

## Evaluation of Colemanite against Wood-Destroying Insects

Aparna Kalawate<sup>1</sup> and K.Ch. Varadarajulu<sup>2\*</sup>

<sup>1</sup> Scientist, Zoological Survey of India, Western Regional Centre, Pune (M.S.), India.

<sup>2</sup> Scientist, Indian Plywood Industries Research and Training Institute, Bangalore (KA), India.

\*Corresponding Author's Email: varadaraju6@gmail.com

### ARTICLE INFO

#### Article history:

Received 29 Apr. 2014

Accepted 22 May 2014

Available online 24 May 2014

#### Keywords:

Colemanite,  
wood,  
preservation,  
borer,  
Termite.

### ABSTRACT

Colemanite is hydrated calcium borate hydroxide and a borate mineral found in evaporate deposits of alkaline lacustrine environments. It is a secondary mineral that forms by alternation of borax and ulexite. As this chemical is less toxic to human beings and other organisms, it was chosen to assess its efficacy against various wood destroying insects. Colemanite at 1% concentration is the lethal dose found in the present investigation to make plywood free from wood destroying insects. In India, this is the first report where colemanite is used in the preservation of plywood.

© 2014 International Journal of Advanced Research in Science and Technology (IJARST).

All rights reserved.

### Introduction:

Wood and wood-based panel products are susceptible to damage from various wood destroying organisms like fungus, borers and termites. This poses a lot of social and economic problems as additional labour and expenses is required to replace the damaged wood. To protect the wood and wood based panel products they are being treated with some wood preservative chemicals. An ideal type of wood preservative chemical should be highly toxic to fungi and insects and less toxic to living beings. Some toxic chemicals, used for wood preservation contain serious pollution risk to the environment. Also, high cost of procurement often contributed to their low level of adoption of preservative treatment in developing countries, like India.

Recently, great interest has been focused on wood preservatives that are relatively cost-effective and have minimal toxicity to mammals and the environment. The commonly used wood preservative chemicals in India are Deltamethrin, Lindane, Sodium-tri and pentachlorophenol, Chlorpyrifos, Boric acid etc., as a glue line poison. Glue line poisoning is the method of treating the panel products wherein, the active ingredient is added to the glue mix during manufacture of the products. Chlorinated phenols are banned in India and elsewhere in the world. Chlorpyrifos has been banned in Australia, China and Japan as a wood preservative for the control of termites. Moreover, synthetic pyrethroids e.g. Deltamethrin,

Lambda-cyhalothrin and Permethrin have been found to be unstable when used under high pH conditions.

Hence, in the present investigation less toxic chemical i.e. Colemanite was tested against some wood destroying insects. Colemanite is a natural Calcium Borate mineral. Calcium Borate is considered to have a low impact on the environment with low mammalian toxicity resulting in relatively safe use end disposal. Colemanite is used as the raw material in the boric acid production. It is one of the most important boron minerals in the world. Colemanite is stable under conditions of high pH and elevated temperature, bonds strongly to the wood and is significantly very less water soluble. The basic structure of colemanite contains endless chains of interlocking  $\text{BO}_2(\text{OH})$  triangles and  $\text{BO}_3(\text{OH})$  tetrahedrons with calcium, water molecules and extra hydroxides interspersed between the chains (Chuck Brown, 2000). Colemanite does not have any environmental health problems and does not instigate pollutants when the treated product is burnt. As the solubility of Colemanite in water is very less (Solubility in Water at 20 °C: Insignificant 0.16 g/100 ml) it has resistance to leaching from the treated wood. It has an ability to withstand high temperature and can be used as a fire retardant chemical also. The  $\text{LD}_{50}$  (Lethal Dose) of Colemanite in rats is more than 5000 mg/kg (Holding 2003). Hence based on toxicological data, Colemanite is less toxic to the human being. By keeping in mind all the above stated advantages of Colemanite, the present investigation was taken up to assess its bioefficacy against wood destroying

organisms. In India this is the first report on the utilization of Colemanite in the field of wood preservation.

