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ORANGESHIELD MOLD PROTECTION PROGRAM

Avtar Sidhu

Diacon Technologies Ltd.

1. Introduction

ORANGESHIELD is a mold inhibition program trademarked by Diacon Technologies Ltd. and it is aimed at protecting as well as offering aesthetic appeal to lumber and lumber components used in new home construction. It uses EPA registered products, providing the homeowner with assurance as to quality, efficacy and toxicity. The ORANGESHIELD program has gone through extensive field-testing proving the efficacy of the program under the harshest conditions. ORANGESHIELD will be applied only by qualified component manufacturers. Wood is most effectively treated when it has been freshly produced to its final dimensions. This requires a program that is effective under full weather conditions until the wood components have been enclosed within the home or building. ORANGESHIELD is a neutral product with non corrosive properties. Testing on truss plates has shown ORANGESHIELD to be non-reactive. ORANGESHIELD provides protection from the point of treatment until the wood component is enclosed in the home. A limited warranty covers both the time of exposure to weather before construction, and for 25 years after completion of the home or building.

It has long been desirable to produce wood products that are artistically and aesthetically acceptable. The question of why companies prefer to color wood products can best be understood from the importance of what a ‘trademark’ means for an organization. A ‘trademark’ is a legally protected name, word, symbol, or design (and combination of these) used by a manufacturer or seller to identify a product or service and distinguish it from other goods (A. Mangani). The economic function of a trademark is to facilitate consumer decisions, because it indicates the inherent quality or other distinguishing features of identified products. The economists have often emphasized the positive relationship between trademarks and high quality products, since high quality producers have greater incentives to protect their brands (names and logos). Therefore, colored wood products, as well as providing a potential aesthetic appeal also tend to differentiate company specific products. Product differentiation is usually seen as a means to build and maintain a competitive advantage. Additionally, colorants can also be used in differentiating between treated and untreated wood stock to avoid any erroneous mistakes.

ORANGESHIELD Program Make-up

ORANGESHIELD program consists of three components (Fig. 1): active ingredient(s) (AI), acidulants & ancilliary additive(s) and colorants. The active ingredients could consist of any one of the following, present alone or in a specific combination: Propiconazole(PCZ), Iodopropylbutylcarbamate(IPBC), Didecyl Dimethyl Ammonium Chloride(DDAC), Didecyl Dimethyl Ammonium Carbonate/Bicarbonate (Carboquat), Alkyl Dimethyl Benzyl Ammonium Chloride (ADBAC), Chlorothalonil, Borates (DOT, Boric Acid), etc. The ancilliary additives and acidulants can consist of water repellents and anticorrosion inhibitors. The colorants could consist of dyes, pigments or combination of the two.

ACTIVE INGREDIENTS	+	**ANCILLIARY PRODUCTS & ACIDULANTS**	+	**COLORANTS**
Mycostat Products (PCZ, IPBC, DDAC, DDACarb/bicarb, ADBAC, CTL, etc.)		Corrosion Inhibitors Water Repellents		Pigments, Dyes

Figure 1. ORANGESHIELD Program.

Efficacy of ORANGESHIELD

Molds tend to be very selective. Some molds grow more on some wood species than they do on others. At the same time some regions have climatic conditions that are more favorable to specific types of molds. ORANGESHIELD is a program that is adjusted to fit both the different wood species and their regional climate. For example, in the southern U.S. ORANGESHIELD applied on southern yellow pine needs to be different than a program applied on other species in other areas of the country. For mold, one size does not fit all. Over the years the Diacon experience has shown that different combination of actives are necessary to control the molds and stains on the Pacific Coast than the molds on pine species on the Atlantic Coast. Additionally, the hardwood stains in the Atlantic coast require even different solutions. An efficacy study was carried out using three different ORANGESHIELD formulations (OSP #1, OSP #2 and OSP #3) using the AWPA E24 standard protocol (Figure 2).

In addition to the recommended mold fungi to use for inoculation in the standard, additional stain fungi (*Ophiostoma Picae, O. Ulmi and O. Piliferum*) were used. Two control scenario were included, Control #1 contained specimens dipped in tap water and Control #2 were the Ponderosa Pine heartwood samples. For the positive control a standard Diacon formulation was used. This formulation is well tested and its performance is well understood at specific dilutions. The specific formulations and dilutions were chosen so that they were at equal cost.

