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ASSESSMENT OF AMMONIUM CHLORIDE AND BORAX AS FIRE RETARDANTS FOR FIBROCELLULOSIC MATERIALS

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ABSTRACT

This paper presents the result of the effect of inoculating printing papers with Flame Retardants (Ammonium chloride and Borax) properties of the papers were lowered and that the retardants reacted by free radical and condensed phase mechanisms respectively. The study is geared towards using locally produced industrials to combat the environmental fire disasters whose consequences have been displeasing.

INTRODUCTION

Man has always been plagued by unwanted fire whose effect have been very disastrous. As such, it is inevitable that he sought ways to reduce the combustibility of his environment (Garba 1995). The importance of printing paper to man is unquestionable. Printing papers in forms of Calendars, Certificates, Files, Newsprints, Cardboards and Duplicating sheets are very variable to man. It is therefore quite rationale to investigate the possible use of flame retardants compounds on it is it way to decrease its readiness to burn and hence he destroyed.

Generally, Flame Retardant polymer means that some changes have been made in a polymer system so that it passes one or more of at least a hundred different flammability tests. These tests are normally designed to minimize, if not to eliminate the fire risk associated with the use of a polymer in some specific applications. Incorporation of halogenated compounds

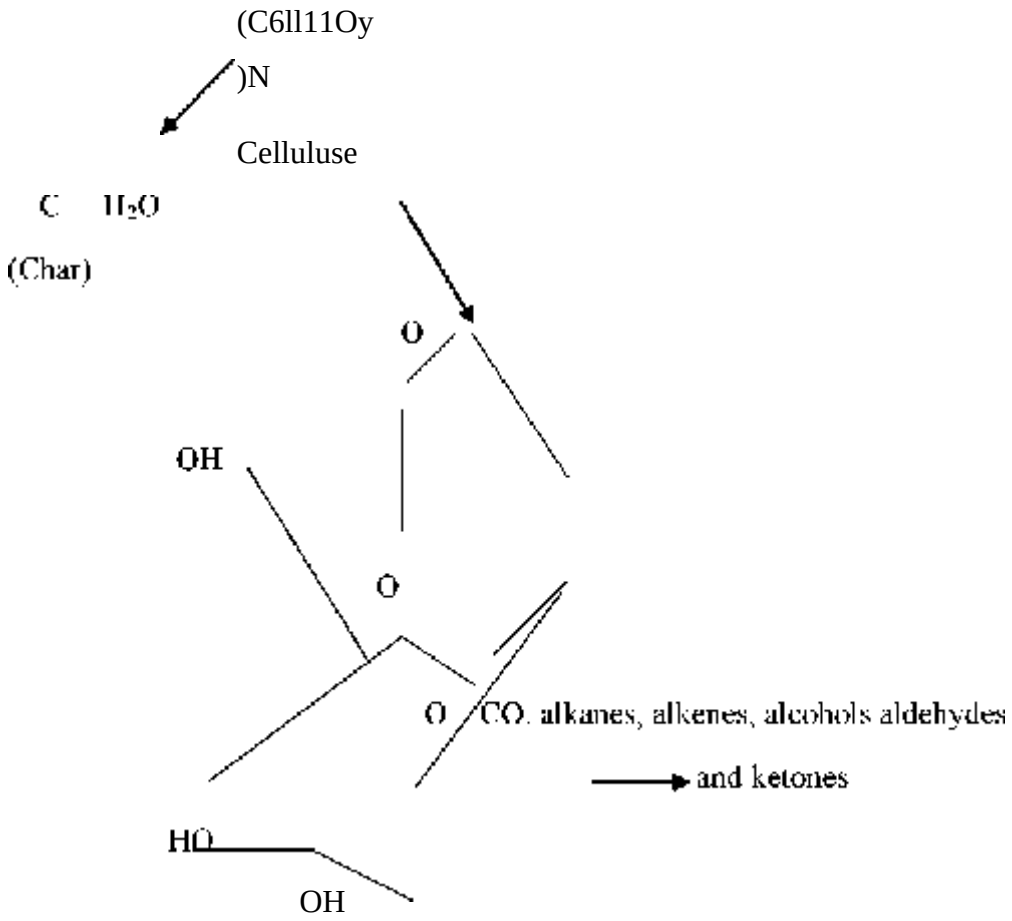
$Na_2O.2B_2O_3.\ I0H_2O$ $.Na_;O\ 2B_2O_3\ \ 5H_2O$

$> Na_2O\ 2B_2O_3\ 4H_2O$ $-Na_2O\ 2B_2O_1$.....(1)

into the polymer matrix is one of the most common approaches used to modify the burning properties of polymers hence the choice of ammonium chloride in this research work. Borax also has some flame retardant properties due to its ability to release its water of crystallization during burning. The gaseous water dilutes the effective concentration of the volatile combustible pyrolysates in the flame zone, which results in the inhibition of optimum pyrolysates.

