Threshold Values for Wood Preservatives

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Fence Posts, utility poles and other wood products used in contact with the ground, give extended service life when they have been chemically treated with wood-preserving compounds. Such wood which has withstood the destructive attacks of fungi and insects for up to 15 to 25 years or more, does not suddenly fail overnight because of the whim of ever present fungi. Failure due to decay or insects starts because the natural toxicity of the wood or the original preservative concentration has been changed or reduced to a point just below that of retention, defined as the "threshold concentration".

A number of methods have been used in the laboratory to determine the relative efficacy of chemical compounds for inhibiting and destroying fungi which attack wood (1, 2). Since its introduction (3) the soil block technique has been used by many investigators (4, 5, 6) for determining the "threshold concentration" of individual compounds. Threshold concentration is defined as "The minimum chemical amount impregnated into a block of wood which will completely inhibit the attack of specific fungus organism on that block of wood under the specified test conditions". It has been determined on untreated sapwood, usually Southern Pine, under ideal growth conditions for the fungi. This laboratory technique has been recognized by the American Society for Testing Materials and described as Standard D1413.

Baechler and Roth (7) have reported on the individual threshold concentrations of both sodium borate by the soil-block technique. Similar tests conducted in our laboratory have generally confirmed their results. Table 1 shows a comparison of the threshold values of these two chemical preservatives against several common fungi.

Table 1. -- THRESHOLD CONCENTRATIONS OF SODIUM FLUORIDE AND SODIUM BORATE (ASTM D 1413 PROCEDURE)

		Lbs./cu. ft.	
Fungi		**NaF**	**$Na_2B_4O_7$**
Lentiunus lepideus	(Madison 534)	0.12 - 0.15	0.05 - 0.07
Coniofera putena	(Madison 515)	0.15 - 0.17	0.05 - 0.07
Poria monticola	(Madison 698)	0.18 - 0.20	0.05 - 0.07
Polyporus versicolor	(Madison 697)*	0.84 - 1.41	0.11 - 0.18
Lentiles frabea	(Madison 617)*	0.16 - 0.19	0.08 - 0.12

For preservative treatment of new wood, results from the soil-block technique have been applied by Lumsden (8) to physical mixtures of creosote and pentachlorophenol. This work has shown that such a mixture was more effective over wider range of fungi at a lower concentration than either preservative individually.

In the evaluation of supplementary groundline preservation of old utility poles, this threshold concentration has often been assumed as the *minimum* amount of a reinforcing chemical preservative which must be added to an existing standing pole, whether it be creosoted, such as pine, or of natural durablility, such as western redcedar. This assumption is not believed to be valid for several reasons. To restore effective protection to such wood, it was postulated that it would not be necessary to add, as a supplementary treatment, a secondary chemical preservative in the entire amount defined as the threshold concentration or retention for that chemical. On the contrary, it should only be necessary to add a sufficient minimum of the new material to raise the already existing residual toxicity to the threshold retention for the combined chemical preservatives. This assumption, of course, is based on laboratory values. In actual use, the retentions required in commercially treated poles are much higher than the threshold values. For practical purposes, therefore, it would be advisable to go somewhat above the minimum threshold to allow for some future decrease within a desirable life extension.

Laboratory work was undertaken to test the validity of these theories and assumptions and to relate them in a quantitative manner to the commonly used wood preserving chemicals, sodium fluoride and sodium borate. To simulate conditions which may be found in actual field conditions, in creosoted southern pine utility poles for example, this work was carried out in three steps.

First, two regular commercial grades of AWPA Grade 1 creosote were seperately subjected to the soil-block testing technique, including standard weathering cycles. In both cases the threshold retention was approximately 4.85 pounds per cubic foot. At a retention of 2.0 pounds, both creosotes lost 12 to 14 percent by weight as compared to 21.5 percent for untreated controls using *fungus Lentinus lepideus* (Madison 534).

Secondly, a large group of blocks were treated to a retention of 2.0 pounds per cubic foot with one of these creosotes. These blocks were subjected to the standard weathering cycle described in ASTM D 1413.