Figure 2. Mold boxes showing mold test specimens at the end of test.

The results for the three different ORANGESHIELD formulations were different on the same substrate (Ponderosa Pine) (Figure 3). If these formulations are further tested on other different substrates (i.e. Douglas Fir, Southern Yellow Pine, etc.), the results would look quite different. Therefore, extensive testing of antisapstain formulations is the norm for any antisapstain supplier prior to recommending a specific program for a specific account.

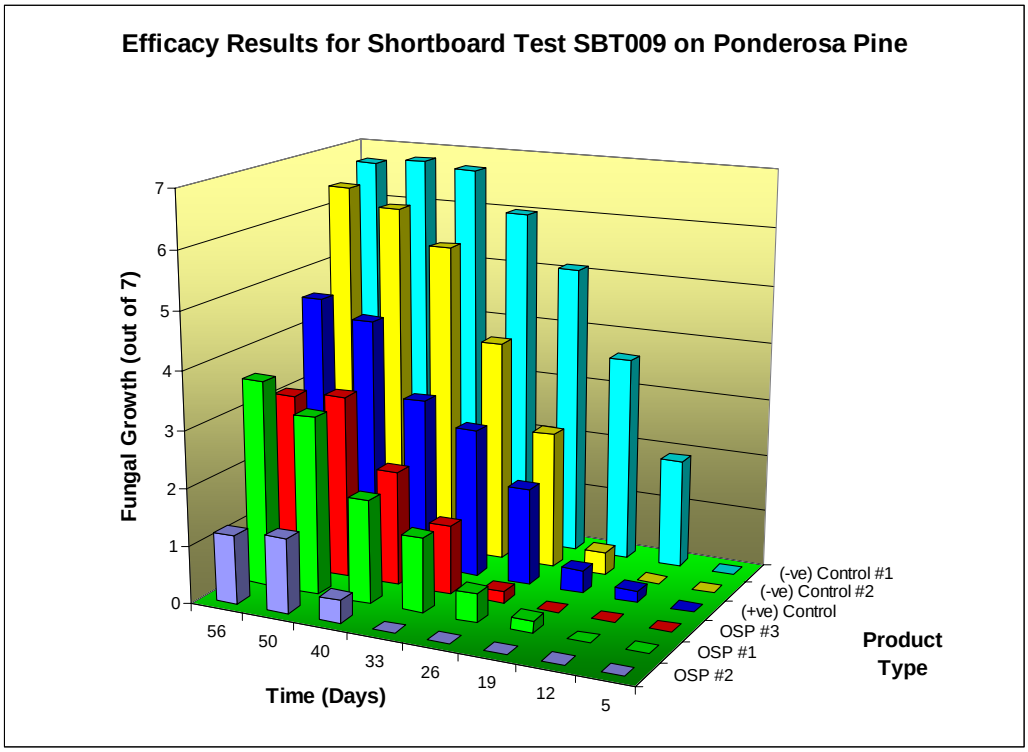

Figure 3. The efficacy results for three different ORANGESHIELD formulations.

Figure 4 shows how the mold specimens typically look like at the end of the mold test. The negative control specimens show heavy mold growth all over whereas the treated portions of the treated specimens show very little or no mold growth. The control side of the treated sample shows heavy mold growth.

Figure 4. Mold specimens at the end of mold test.

Colorant Facts

Various conventional methods are available for coloring and staining wood, and in the same respect various methods are available for applying antisapstain chemicals on lumber to provide protection from molds and stains. Yet only a few methods are available that can apply a colorant and an antisapstain chemical on lumber in one step. In order to apply a colorant and antisapstain chemical in one step, the two must be compatible when combined together. Majority of the wood protecting formulations against mold and stain are based on cationic based adjuvants that cause most of the acid dyes and direct dyes to be incompatible. Once the colorants are mixed with these systems, the colorants degrade or precipitate (Figure 5). There are basically two types of colorants that have been used in paint and stain formulations for many years (L.M. Saija). These are pigments and dyes. Pigments are finely ground, inert, colored powder that can be natural or man-made, organic or inorganic. The ones that find the most use are iron oxides which are yellowish to reddish-brown inorganic constituent that makes rust brown and clay red. The dyes are complex organic chemical derived from petroleum products like benzene, toluene and naphthalene. Through chemical processes such as nitration and sulfonation, these chemicals are processed into dye intermediates such as aniline which are processed further by special operations like diazotization to give the final product – a dry chemical powder. Dye stains are composed of only two components – a dye and a carrier. The carrier can be water, alcohol or oil. While at the surface this may seem to be a simpler arrangement than a pigment stain – dyes are little more complex to understand.