Calcine

Cellulose, the major constituent of printing papers is believed to pyrolyse via two possible routes (Eboatu, et al, 1992



This work set to examine the possible ways through which the disturbing but unavoidable loss of valuable documents (inform of printing papers and other Cellulosic materials) to fire can be reduced to the bearest minimum, if not totally eliminated. It also sets to justify the statement that, the cost of material treatment with flame retardant element is cheaper than that involve in the repairs or replacement of the materials destroyed by fire.

FLAMMABILITY TESTS

With the aim of the work in mind four (4) different flammability tests were conducted on the substrates. These were:-

Add -on (%) -This refers to the weight in percent of flame retardant materials imbibed by the printing papers (Shet and Yabani, 1981)

Add on (%) = wt after treatment - wt before treatment

Wt before treatment

After Glow Time -This refers to the time in seconds between flame-out and the last visual glow

Flame Propagation Rate -This is the distance travelled in centimeters at a stipulated time interval by the fire when the sample was held vertically at room temperature and ignited (Eboatu et al, 1990)

Ignition Time -This is the time interval in seconds between striking of the lighten (Match stick) and a visual perceptible flame on the sample (Shet and Yabani 1981).

EXPERIMENTAL

Materials

Six (6) different types of printing papers were obtained from Pollyson C and Company in Sokoto, Sokoto State, Nigeria Characteristics of the papers used in this research work are presented in Table 1 below

S\No	Type of paper	Dimension (CM)	Weight (g)	Thickness (M)	P (Density) g\m^1	Designation
1	Calendar	2 x 15	3 2	0.005	23.3	A
2	Newsprint	2 x 15	1 2	0.003	10.9	B
3	File paper	2 x 15	1 8	0.025	26.2	C
4	Duplicating pape4r	2 x 15	2 3	0.001	19.2	D
5	Academic Certificate	2 x 15	7 0	0.020	10.2	E
6	Birth Certificate	2 x 15	6 5	0.022	10.0	F

The table above shows the Characteristics of Printing Papers used for the study

Ammonium Chloride and Borax were procured from BDH, Poole, England.

For each of these chemical compounds concentrations **(**g/dm^3) of 0,20,40,60 and 80 were prepared for the purpose of the work.

Methods

Flame Retardant Treatment

Different concentrations (**(**g/dm^3) of the two Flame Retardant Compounds (Borax and Ammonium Chloride) were made. Weighed Printing papers (Substrates) as presented in table

1, were immersed completely in them. The residence time was 24 hours. (Bashiru 1992) on removal, they were dried at room temperature and finally cured in an air oven at 1030C for 15 minutes. The samples were then conditioned at the same temperature for 24 hours and re-weighed.

MEASUREMENTS AFTER TREATMENT

Add - on (%). After Glow time, Flame preparation rate and ignition time tests were conducted on the sample materials as described by Shet and Yabani (1981).

RESULT AND DISCUSSION

The results of the study indicate that the thermal characteristics of the papers have been altered. This is not only because the quantity of the flame retardant concentration differs but also on the different specific gravity of the materials. As expected the least compact paper (the News print) has the highest add on (%) whereas the most compact one (Calendar paper) has the least.

In all the cases there were reasonable reductions in the Flame Propagation Rates (cm sec^2) for all the substrates. This is so because as the quantity of the Flame Retardant Compound increases the Flame Propagation Rate decreases.

The effect of our investigation on Ignition Time (sec) increases directly with increase in concentration of the Flame Retardant Compounds in both cases.

Glow, which is a heterogeneous oxidative surface reaction depends on the amount of burnt material and availability of oxygen. The result also indicates that treatment with these Flame Retardant Compounds decreases the Afterglow time (in sec) for all the substrates.

