

# Borates in wood protection

## Introduction

Wood protection solutions for today's engineered wood and timber products must meet a wide range of demands depending on regional environmental conditions and regulatory requirements. For almost 100 years, U.S. Borax refined borates have been used to protect solid wood and engineered wood products against biological degradation and fire risks.

U.S. Borax products designed for wood preservation:

- *Borogard*® ZB
- *Tim-bor*® Industrial

And, we offer the following products for fire retardancy:

- *Firebrake*® ZB
- *Polybor*®
- *Optibor*®

## Why borates for wood protection?

Borates are inorganic, non-volatile compounds with proven efficacy against all major wood-destroying organisms. Their unique chemistry provides protection while preserving wood's structural integrity and sustainability profile.

Key benefits of borate-based preservatives:

- Broad-spectrum protection against termites, beetles, and decay fungi
- Low mammalian toxicity and a favorable environmental profile
- No corrosion of fasteners
- No negative impact on mechanical properties
- A long history of use backed by extensive laboratory and field data
- The dual functionality of durability and fire resistance

## Mode of action

Borates act through a biostatic mechanism—disrupting enzyme systems and energy metabolism in fungi and insects. This prevents growth and reproduction, rather than relying on acute toxicity, enabling long-term protection at low loading levels.

Two protection mechanisms are used depending on product and application:

1. Diffusive protection in solid wood (borates migrate with moisture)
2. In-matrix protection in engineered wood products (borates locked into the composite structure)

## Application versatility

Depending on exposure and substrate, borates can be used in:

- Solid wood framing and structural timber
- Oriented strand board (OSB)
- Engineered wood (LSL, PSL and LVL)
- Plywood
- Fiberboard (MDF) and particleboard
- Wood-plastic composites

This versatility makes borates a preferred solution for above-ground and protected construction systems worldwide.

### Borogard ZB: Durable protection for engineered wood products

Borogard ZB is an insoluble zinc borate specifically developed for engineered wood products (EWP) where aqueous treatments are not possible.

Performance advantages:

- Low water solubility → high leach resistance
- Uniform distribution when added during blending
- Thermal stability up to 290 °C (compatible with EWP processing)
- Proven efficacy against termites and decay fungi
- No negative effects on mechanical performance

Borogard ZB has more than 30 years of commercial use and extensive lab and field data demonstrating long-term durability, including 10-year, ground-contact field trials in high-hazard environments.

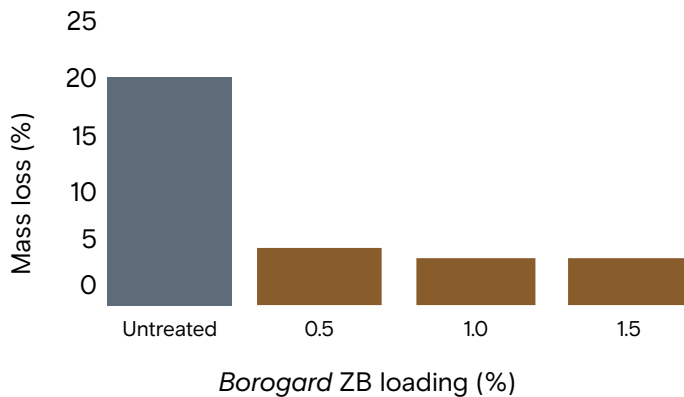


Borogard ZB (1%)

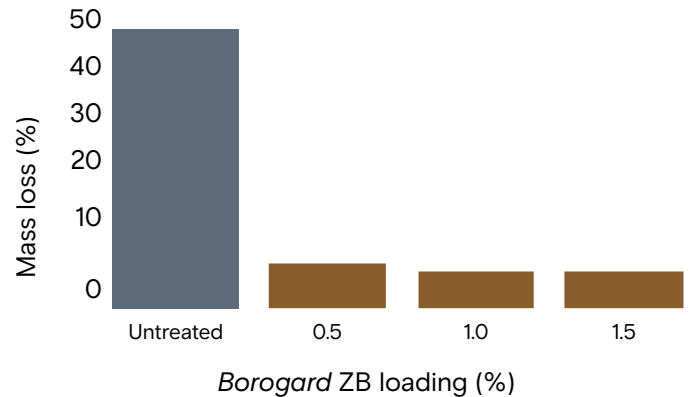


Untreated

#### Formosan subterranean termite test mass loss



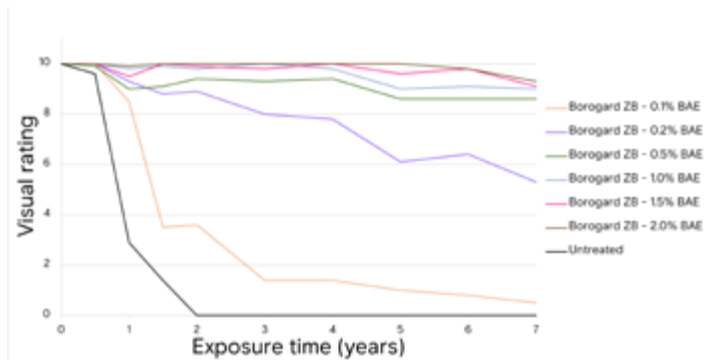
#### Brown rot fungal decay test mass loss