Figure 5. Unstable colorant with antisapstain system and thus precipitates.

There are three main physical differences between dyes and pigments and these affect the working qualities and performance of the stain (Table 1). The differences are **size**, **method of attachment** to wood and **lightfastness.**

	Pigment	**Dye**
Size	1-2 Micrometer	1-2 Nanometer
Method of Attachment	Requires binder	Binds via functional groups
Lightfastness	Stable	unstable

Table 1. Physical Differences between Dyes and Pigments.

The differences between pigments and dyes can be best visualized by their size. Pigment particles in most wood stains are about 1-2 microns. Because 1-2 microns is well above the wavelength of visible light, pigments absorb light and block its transmission by reflecting it. In comparison dye molecules are much smaller – it would be like comparing a soccer ball (pigment) to the head of a pin (dye). Dye molecule size results in several other differences. Dyes color wood evenly – regardless of the density or pore structure of the wood and light is not blocked by the dye molecules, it's absorbed and transmitted. For method of attachment the pigment requires a binder (alkyd, polyurethane or acrylic resin) to stick to the surface of wood. A pigment is an inert substance that's merely suspended in a carrier/binder. A dye on the other hand is in a true solution and to

understand how a dye “sticks” to wood it’s important to be able to visualize dyes at the molecular level. Both the dye and the substrate being dyed (wood) are chemicals – possessing certain functional groups. At the molecular level these groups can be visualized as open pockets of electrostatic charges (+ or -) or acid-base characteristics. In dyes, the functional group can serve as a method of attaching the dye to the wood. Acid and direct dyes can attach themselves through molecular electromagnetic forces like zillions of tiny little magnets, basic dyes can have an acid-base attraction (wood is acidic) while solvent dyes are just absorbed into the wood (which is why oil and alcohol dyes have more of a tendency to bleed). This is why dyes do not necessarily require a binder like pigment does. Water dyes penetrate the deepest because wood is hydrophilic, but water causes the wood fibers to swell – which raises the grain. Typically, the colorant or dye in any type of coating, when contacted with a wooden surface, typically associates either physically or chemically with the wood surface. The coloring effect results form the absorption, mechanical admixture, entrapment, or dipolar attraction of the colorant and the cellulosic wood constituents. Often reactions between the dye and the binder can occur in combination with the cellulose or the dye and the binder can be physically associated with the cellulose.

The lightfastness describes the performance difference between dyes and pigments. It is a well known fact that light has a destructive effect on both pigments and dyes due to the presence of electromagnetic radiation, but dyes are most vulnerable. A pigment, such as iron oxide, has very stable, strong molecular forces which hold the atoms in the molecule together. The energy in sunlight is not sufficient to break these bonds. Conversely, the bonds that hold an organic dye molecule together are much weaker and thus sunlight is ultimately able to disrupt or break the bonding arrangement which causes the color to fade. The metallized alcohol/ketone soluble dyes such as those made by Ciba-Geigy and BASF are very light-stable. Of course, benzotriazole additives are available that can be added to finishes to mitigate dye fading and wood patination. These additives are called UV absorbers and they work on a process called tautomerism, in which harmful UV is absorbed and dissipated as harmless heat.

Background on Diacon Technologies Ltd.

It is only fitting that we give a brief on Diacon’s history at this point since ORANGESHIELD is trademarked by Diacon. Diacon Technologies Ltd. have been in the antisapstain business for the last four decades. The early antisapstain products that Diacon had at its disposal were tetrachlorophenates, PQ-8, Ecobrite, TCMTB and azaconazole. Due to environmental and health concerns these products were replaced over time with products such as propiconazole, iodopropylbutylcarbamate, didecyl dimethyl ammonium chloride, didecyl dimethyl ammonium carbonate/bicarbonate, alkyl dimethyl benzyl ammonium chloride, borates(boric acid, disodium octaborate, sodium borate pentahydrate, etc.), chlorothalonil. Over time the adjuvant technology has taken a different dimension and with appropriate adjuvants the active ingredients used at much lower levels thus reducing the risk to the environment and the workers.