It is generally agreed that the combustion of gaseous fuel is a high temperature process, which proceeds via a free radical Mechanism (Garba et al 1995). The overall reaction is shown thus:

Fuel + O2 ------- ► CO + H2O + heat + light - (1)

This involves a great variety of discrete reactions, which can be of the type

Mir 4- CCi **CM 1 IT** (2)

CALJ -I- T> r'LJ CO2 + H (3)

OH + RCHI RCH2 1 H2 O (4)

RCH2 + O_2 ---------- ► RCHO + OH

OH + O2 ----------► H + O (5)

Halogenated compounds of which ammonium chloride is one have been shown to enter into

flame chemistry via a series of reactions (Eboatu et al 1990)

$NH_4CI + OH$ ---------- ► $NH_4OH + CI$ (6)

NH4CI + O ---------- ► OH + CI (7)

NH4CI + H ---------- ► H + CI (8)

NH4CI + RCH2 ---------- ► RCH1 + CI (9)

NH4CI ---------- ► $NH_4 + CI$ (10)

In the radical trap theory of flame inhibition, it is true that equations 6 - 10 effectively compare with equation 2 - 5 for those radical species that are critical for the propagation of oh and of theory showing down the rate of energy production land resulting in the extinction of the flame.

The Flame Retardant property of Borax is due to its ability to decompose on heating thereby releasing is water of crystallization and the spongy dehydrate borax as shown below

Na2O 2B2O3 1OH2O(s) 5H2O(s) Na2O 2B2O1 5H2O1 H2O(s) \a<) 4H2O1
k
Na2O 2B2O3

There gaseous water so produced dilutes the required concentration of the volatile combustible pyrolysates in the flame zone, thereby inhibiting the attainment of the optimum pyrolysate oxygen concentration necessary for both ignition and sustenance of burning.

In addition, the spongy dehydrated borax product (Na2 2H2O3) forms an impervious envelop/layer on the pyrolysing substrate which seriously prevents the escape of the small molecules that feed the flame zone. It also reacts which the hydroxyl groups of the substrate to generate additional water and inorganic char which does not ignite readily.

CONCLUSION

Deductions and observations made from the results of the study indicate that flame propagation rate and afterglow time were decreased while ignition time and activation energy of pyrolysis were enhanced, thereby lowering the flammability of the printing papers.

It can therefore the conclusively said that both Borax and Ammonium Chloride are good flame-retardant compounds for our printing papers. Hence, these compounds are recommended for use in paper and other Cellulosic industries.

RECOMMENDATIONS

1. Both Ammonium chloride and Borax have outstanding flame retardants properties.
2. Both Ammonium chloride and Borax are very good Flame Retardants for Fibrocellulosic materials
3. Both Chemicals could be use additives in various industries using Fibrocellulosic materials as Flame Retardants additives.
4. More researches on the Flame Retardancy of both elements and compounds for enhance safety of both man and his environment.

REFERENCES

Amanfo, I And Eboatu A. N. (1991), "Effect of Alum treatment on the Mechanical

properties of some Nigerian Timbers" . *Journal of Applied Polymer Science*, 23,2

Bashir, G. (1992), "The possible use of superphosphate fertilizer as flame retardant formulation on some Cellulosic materials. An unpublished M.Sc Thesis, submitted to Department of Chemistry, University of Jos, Nigeria.

Eboatu A. N. (1992) "Fire, Flammability and fire fighting, *Achor Educ. Press* New York.

Eboatu A. N. Abdulrahman, F. W. Garba B and Altine, M. (1990), Studies on the thermal characteristic of some tropical Timbers, Paper presented at the 31st Annual *Conference of Science Association of Nigeria*, 1990, Akure, Nigeria.

Garba, B. Zuru A. A. and Hassan L. G. (1995), "Effect of Flame Retardant treatment on the thermal characteristics of some lignocellulosic materials International Journal of Polymeric Materials 29. P 139 - 145.

Garba B., Abdulrahman, F. W. and Obaseki, M. E. (1995). Effect of some Halogenated Flame Retardants on the thermal characteristics of selected Tropic Construction Materials. *Journal of thermal Analysis*. 21, P5 - 21

Shet, R. T. and A. M. Yabani (1981). "Reaction of Formaldehyde and Demethylol Urea with unmodified and modified cellulose" - *Textile Research Journal, Vol, 51 (10)* 621 - 622