### Material and Methods:

#### Test Pesticide/ Chemical:

The pesticide chemical was procured from Borochemie (India) pvt. Ltd. Mumbai (M.S.), India.

#### Physical Properties of Colemanite

**Appearance** : Grounded, light grey to tan stones granulate (80% -75 micron or 80% - 45 micron)

**Appearance** : Light grey to tan stones granulate (3-125 mm)

**pH** : 9.1

**Boiling point** : Not applicable

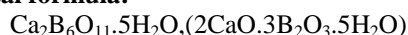
**Freezing point** : Not applicable.

**Melting point** : 986°C

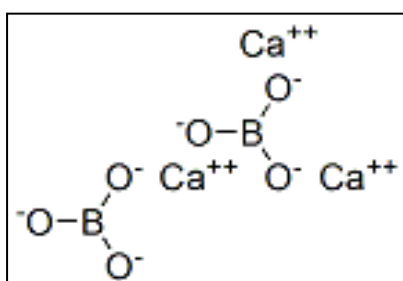
**Bulk density** : 1460-1520 kg/m<sup>3</sup>

**Density** : 2400 kg/m<sup>3</sup>

#### Chemical formula:



**Molecular weight:** 411.084



**Fig: 2.1 Molecular structure of Colemanite.**  
(Source: Anonymous 2013)

#### Glue line treatment of plywood:

Three concentration levels viz., 1, 2 and 3% of Colemanite respectively were mixed with liquid PF resin (48% solid content) as glue additive on the weight of liquid PF resin. Untreated Control samples were also prepared in which preservative chemical was not added in glue. Laboratory scale plywood of 4 mm thickness was prepared by using rubber wood for three ply construction. The glue core veneers were brush coated

with the above mentioned adhesive. Open assembly time of 1 ½ to 2 hours to attain moisture content of 12 – 14% were given. The veneers were then assembled and loaded into the hot press. The assembly was hot pressed at a temperature of 145 ± 5°C with a specific pressure of 14 – 16 kg/cm<sup>2</sup>. Curing time of thickness + 3 minutes was employed. The hot pressed panel was downloaded and stacked for about 24 – 48 hours for stabilisation. The panels were then dimensioned to required size for further evaluation.

#### Bond quality:

Cyclic test was carried out for the samples of size 12.5x12.5 cm as per IS: 848 (Anonymous 2006) for BWP grade plywood. The samples were subjected for cyclic boiled dry test. Each cycle consists of immersion in boiling water for 8 hours and then allowed to dry at 65 ± 2 °C for 16 hours. This process was repeated for six cycles as per IS: 848 (Anonymous 2006). Thereafter, knife test was done by forcibly separating the plies. The results are presented in Table No 1.

#### Bioefficacy study

##### Powder post beetle resistance test:

The study was undertaken as per IS: 4873 Part 2 (Anonymous 2008). Adults of the powder post beetle i.e., *Lyctus africanus* were used for the test which were obtained from the laboratory cultures. Samples were cut into test samples of size 10 cm x 4 cm. Six replications were used in each treatment. The treated along with untreated control samples were kept with material infested with powder post beetles (*Lyctus africanus*) in culture tubs. Monthly observations were made and recorded, covering a total exposure period of 18 months. Results are presented in Table 2.

##### Termite resistance test:

Toxicity test was performed according to IS:4833 (Anonymous, 1993). Treated and untreated plywood samples were randomly installed in test yard. Twelve replications were made for each treatment with control stakes in rows at test yard. Termite activity and percentage of damage to the test panels were recorded at the intervals of three months. Observations were made covering a total exposure period of 12 months. Specimens were reinstalled in their respective positions after each inspection. Results are presented in Table 3.

#### Results and Discussion:

The results for bond quality test are given in Table 1. All the tested concentration of Colemanite treated samples did not get delaminated after boiling test. Hence, Colemanite has not affected the bond quality of the plywood.