Diacon has two manufacturing sites in Richmond, B.C, Canada and Vancouver, WA, USA. It also has warehousing facilities in Montreal, QC, Canada and Greensboro, NC,

USA. It has sales offices in Richmond, B.C. Canada, Portland, OR, USA and Montreal, QC, Canada. The typical trademarked products that Diacon carries include, Mycostat (antisapstain products), Ferrobrite (corrosion inhibitors), Diachrome (pigmented colorants) and Seabrella (water repellents). Diacon also designs, procures, builds and installs the equipment required for application of antisapstains. This equipment includes, chemical make-up systems (Figure 6), Diaplex™ spray systems (Figure 7 and 8), mist eliminator systems (Figure 9) and Diaplex control systems (Figure 10) for monitoring chemical use and application rates.

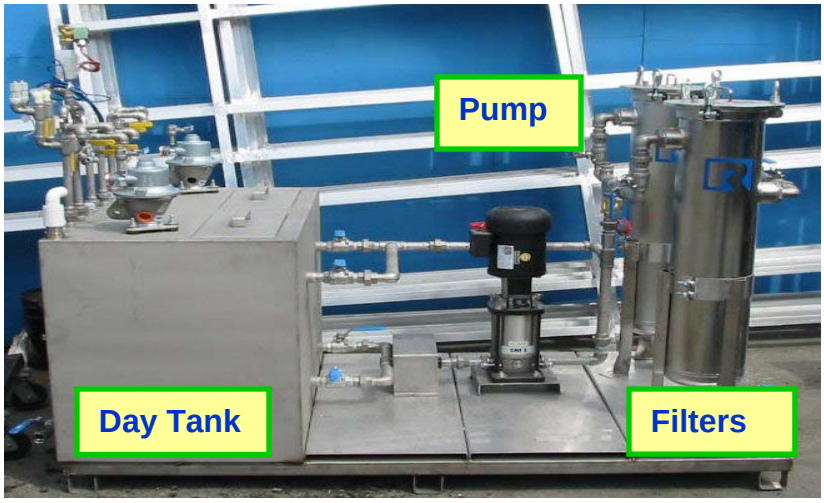

Figure 6. Chemical Make-up System

Figure 7. Diaplex Linear Spray Systems

Figure 8. Transverse Spray Systems

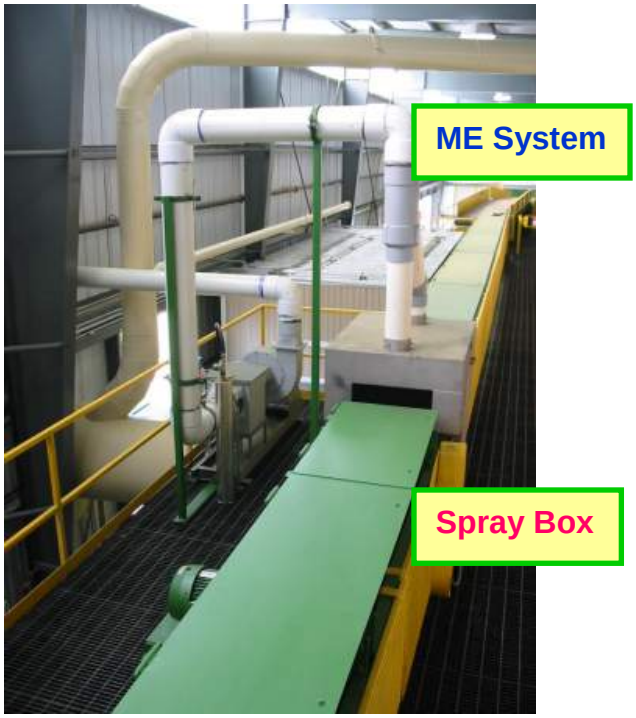

Figure 9. Mist Elimination (ME) System

Figure 10. Diaplex Control System

In addition to this sophisticated application equipment and control systems, Diacon provides routine technical services which include evaluating and troubleshooting all application systems, carrying out routine trials on existing and new products and providing routine retention analysis for all accounts.

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