Anti-Sapstain Biocides for Fresh Southern Hardwood logs When Delays Occur between Felling and Water-Spray Storage

by

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Abstract

Sapwood discolorations in highly valued southern hardwood species have been a costly problem for the U.S. forest products industry. Mold and sapstain fungal occurrences are more prevalent in the southeast than in other regions, so preventive measures must be implemented to keep hardwood logs and lumber discoloration-free. Since conditions that favor stain development are prolonged after tree felling, logs that cannot be transported to a water-storage facility within 7 days after felling should have a biocide applied to their ends and, preferably, their debarked areas. Treatment practices should incorporate accurate and consistent chemical/water concentrations, proper spray applicators, and sufficient coverage of freshly exposed log cross-sections within 24 hours of tree felling to prevent the growth of sapstain fungi for approximately 6 weeks.

Introduction

Although the practice of spray application of anti-sapstain biocides onto hardwood log cross-sections began experimentally in the late 1930’s (Scheffer and Lindgren 1940, Johnston 1959), it did not become an industry-accepted practice until the mid 1990’s (Wengert 1992). Unfortunately, relatively few hardwood sawmills utilize this procedure today. A few considerations must be observed before one begins log treatment. Initially, logging personnel must apply preservative treatment to the logs as soon as possible. Secondly, the anti-sapstain product should be mixed with water with a low chlorine content rather than muddy lake or river water. Furthermore, the correct ratio of chemical to water must be achieved (Table 1). It should be stated that it is important to not mix the chemical to water ratio too “hot”, meaning too much chemical. The ratio itself, if too hot, could inhibit the chemical’s overall anti-microbial performance and waste both chemicals and money. If logs in the southeast are treated within the first 24 hours of being felled, and the correct concentration of biocide is mixed according to
seasonal climate, the colonization of both mold and sapstaining fungi can be minimized. It should be remembered, however, that most anti-sapstain formulations do not contain an insecticide and will not protect logs from beetles such as Ambrosia, Buprestids, or Cerambycids that may introduce sapstain fungi into the logs (Findlay 1967, Williams 1973).

**Table 1**

Anti-Sapstain Mixtures Chart Illustrating the Amount of Chemical to Water Ratio and Seasonal Dependent Recommendation*

<table>
<thead>
<tr>
<th>Mixture (chemical/water)</th>
<th>0.02 (50/1) winter</th>
<th>0.025 (40/1) spring/fall</th>
<th>0.05 (20/1) summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>oz./ 1 gallon</td>
<td>2.56</td>
<td>3.2</td>
<td>6.4</td>
</tr>
<tr>
<td>oz./ 2 gallon</td>
<td>5.12</td>
<td>6.4</td>
<td>12.8</td>
</tr>
<tr>
<td>oz./ 5 gallon</td>
<td>12.8</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>oz./ 25 gallon</td>
<td>64</td>
<td>80</td>
<td>160</td>
</tr>
</tbody>
</table>

*These numbers are general recommendations derived from a plethora of industry sources and may be slightly different depending upon actual product being applied.


Observation of mold on log cross-sections does not raise much concern due to the fact that mold fungi cause a superficial discoloration, but limited discoloration can occur in the vessels of large-pored hardwoods such as oaks. Discolorations caused by mold fungi often appear green and/or black but can look red, blue, or yellow depending on the pigmentation of the spores produced by mold species colonizing the log (Amburgey 2008). If logs are left untreated and mold does appear on the surface of lumber, a simple molding or planing operation usually can remove the mold growth after drying.