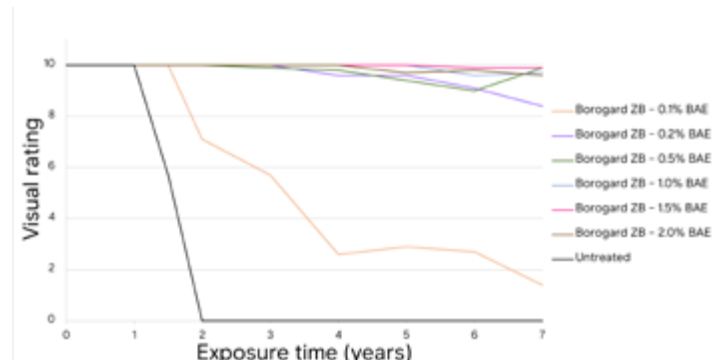
Termite test AWPA E1 after 4 weeks exposure to *Coptotermes formosanus*. Aspen OSB untreated vs treated with Borogard ZB.

Fungal decay test AWPA E10 after 12 weeks exposure to *Gloeophyllum trabeum*. Aspen OSB untreated vs treated with Borogard ZB.

#### Field test: Termite damage



#### Field test: Fungal decay



Fungal decay and termite evaluation after 7 years exposure in Hawaii in outdoor, above ground, protected conditions according to AWPA E21. Untreated OSB vs Borogard ZB treated OSB.

### *Tim-bor* Industrial: Diffusive protection for solid wood

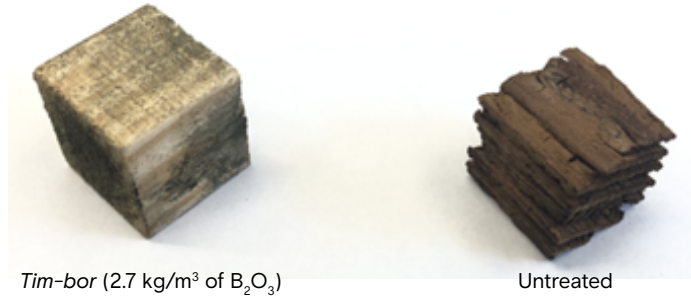
*Tim-bor* Industrial (disodium octaborate tetrahydrate, DOT) is a highly-soluble, borate wood preservative designed for solid wood applications where deep diffusion and complete penetration are required.

Key features include:

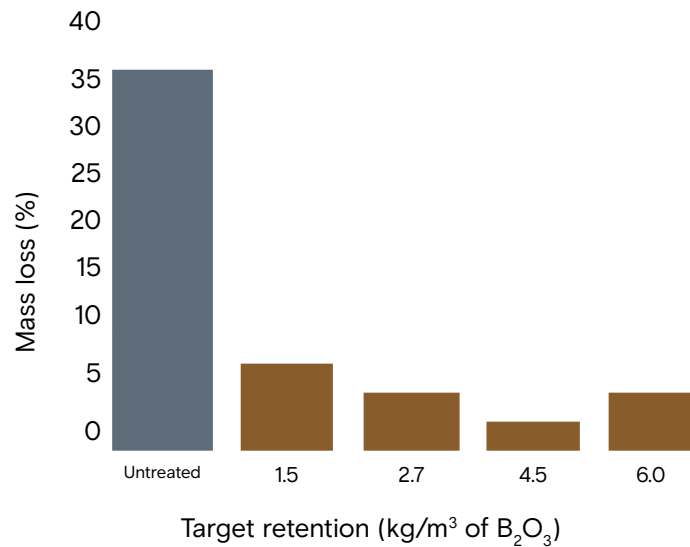
- Rapid diffusion throughout wood cross-section
- Protection against termites, beetles, and decay fungi
- Compatible with dip-diffusion and pressure treatment
- Non-corrosive and odorless

- Ideal for framing, sill plates, trusses, and interior structural members
- Provides effective fire retardancy and smoke suppression

*Tim-bor* Industrial has been used for decades in residential, commercial, and institutional buildings—delivering reliable protection where moisture-driven diffusion can occur.

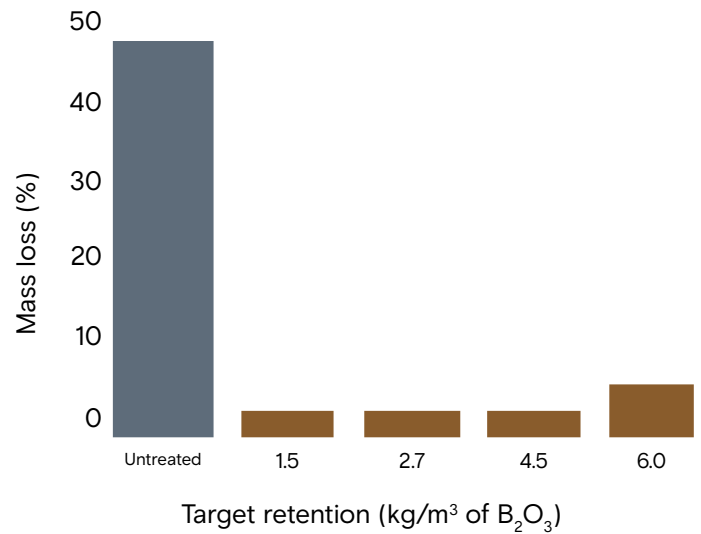


### Formosan subterranean termite test mass loss



Termite test AWPA E1 after 4 weeks exposure to *Coptotermes formosanus*. Southern Pine untreated vs treated with *Tim-bor*.