Finally, following drying and conditioning, these blocks were then subdivided into groups and each vacuum-treated with water solutions of varying concentrations of sodium flouride or sodium borate to obtain graduated retentions of dry salts. This procedure is intended to simulate the supplementary groundline treatment of a pine utility pole possessing a below threshold concentration of creosote. In actual practice, 2.0 pounds of creosote is substantially less than that usually in below-ground portions of southern then redried and reconditioned prior to subjecting them to the decay fungi *Lentinus lepideus* (Madison 534) in the soil-block bottles for 84 days. Figure 1 graphically shows the results of these tests by comparing weight loss of the 2.0 pounds per cubic foot creosoted blocks containg sodium fluoride or sodium borate in various retentions.

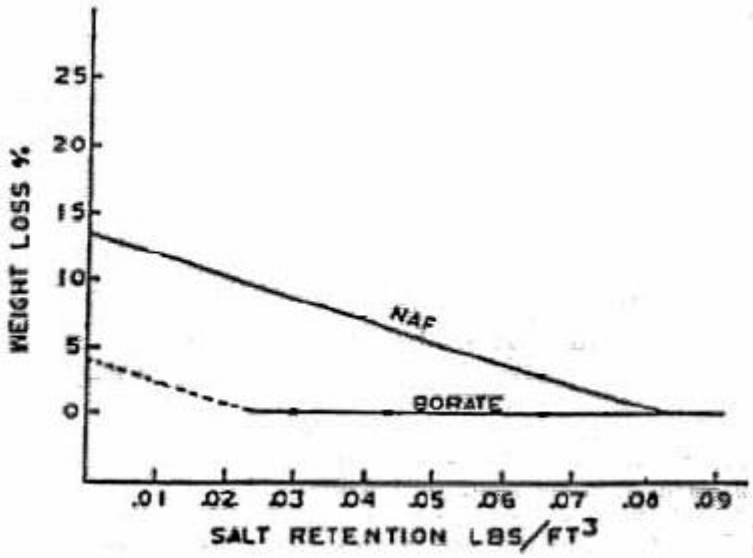

Figure 1. -- Threshold determinations of sodium fluoride and sodium borate for *Lentinus lepideus* in pine blocks containing sub-threshold creosote retentions of 2.0 pounds per cubic foot.

The results of this series of tests prove that the threshold concentrations of these inorganic chemicals (table 2) as determined individually in the soil-block test are not required in order to protect creosoted pine sapwood containing less than one-half of the minimun threshold concentration of creosote. Specifically, these results show that amounts equivalent to only about one-half the standard threshold values of these inorganic salts are required to protect creosoed pine sapwood containing sub-threshold retentions of creosote. The threshold concentrations of sodium fluoride and sodium borate in creosoted wood (2.0 pounds per cubic foot) according to the ASTM D 1413 procedure, using the fungus *Lentinus lepideus* (Madison 534) are shown in Table 2.

Table 2. -- Threshold Concentrations In Creosoted Wood

	Lbs./cu. ft.	
Fungi	**NaF**	**$Na_2B_4O_7$**
Lentinus lepideus	0.08-0.09	over 0.01--under 0.03

The consistently superior performance of sodium borate over sodium fluoride in effectively controlling fungi at lower retentions in these tests on untreated wood as well as at subthreshold concentrations of creosote, prompted further investigation of sodium borate. Additional literature review further confirmed this superiority covering a wider range of fungi and by other standardized methods of laboratory testing (9, 10).

Conclusions

Two important conclusions can be derived from these tests. First, total threshold concentrations of supplementary preservative chemicals, as determined by Standard ASTM D 1413 soil-block techniques on untreated wood, are not required for protection when supplementing sub-threshold retentions of creosote. Secondly, sodium borate is superior to sodium fluoride as a wood preserving chemical for use as a water-borne salt preservative in a supplementary treatment for previously creosoted wood in the below-ground area. These conclusions are based on laboratory tests, and additional data should be obtained in field tests to substantiate laboratory findings.

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