

Tests on the Toxicity of Borate Concentrated Solution Wood Preservative

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Abstract Tests on toxicity of SGB borate concentrated solution wood preservative to termites, fungi and mammals were conducted. The results showed that SGB preservative treated timber had high resistance to termite or decay and its acute oral toxicity belonged to low grade. SGB is an environmentally sound preservative and can be used in non-pressure treating.

Keyword borate concentrating solution wood preservative toxicity

Recently, study on wood preservatives are mostly focused on those with vacuum/pressure process treatment at home and abroad, such as CCA used broadly in China, and new generation of preservatives like ACQ, CuAz, CuN8, and so on. Vacuum/pressure process which not only has a high production efficiency, but also facilitate industrial production needs large equipment, and it makes strict demands on tree species and reagent. It isn't appropriate when wood is difficult to penetrate, or requested low protection effect, or contains high moisture content under special condition. Brushing, the simplest method of wood preservative treatment till now, is large-scale used in many occasions due to its simplicity and shortcut. Now, the preservative in non-pressure treating, in general, consists of BP mixture, organophosphate, parathyroid, quaternary ammonium salt and boron preservative. BP mixture containing pentachlorophenol is banned. The application of organ preservatives will be limited due to their high price, single-spectrum and low solubility. Boron preservative has been paid a great attention owing to their advantages such as low price, high permeability, colorless, odorless, high resistance to insects and fungi. Boride preservative solution with low boron content isn't fitted for brushing at present. In order to meet domestic needs, recently authors started to develop SGB borate concentration solution as wood preservative (called SGB preservative in the following). The laboratory tests on the toxicity of the preservative to termites, fungi, and mammals have been carried out and the results were reported as follows:

1. Test materials and Methods

1.1 Preparation of SGB preservative

The SGB preservative is a self-made Borate concentrated solution, its basic physical and chemical properties were presented in Table 1

Table 1 physical and chemical properties of SGB

Main properties	Index
Boron content(%) (according to boracic acid)	42.4%
Specific gravity (25.2°C)	1.296
Color	light yellow

PH	7-8
Solubility in water	mixable with water
Viscosity	slightly sticky

1.2 Toxicity test on termite

1.2.1 Test materials

Wood sample: *Pinus massoniana* Lamb, dimension: 25×25×6mm³

Termite: *Coptotermes formosanus*

Reagent: A series of diluted solutions of SGB preservative were prepared by mixing SGB preservative with water in a dilution ratio of 1:1, 1:2, 1:3, 1:4 and 1:5 (m/m), respectively.

1.2.2 Test methods

The experiments were carried out by following the method introduced in American's standard AWPA EI-97, 《Standard Method for Laboratory Evaluation to Determine Resistance to Subterranean Termites》. Wood samples were treated with preservative by brush treatment.

1.3 Toxicity test on fungus

1.3.1 Test materials

Wood sample: (*Eucalyptus urophylla*) sap wood, dimension: 20×20×10mm³

Fungus: *Coriolus versicolor*

Reagent: A series of diluted water solutions of SGB preservative were prepared, the concentration of SGB in these solution included 0.125%, 0.25%, 0.5%, 1.0% and 2.0%, respectively.

1.3.2 Test methods

The test was done by following the method introduced in Chinese Standard LY/T 1283-1998, 《Standard Method for Laboratory Evaluation to Determine Resistance to decay fungus》.

1.4 Toxicity test on mammal

1.4.1 Test materials

Mammal: SPF grade SD mice were supplied by Medical Experimental Animal Center of Guangdong Province, healthy and weighing 180-220g, totaled 10 mice including 5 males and 5 females, and randomized grouping test.

1.4.2 Test methods

The test was carried out by following the method introduced in Chinese Standard GB15670-1995, 《Toxicological Testing Methods for Pesticide Registration》. After being fasted (not cut-off water) for 12h, the animals were given test substance with a dose of 10ml/kg body weight by gavage and observed for 14d.

2. Results and discussion

2.1 Toxicity test on termite

The results of termite feeding can be seen in Table 2. At the end of experiments, Termite Resistance Grade of control wood was zero, and most of the wood structures were damaged. With the decrease of Proportion of SGB in diluted solution, retention of SGB and B₂O₃ content in treated wood decreased accordingly. When wood samples measuring 25mm×25mm×6mm were brushed with a mixture of SGB to water (1:1,

mass ratio), preservative retention may attained 75.55Kg/m^3 and the B_2O_3 content can reached 16.62 Kg/m^3 . All the treated wood samples caused a significant decrease in termites' feeding than the control ones, wood treated with SGB at a dilution ratio of 1:1 and 1:2 (w/w) were strongly resistant to termite and their termite resistance grade is Grade No.10, i.e. no termite feeding on these treated wood at all. Other wood treated with 3 different diluted solutions of SGB in water (1:3, 1:4, 1:5), were not very resistant to termites, and fed and damaged by termites more or less, their termite grade is Grade No.7.