Sapstain fungi thrive on simple sugars and starches stored in sapwood parenchyma cells (Kirk and Cowling 1984). Because the hyphae of sapstain fungi are pigmented, the sapwood colonized by them is discolored (Irby 2008b). As these fungi utilize contents of ray parenchyma cells of sapwood, their presence often appears as dark blue to black pie-shaped wedges, with the point of the wedge extending deep into the sapwood, as they colonize rays (Scheffer and
Lindgren 1940, Knaebe 2002, and Irby 2008b). Since this type of fungus grows deep into the interior, if logs are left untreated the fungi typically spread throughout the depth of the sapwood. Discolorations by sapstain fungi cannot be simply surfaced off by a molder or planer (Irby and Amburgey 2008). Chemical control of both mold and sapstain fungi is indeed important and is supported by a competitive chemical supplier market.

Chemicals used for wood preservation have changed with changing technology, stringent regulations, and by uninformed perception of safety issues. Hardwood log/lumber preservation began with application of a few low pH chemicals such as benzene hexachloride or sodium pentachlorophenate (Johnston 1959, Amburgey 1979). These chemicals provided increased storage time due to the elimination of fungal spores, but no longer are recommended due to safety and environmental issues associated with their use.

Table 2

A Partial List of Commercial Anti-Sapstain Brand Names Currently Used in Southern Hardwood Sawmills*

<table>
<thead>
<tr>
<th>Brand</th>
<th>Distributor</th>
<th>Active(s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prosan</td>
<td>Buckman</td>
<td>Propiconazole</td>
<td>Expensive but Robust</td>
</tr>
<tr>
<td>AntiBlu XP</td>
<td>Arch Chemical</td>
<td>IPBC, BAC, Propiconazole</td>
<td>Compatible with Boron</td>
</tr>
<tr>
<td>NexGen</td>
<td>ISK</td>
<td>Chlorothalonil, MBT</td>
<td>Low Hazard</td>
</tr>
<tr>
<td>NP-1 Plus</td>
<td>Kop Coat</td>
<td>DDAC, IPBC</td>
<td>Compatible with Additives</td>
</tr>
</tbody>
</table>

*Listing of brand names does not indicate their endorsement by the authors or North Carolina State University or Mississippi State University to any that may not be listed.

Feasible Hardwood Log Treating

Standard operating procedures for applying biocide chemicals to log cross-sections must incorporate: concentration of mixture (Table 1), choice of product and corresponding active ingredients (Table 2), type of applicator, amount of chemical applied, and possible incompatibility problems associated with adding a dye to the water/biocide emulsion to track where the biocide was applied. Proper choice of spraying apparatus is usually dependent on the size of log inventory being held and employee availability. Many smaller firms, producing less than 10 million bf/year, simply use carry or backpack-type pump-up hand sprayers. These hand sprayers allow for easy mixture and should provide sufficient coverage of each individual log cross-section surface. Obviously, a few shortcomings of using carry or backpack hand sprayers include the intensity of labor involved and the time it requires to treat several thousand log cross-sections. On the other end of the spectrum, high-volume firms that process in excess of 10 million bf/year utilize electric sprayers mounted on ATV’s with a hand wand. Other possible applicators for high-volume log handlers could be the use of electric sprayers with fixed-position nozzles, so no hand motion is required, that are mounted to, or pulled behind ATV’s, golf carts, or small tractors. These fixed-position sprayers provide quicker application of chemical but provide poor coverage efficiency due to the fact that typical log runs incorporate many different lengths of logs (10, 12, 14, 16, or 18 feet) which creates an uneven spray surface. Some hardwood lumber operations add a fluorescent dye to the anti-sapstain formulation for quality control purposes. This practice does provide a visual audit of treated vs. non-treated inventory, but the dye itself is questionable. Many anti-sapstain chemicals are comprised of both active and inactive ingredients that may be pH sensitive. If a dye of a non-neutral pH is added into a sensitive emulsion, the product’s performance may be compromised. It is important for log handlers to understand the general chemical make-up of their product and not deviate from the manufacturer’s specifications.

