on wood splint of Owen and Gmelina showed that retardancy increases with increase in concentration. This was observed by the effect on flame propagation rate (FPR), after-glow time (AGT) and ignition time (IT). It was observed that wood splint of Owen for both emulsion and gloss paint gave slower flame propagation rate and ignition time than those of Gmelina but for after-glow time, it was less with emulsion paint than that of gloss. Attempts were made to explain these observations.

Key words: Borax · Flame retardant · Timber · AGT · FPR and IT

INTRODUCTION

Man's concern with the hazards associated with combustibility of cellulosic materials e.g. wood, textile etc has continued since the discovery and utilization of fire. Huge damages due to fire had been recorded and this has lead to continue research for materials which when incorporated into these combustible materials could reduce or suppress the ease of ignition and flame propagation [1-4]. This prompted the emergency of flame retardants which are very important because of numerous devastating effects fire has on our everyday life [5]. Fire safety is an integral part of fire precaution, which have the objective of minimizing the number of damages from fire, by measures hindering their initiation and limiting their propagation [6]. Flame retardants are used in cellulosic, plastic materials etc because they increase the resistance to ignition and once ignition occurs, they slow down the rate of flame spread. FR materials resist ignition for a longer period, take more time to burn and generate less heat compared to the unmodified material [7]. The effectiveness of this depends upon dilution and/ or modification of the pyrolysis product to low or non-flammable gases that reduce the oxygen-fuel gas ratio [1].

MATERIALS AND METHODS

Experimenta: The paints, emulsion and gloss used for this study were procured from the Citizens Paint Industry, Awka, Anambra State. Borax ($Na_2B_4O_7.10H_2O$) was obtained from BDH, Poole, England while Owen and Gmelina were procured from Timber Market and identified by Botany Department.

The timbers were cut into splints of uniform sizes of length 60cm, width 0.8cm and thickness 0.4cm and were oven dried for 2 hrs at 120°C.

Flame retardant paint was prepared by mixing each 80.0cm^3 of white emulsion paint with varying concentrations (0.0, 0.10, 0.20, 0.50, 1.00, 3.00 and 5.00) g of borax. The mixture was stirred thoroughly for even distribution. Each concentration was used to evenly coat three splints. These were allowed to dry for 2 weeks at room temperature. The same method was employed for the gloss paint.

Methods

The Painted Wood Splints Were Characterized By

- Determination of ignition time: The method applied was as in [8], i.e., by bringing the ignition source (flame from a cigarette lighter) in contact with

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the base of the wood splint and noting the time interval between this contact and onset of combustion.

- Determination of flame propagation rate (FPR).

The method adopted was according to [9]. The vertically clamped coated sample was ignited at the base with a cigarette lighter. The distance travelled by the char front and time taken were recorded. The same method was repeated for other splints.

FPR (cm/sec) = Distance travelled by the char front / time taken

- Determination of after-glow time: The after-glow time was recorded as the time between flames out and last visible, perceptible glow. For each FR concentration, two painted splints were investigated and the average taken.

RESULTS AND DISCUSSION

The burning process involves heating of a material to a temperature high enough to drive off flammable vapour (pyrolysis). When the rate of vapour evolution in presence of O_2 becomes high enough to generate flammable mixture, ignition occurs. The use of flame retardant chemical may inhibit the rate of pyrolysis generation. If this happens, ignition time is increased.

In Fig. 1, it is observed that as the concentration of the retardant in the paint increased from 0.00-5.0g, the ignition time increased for both emulsion and gloss painted wood splints. The ignition time of Owen was observed to be higher than that of Gmelina in the two treated paints and the FR was more effective for the emulsion paint-treated sample. The observation in this work that emulsion painted wood responded better than gloss treated one could be due to combination (synergistic) effect of the FR and water. Furthermore, it is observed that the FR effect is more noticeable at the lower concentrations and tended to even out at higher FR levels.

The flame propagation rate result shown in Fig. 2 indicates that as the concentration of borax increases, the flame speed is hindered for both emulsion and gloss splints. For the emulsion painted splints, Owen gave least FPR value while Gmelina indicated highest FPR for gloss treated splints. Splints coated with gloss are more flammable. These observations are explained in the manner that borax on heating decomposes and release water of crystallization which dilutes the effective concentration of volatile combustible pyrolysate in the optimum pyrolysate oxygen concentration necessary for ignition and sustenance of burning. This is in agreement with the results obtained in [10, 11]. The reaction is shown below.

$$Na_2B_4O_7.10H_2O \xrightarrow{\text{Heat}} Na_2B_4O_7 + 5H_2O$$

$$Na_2B_4O_7.5H_2O \xrightarrow{\text{Heat}} Na2B_4O_7 + 5H_2O$$

Fig. 3 is clear evidence that as the concentration of the retardant increases, the after-glow time decreased for both gloss and emulsion. Glow as a surface oxidative process which depends on the concentration of char after combustion. Samples that have long AGT are susceptible to rekindle after fire has been put out. Thus, reduction in AGT is a major advantage in a fire situation.