Table2 The resistance of wood treated with SGB solutions to termite

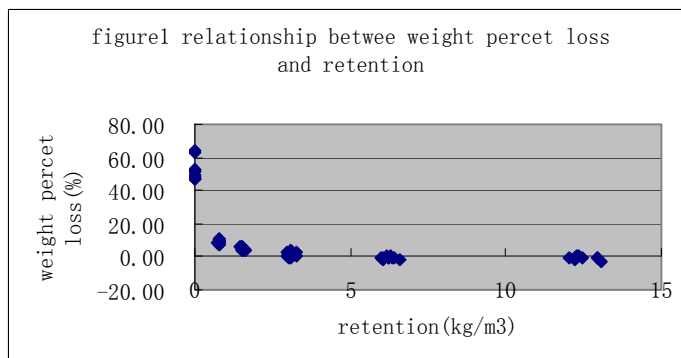
SGB: water (mass ratio)	Retention (Kg/m^3)	B_2O_3 content(Kg/m^3)	Termite resistance grade
1:1	75.55	16.62	10
1:2	57.93	12.74	10
1:3	34.84	7.67	7
1:4	23.72	5.22	7
1:5	22.13	4.87	7
0:1	0	0	0

According to a Chinese Industry Standard LY1636-2005 《Classification and Requirements of Preservative-Treated Wood》, 4.5 Kg/m^3 B_2O_3 content in treated wood and C2 (indoor, resist termite) were recommended. In this experiment, B_2O_3 content used for treatment of wood were all above 4.5 Kg/m^3 , therefore, the treated wood was highly resistant to termites. B_2O_3 content in SGB can reach above 22%, so adequate retention in wood could be obtained easily when brushing treatment is applied.

2.2 Toxicity tests on fungus

It can be seen from figure 1 the weight loss of the control wood is 52%, while the weight loss of all SGB treated wood is less than 10%, and the result indicated that SGB preservative could enhance the resistance of wood to fungus. It can be seen also from figure 1 that the retention level of treated wood increased with the increasing concentration of SGB water solution, but the weight loss decreased accordingly. when wood was treated with 0.5% SGB water Solution, at a retention level below 3.119Kg/m^3 , the weight loss was still less than 3%. So lethal dose of SGB preservative to fungus is retention level 3.119Kg/m^3 .

With SGB retention level of 3.119Kg/m^3 , BAE value lower than BAE value 0.3% of data record which can resist fungus is 0.235%.



Lethal concentration of SGB to fungus is far lower than it to termite, and therefore wood treated with non-pressure treating of SGB preservative could be enhanced their resistance to fungus greatly.

2.3 Toxicity tests on mammal

The results of acute oral toxic tests on mammal were listed in Table 3. It can be seen from Table 3 that the animal appeared spiritless and less activity after being exposure to SGB for 5 hours and still spiritless 4d later while the male was lost weight. The hart rate of the animal was approximately normal 7days later and all the tested animals survived at dose of 5050mg/kg of SGB fed after 14 days, the end of the test. According to Chinese national standard GB15760-1995 《Acute oral toxicity of pesticide classification standards》, if a dose of more than 5,000mg/kg was applied in acute oral toxic tests and none of animals was dead, then it is not necessary to try to use a higher dose any more. The dose of SGB used in this acute oral test on SD mice are higher than 5050 mg/kg and did not cause death of the animal, so the acute oral toxicity of SGB is belonged to low grade according to standard GB15760-1995.

This study demonstrated SGB has high toxicity to termite and fungus, but its toxicity on mammal is very low. Borate, the major toxic component in SGB, its toxicity is less than salt's according to data, therefore, SGB is an environmentally sound preservative and harmless for human and animal.

Table 3 Rat body weight changed after being exposure to SGB preservative

Dose (mg/kg)	sex	0d weight	4d weight	7d weight	14d weight	14d Death number
5050	female	211.8 ± 6.4 (5)	216.4 ± 12.1 (5)	219.8 ± 13.4 (5)	235.6 ± 13.4 (5)	0
	male	205.0 ± 5.4 (5)	192.2 ± 20.0 (5)	192.4 ± 17.0 (5)	217.4 ± 10.6 (5)	0

3. Conclusion

- (1) When wood were brushed with a mixture of SGB preservative and water (1:1 and 1:2, mass ratio respectively), it is very resistant to termites.
- (2) Wood treated with SGB preservative at a retention level more than 3.119 Kg/m³ by non-pressure treating could be highly resistant to decay fungi.
- (3) Acute oral toxicity of SGB wood preservative to mammal is belonged to low grade.
- (4) SGB preservative used by non-pressure treating is an environmentally sound preservative.