### Brown rot fungal decay test mass loss



Fungal decay test AWPA E10 after 12 weeks exposure to *Gloeophyllum trabeum*. Southern Pine untreated vs treated with *Tim-bor*.

# TECHNICAL BULLETIN

## Borates in wood protection

Property	 Borogard® ZB	 Tim-bor®
Chemical type	Zinc borate ( $2\text{ZnO} \cdot 3\text{B}_2\text{O}_3 \cdot 3.5\text{H}_2\text{O}$ )	Sodium borate ( $\text{Na}_2\text{B}_4\text{O}_7 \cdot 4\text{H}_2\text{O}$ )
Water solubility	Low	High
Protection mechanism	In matrix preservative	Diffusive preservative
Leach resistance	High	Moderate
Fire performance	Flame spread and smoke reduction	Flame spread and smoke reduction
Typical substrates	Wood composites	Solid wood
Processing method	Additive during blending	Pressure treatment, dip diffusion, or spray

### Fire retardancy and smoke suppression

Borate compounds—including boric acid, borax, zinc borate, and disodium octaborate tetrahydrate (DOT)—have a long history of use as fire retardants in wood.

#### How borates improve fire performance

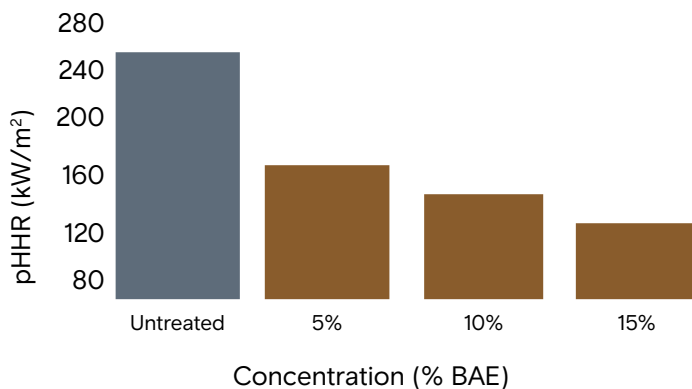
Borates enhance fire safety through multiple, well documented mechanisms in wood:

- Promotion of char formation, creating a protective carbonaceous layer that insulates the substrate
- Catalyzed dehydration of cellulose and hemicellulose, reducing the generation of flammable volatiles

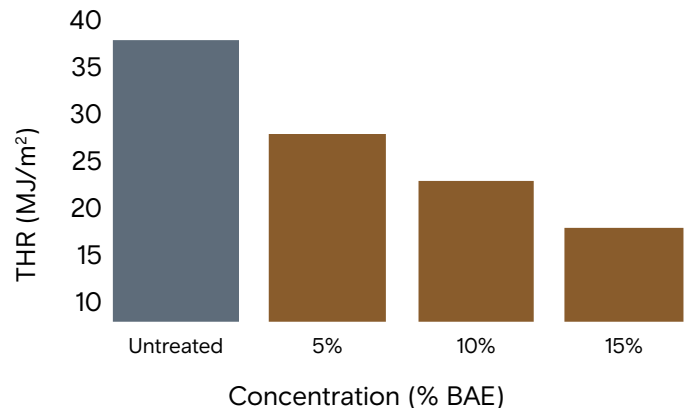
- Formation of a glass-like (vitreous) surface layer, limiting oxygen diffusion
- Reduction in flame spread, heat release rate, and smoke production

These mechanisms interrupt the combustion cycle by acting on the fuel and heat components of fire development.

#### Peak heat release rate (pHHR)



#### Total heat release rate (HHR)



Mass loss cone calorimeter (ISO 13927). Pine untreated vs pressure treated with borates at various solution concentrations.

#### About U.S. Borax

U.S. Borax, part of Rio Tinto, is a global leader in the supply and science of borates—naturally-occurring minerals containing boron and other elements. We are 1,000 people serving our customers with more than 1,200 delivery locations globally. We supply around 30% of the world's need for refined borates from our world-class mine in Boron, California, about 100 miles northeast of Los Angeles.

#### About 20 Mule Team products

U.S. Borax produces the 20 Mule Team® borates family of products from naturally occurring minerals and have an excellent reputation for purity and safety when used as directed. Borates are key ingredients in a number of industrial applications including fiberglass, glass, ceramics, batteries and capacitors, wood preservatives, and flame retardants.

High quality, high reliability, high performance borate products. It's what we're known for.



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