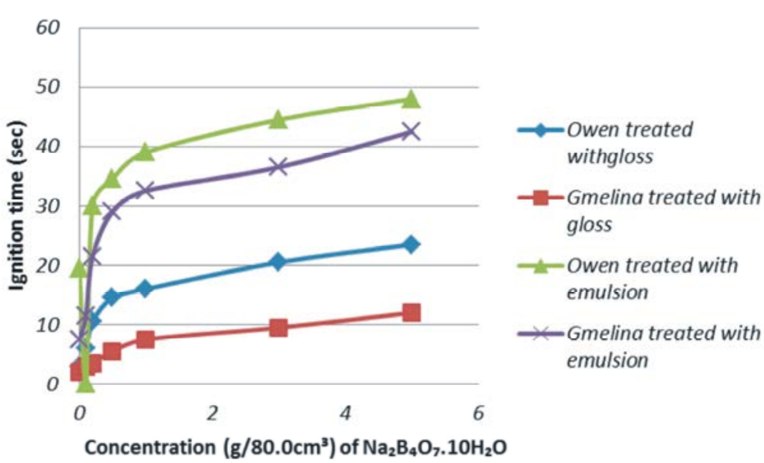

Fig. 1: Effect of borax flame retardant on the ignition time of treated wood splints.

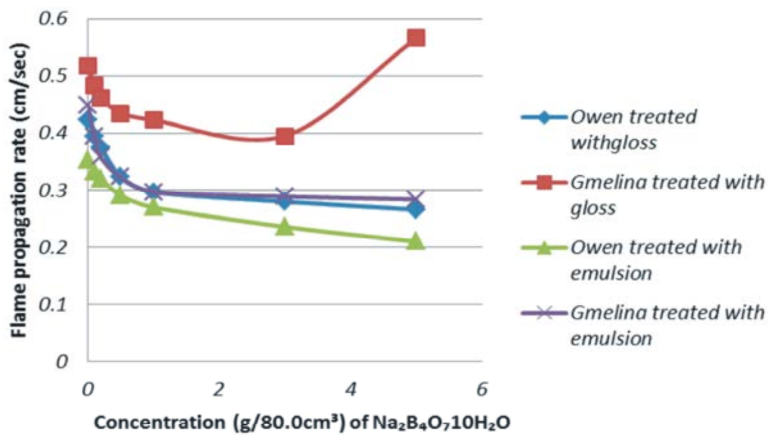

Fig. 2: Effect of borax flame retardant on flame propagation rate of treated wood splints.

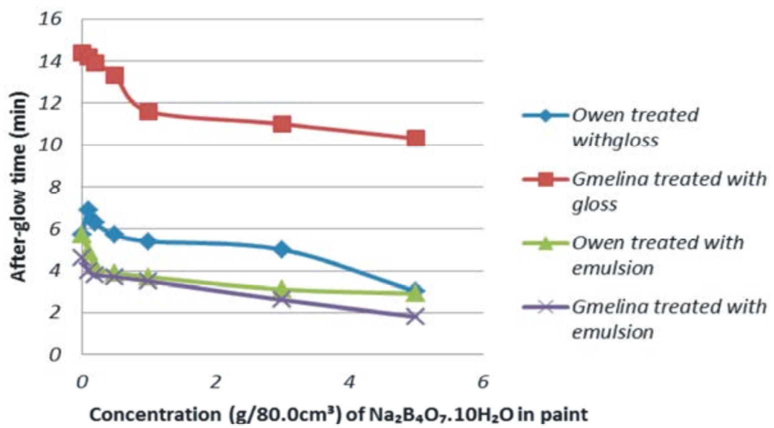

Fig. 3: Effect of borax flame retardant on the after-glow time of treated wood splints.

CONCLUSION

The FR used lowered the ignitability of the coated wood splints and thus inhibited the combustion process, limiting the amount of heat released. The FPR and AGT of both emulsion and gloss coated wood splints decreased with increases in concentration of the retardant. On the other hand ignition time was raised.

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