Anti-sapstain biocides come in a variety of “flavors” and are generally categorized by their active ingredients. Chemical emulsions targeting mold and sapstain fungi in the early 1990’s were primarily comprised of chlorothalonil as the primary active ingredient (Laks et al. 1991). The use of chlorothalonil generated a few problems. First, the ingredient simply “falls-out” of solution, if not agitated, due to its higher molecular weight compared to other ingredients
in the emulsion. Secondly, chlorothalonil itself is heavily chlorine-based and provides a few environmental and associated health hazards. Other active ingredients come with their own associated shortcomings. Propiconazole is a popular and currently-used active ingredient in anti-sapstain biocides but is rather expensive. Iodo-propynyl-butyly-carbamate (IPBC) is a widely-used active, and is currently accepted industry-wide, but typically comprises less than 5% of the total emulsion (Anti-Blu XP, NP-1, and Prosan) due to pH incompatibility issues. Other active ingredients include benzalkonium chloride (BAC), didecyl dimethyl ammonium chloride (DDAC), or methylene-bis-thiocyanate (MBT) and can be found in a variety of anti-sapstain biocides at low concentration percentages. Basically, chemical emulsions are very sensitive and pH balance is the overwhelming concern when mixing different ingredients.

Current market trends have focused on the idea of multi-functional chemicals, known throughout the industry as “cocktails” (Ross 2008). These “cocktails” generally intend to provide both an anti-fungal agent and some sort of brightener (Craciun and Mitchell 2007). Brighteners are added to decrease another type of hardwood discoloration known as enzyme-mediated “gray” stain (Bailey 1910, Forsyth and Amburgey 1987). In general, brighteners are antioxidants that are added to inactivate oxidative enzymes in parenchyma cells in the log to inhibit the occurrence of gray stain (Wiemann et al. 2007). Many companies have tested this anti-fungal/brightener “cocktail” concept within the realm of dipping lumber and released several products onto the market, but log treatment with that chemical has not become an accepted practice.

Log treatment “cocktails” have been used experimentally in the southeast with inconclusive results (Irby 2008b). These experiments included the application of a combined emulsion containing an anti-sapstain, an antioxidant, and an end sealer to the log cross-section. The objective was to provide total log quality by eliminating the threat of both microbial and enzyme-mediated discolorations, while keeping the log from checking and splitting by the addition of an end sealant specifically designed for hardwood logs. Several experiments were conducted, and the underlying result was lack of sapstain prevention caused by chemical incompatibility. Other experiments conducted by private industry attempted to mix the anti-sapstain product directly with an end-sealing product. Results showed that the end sealant retained excessive moisture, which is the intended action of the product because it prevents rapid drying, within the log cross-section and the anti-microbial chemical could not stop fungal
colonization. Future research in the area of log treating “cocktails” should, perhaps, incorporate a staggered treatment approach in which different chemicals are applied gradually over time (typically in half hour intervals) to allow each chemical an opportunity to soak into the log interior before the addition of another chemical.

**Conclusions**

Cost of treating hardwood logs with an anti-sapstain chemical formulation is cost-effective. To fully comprehend the concept, one should compare the cost of log treatment, currently ~$10/mbf, to the cost of grade loss, ~$200/mbf from FAS to 1 Common depending on wood species. Hardwood lumber domestic and foreign markets do not accept FAS lumber at FAS prices if the lumber is discolored (Amburgey et al. 2008). Although the lumber is sound and knot-free, the loss of aesthetic quality decreases the price per mbf.

So, is treating southern hardwood logs that cannot be water-stored feasible? Yes. Treating hardwood logs can greatly increase appearance grade yield in the sawmill and decrease deterioration in stored logs, if done according to specifications outlined previously. However, it must be emphasized that anti-sapstain formulations will prevent the growth of sapstain fungi, but they will not control the growth of fungi or insects that colonize the logs or lumber prior to their application. Time is the single most important component of this log treatment protocol. Logs must be treated within 24 hours in warm, moist climates to minimize fungal colonization of sapwood.
Literature Cited