Results of toxicity test for borer exposure periods of 6, 12 and 18 months are presented in the Table 2. The results of borer tests indicated that borer holes appeared within six months of exposure in the untreated control samples. The samples treated with Colemanite at all the concentration level resisted the attack from *Lyctus africanus*. So, the lower dosage i.e. 1% would be appropriate to treat the plywood to make it resistant against *Lyctus africanus*.

The results of toxicity test for termite of the tested preservative chemical are presented Table 3. During the study period of 12 months the treated samples at all levels of concentration were free from the attack of subterranean termite. While in control samples, within six months of exposure period the attack of subterranean termite was observed. Hence, the lethal dose at 1% is sufficient to make the plywood resistant against termites.

As this is the first report on efficacy study of colemanite against wood destroying insects there is no available data to compare the findings of this study. As colemanite is a member of boric acid family it is less toxic to the living beings.

On the basis of results of the present investigation, it can be concluded that Colemanite at 1% has provided effective control of wood destroying borer and termite. Hence, Colemanite at 1% concentration is the lethal dose to be considered while making a plywood resistant to the wood destroying insects. The additional benefit of using Colemanite is the lack of any adverse effect on environment. Also, Colemanite is very economical as compared to Borax and Boric acid. The present market rate of Colemanite is Rs. 31 per kg whereas, for Borax it is Rs. 54 per kg and Rs. 91 per kg for Boric acid. Hence, Colemanite can be recommended as an economical and less toxic wood preservative chemical.

**Table: 1. Bond quality of plywood**

Test	Criteria for conformity Clauses 4 and 7.3.2 of IS: 848-2006	Result		
		1%	2%	3%
BWP GRADE (Boiling Water Proof) Six cycles : Each cycle consisting of 8 hours boiling in water and thereafter drying at 65 ± 20C for 16 hours	No separation of plies at the edges and/or surface at the end of six cycles.  On forcible separation of plies with knife, wood failure shall be predominant and shall be more than 75% for excellent bond and not less than 50% for pass standard. For less than 50% wood failure, the specimen shall be considered as failed.	No separation of plies at the edges and/or surface at the end of six cycles.  On forcible separation of plies with knife, 50% wood failure  Pass Standard	No separation of plies at the edges and/or surface at the end of six cycles.  On forcible separation of plies with knife, 50% wood failure  Pass Standard	No separation of plies at the edges and/or surface at the end of six cycles.  On forcible separation of plies with knife, 50% wood failure  Pass Standard

**Table: 2. Efficacy of Colemanite against Powder post beetle**

Chemical Concentration (%)	Borer attack		
	6 months	12 months	18 months
1	No exit hole appear	No exit hole appear	No exit hole appear
2	No exit hole appear	No exit hole appear	No exit hole appear
3	No exit hole appear	No exit hole appear	No exit hole appear
control	Exit hole appeared	Exit hole appeared	Severe attack

**Table: 3. Efficacy of Colemanite against termite**

Chemical Concentration (%)	Termite Damage (%)	
	6 months	12 months
1	0	0
2	0	0
3	0	0
Control	40	100

**References:**

1. Anonymous 2008 IS: 4873 Part 2. Methods of laboratory testing of Wood preservatives against fungi and Borers (powder post beetles) determination of threshold values of Wood preservatives against borers (powder post beetles) (second revision). Bureau of Indian Standards, New Delhi.
2. Anonymous (1993) IS 4833. Methods for field testing of Wood Preservatives in wood (First revision). Bureau of Indian Standards. New Delhi.
3. Anonymous 2006. IS: 848. Specification for synthetic resin adhesives for making plywood (phenolic and amino plastics). Bureau of Indian Standards, New Delhi.
4. Anonymous 2000 Chuck Brown, "Minerals-n-More", 2000 URL: [http://www.minerals-n-more.com/Colemanite\\_Info.html](http://www.minerals-n-more.com/Colemanite_Info.html). Accessed on 12.01.2014
5. Anonymous 2013 Calcium borate. <http://www.lookchem.com/Calcium-Borate>
6. Holding AS (2003) Health and safety data sheet. Research and development department Istanbul. <http://www.etimineusa.com/files/ground-colemanite.doc>