

## BORATE REMEDIAL TREATMENT

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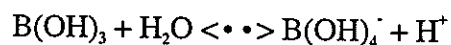
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### Summary

Boric acid has been used in traditional medicine as a home remedy against slight inflammations, for preservation of food and for extermination of ants. Boracol 20/2 BD is a modern boron product used for prevention and control of fungal decay in wood. Boracol 10/2 BD is used as a disinfectant against molds and algae. Boron remedies are able to diffuse into wood and penetrate it even when superficially applied, e.g. on wooden facades and on windows. Under moist conditions IMPEL™ rods inserted into wood will act as a depot which continually supplies the wood with boric acid, e.g. in railroad sleepers and telephone poles.

### Boron chemistry

Boron is an element which lies as number five in the periodical system with a molecular weight of 10.8 and with the valency of 3 towards oxygen. Boron is found everywhere in the soil surface in small quantities and belongs to the micronutrients which are essential to both plants and animals. In large quantities boron is found as borax ( $\text{Na}_2\text{B}_4\text{O}_7$ ). In watery solution boron occurs as a Lewis acid accepting  $\text{OH}^-$ .



For practical application the concentrated anhydride di-sodium octaborate tetrahydrate [ $\text{Na}_2\text{B}_8\text{O}_{13} \cdot 4(\text{H}_2\text{O})$ ] is often used. When 7 molecules of water is added to the latter, 8 molecules of boric acid is produced. Boric acid reacts easily with alcohols liberating water and thus forming an ester. This process goes on with Boracol 20/2 BD, which is di-sodium octaborate tetrahydrate dissolved or partly esterised in the alcohol monopropylene glycol.

### The effect of boric acid

In traditional medicine boric acid ( $\text{H}_3\text{BO}_3$ ) was used for washing eyes and cleaning wounds, since it is antiseptic to bacteria and fungi. For the same reason it has been used to preserve cosmetics and perishables such as pickled herring and caviar. In the markets of the Mediterranean boric acid solutions are often used to spray on meat which is often directly exposed to the sun and therefore soon goes bad. An old household remedy recommends a mixture of boric acid and honey to kill ants. The mixture is placed along the ant trails from where it is picked up by the ants and brought home to feed the larvae, which subsequently die.

Boracol 20/2 BD™ is a modern version of the traditional medicine and household remedies, which combines boric acid and Bardac™, a benzalconium chloride compound.

### **The effect of boric acid on fungi**

The toxicity of boron towards wood decaying fungi was shown by Baechler in 1937 in an experiment with fence posts (Baechler, 1937). Later the Forest Products Research Laboratories at Princes Risborough, England, Madison, USA and New Zealand also showed the toxicity of boron towards wood decaying fungi and sapstain fungi. It was recently shown by J.D. Lloyd that boron influences the metabolism by interaction of the borate anion with polyols and the oxidized coenzymes  $\text{NAD}^+$ ,  $\text{NMN}^+$  and  $\text{NADP}^+$ .

Boric acid is effective against sapstain fungi, such as *Alternaria* and *Aureobasidium* at a concentration of 2 kilograms per cubic metre wood. In basidiomycetes such as *Gloeophyllum* and *Coniophora* it is effective at 0.3-0.8 kilograms per cubic metre wood (Lloyd, 1993).

### **The effect of boric acid on insects**

Cummins showed that boric acid is effective against the powder post beetle, while Spiller showed its restraining effect on *Anobium punctatum* and *Hylotrupes bajulus* (Cummins, 1936; Spiller, 1952 & 1956). The biological effect of boric acid on termites was shown in a laboratory test by McNulty and Wilkinson to affect the intestinal protozoa which are responsible for the breakdown of cellulose in the gut (McNulty & Wilkinson, 1958). The termites are dependant on these protozoa. Mansikkamäki & Vihavainen showed that boric acid also works as a contact poison on termites where the cuticle that covers the insect is disrupted and it dries up and dies (Mansikkamäki & Vihavainen, 1980). Boric acid remedies are effective against woodboring insects at different concentrations, e.g. 0.3 kilograms per cubic metre for *Anobium punctatum*, 0.7 kilograms per cubic metre for *Hylotrupes bajulus* and 6 kilograms per cubic metre for Formosan termites (Lloyd, 1993).

### **Toxicity of boric acid to humans**

Di-Sodium octaborate tetrahydrate has an oral  $\text{LD}_{50}$  in male rats of 2500 mg/kg, and a dermal  $\text{LD}_{50}$  in rabbits of more than 2000 mg/kg (Anonymous, 1997). Boracol 20/2 BD which is produced in Canada and contains di-Sodium octaborate tetrahydrate dissolved in monopropylene glycol and Bardac has a  $\text{LD}_{50}$  in male rats of more than 12,000 mg/kg. For comparison pentachlor phenole has a  $\text{LD}_{50}$  of 125 mg/kg.

### **Dosage of boric acid**

Boric acid remedies are approved by the DIN 68-800 standard for prevention of fungi in wood at a concentration of 1 kilogram boric acid per cubic metre wood, while the UK-EN 599/x1 standard prescribe 1.8 kilograms per cubic metre.

### **Application of boric acid**

Boracol 20/2 BD is applied either by brush, which only requires gloves for protection or spraying, which requires wearing a disposable suit and a fresh-air intake. The wood is painted or sprayed twice. Dipping is done for 1-3 minutes depending on the dimension of the timber. Application in boreholes are performed by drilling holes with a distance of 15 centimetres to a depth which is 2 centimetres from the opposite side of the wood. The holes are filled 1-3 times according to the dimension of the timber.

### **Depot preservation**

TIMBOR rods (IMPEL) consist of pure di-Sodium octaborate. With each 11 molecules of water added to the rods 8 molecules of boric acid are released. When the wood moisture content rises above 20-30% (optimum 50%) the IMPEL rods are dissolved and boric acid produced.

### **Detection of boron**

Boron can be detected with the yellow curcumin dye, which will turn red under acid conditions in the presence of boron.

### **Diffusion of Boracol**

Contrary to products with white spirit, which will stay on the surface of the wood, the boric acid monopropylene glycol ester will diffuse into the wood when there is a gradient. A possible mode of action is a substitution of the hydroxyl group (OH) from the alcohol with a hydroxyl group from the cellulose. The rate of diffusion rises with the moisture content. Generally the rate of diffusion will be 0.5, 1.0 or 1.5 centimetres per month at 10, 20 and 30% moisture content respectively (Bech-Andersen, 1990). At a wood moisture content of 50% it is recommended to use pure boric acid. Under influence of water the boric acid will wash out partly, especially in sapwood. For the latter reason Boracol must be used indoors for dry rot repair. For prevention of fungal and insect attack outdoors, it must be protected by a layer of paint. For protection of windows Boracol 20/2 BD can be used as a pretreatment and then painted after 24 hours.

Out of doors telephone poles, railway sleepers and windows can be protected with TIMBOR rods.

When controlling dry rot Boracol 20/2 BD can be used on masonry to establish a barrier to future attacks (Bech-Andersen, 1987).

## Literature

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