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Wolman® AG – CARBON BASED WOOD PRESERVATIVE

Roger Fox

Arch Wood Protection, Inc., Conley, GA

Summary

Wolman® AG was commercially introduced into the U.S. in early 2006. It is a non-metal preservative applied by pressure treatment for use in above ground applications.
The formulation comprises three carbon-based ingredients that enable wood to resist damage from fungal decay and termites. The preservative effectively protects lumber used for decking, fence boards, and many backyard applications as well as being well suited for use in doors, windows and other millwork. Extensive testing has demonstrated the effectiveness of the system and provided a basis for a ICC Evaluation Services Report and WDMA Hallmark Certification. Listings are also being sought in AWPA and CSA standards.

Introduction

This update on the Wolman® AG non-metal preservative will include information on the preservative itself, efficacy data from some of the field tests, ongoing testing, and information on the ancillary properties of the treated wood. In addition, information will be provided on the use of with colors and stabilizers to improve the weathering and appearance of the treated product. An update will be provided on the current recognition of Wolman® AG as well as the commodities and species recommended for treatment with this preservative system. Information will also be provided on how Quality Control is being conducted on this product in comparison to current metal based preservative systems.

Wolman® AG Preservative

Wolman® AG is water based non-metal preservative consisting of a mixture of azoles and insecticide. It contains the fungicides propiconazole, tebuconazole and imidacloprid at a ratio of 10:10:1. A preservative designation of PTI has been proposed to AWPA. The efficacy of propiconazole and tebuconazole mixture is synergistic and patented. The preservative is supplied as a 10.5% concentrate and is supplied in 275 gallon totes. Since it is very effective at low retentions two totes of Wolman® AG will generally treat as much material as a tanker truck of a copper preservative concentrate. Wolman® AG is registered by the U.S. EPA.

Attributes of Wolman® AG Treated Wood

Wolman® AG is a broad spectrum preservative system developed to provide extended protection to wood from decay and termites in above ground applications. It is a colorless preservative which makes it ideal for wood doors, windows, siding, trim and other millwork applications. With the incorporation of colorants it is also ideal for decking, fencing, plywood, outdoor furniture, playground structures and many other outdoor applications. Wolman® AG treated wood can be painted or stained and has improved gluing, drying, corrosion and machining properties in comparison to copper based preservative systems. In addition, there are no copper storm water run-off issues at plants or paint bleed through issues on the treated product.

Biological Performance of Wolman® AG Treated Wood

Wolman® AG has shown good performance against a wide range of biological organisms in a wide range of laboratory and field tests. It has been evaluated in the laboratory using soil block tests and in termite tests on both *Reticulitermes flavipes* and on *Coptotermes formosan*. In field tests it has been evaluated in lap-joint exposed in Hawaii, in L-joints exposed in southern Mississippi and in decking tests exposed in Georgia. In addition, it has been tested against *Coptotmeres formosan* termites in an above ground test in Hilo, Hawaii. In the lap-joint tests, the use of a stabilizer significantly enhanced the performance of the Wolman® AG treated samples. A brief review of these four field tests follows:

1. AWPA E16 Lap-joint Test – Hilo, HI

AWPA E16 lap-joint tests were conducted by Michigan Technological University (MTU) on southern pine specimens prepared and treated by Arch Wood Protection. These samples remain on exposure racks at a test site near Hilo, Hawaii.

Southern pine lumber was clear, straight grained sapwood with six to ten rings per inch. The wood was machined prior to preservative treatment. Pressure treatment was carried out using Wolman® AG (no insecticide) with and without a stabilizer and Wolman® E (CBA-A). Ten replicates were used for each treatment including non-treated southern pine controls. The treatments and retentions are in Table 1.

Table 1: Lap-joint Treatments and Retentions

Treatment	AG Retention (pcf)	CBA-A Retention (pcf)
AG	0.007	--
AG	0.011	--
AG + Stabilizer	0.009	
AG + Stabilizer	0.013	
CBA–A	--	0.11
Non-treated	--	--

The lap-joints were put on exposure at the MTU Mauna Kea Field Test Site starting in August 2000. In November 2005, these samples were re-located (contract on land could not be renewed) to the MTU Kipuka Field Test Site. Both sites are near Hilo and have similar climates as can be seen in Table 2.

Table 2: Lap-joint Test Site Locations and Climate

Location	Mauna Kea Test Site (near Hilo, HI)	Kipuka Test Site (near Keaau & Hilo, HI)
Elevation	500 ft.	359 ft.
Mean Annual Temp. (ºF/ºC)	74/23	74/23
Mean Annual Precip. (in/cm)	127/322	127/322
Scheffer Index	~ 340	~ 340
Hazards	Decay and termite (*C. formosanus*)	Decay and termite (*C. formosanus*)

These samples were graded periodically for decay and termite deterioration over the next six years. The grading scale in AWPA E7-07 was used and is shown in Table 3.

Table 3: Decay and Insect Rating Scale

Rating	Fungal Decay	Insect Attack
10	Sound	Sound
9.5	Discoloration and softening associated with Decay	Trace, surface nibbles permitted
9	≤ 3% cross section affected	≤ 3% cross section affected
8	3 to 10%	3 to 10%
7	11 to 30%	11 to 30%
6	31 to 50%	31 to 50%
4	51 to 75%	51 to 75%
0	Failure	Failure

The untreated controls started to deteriorate by fifteen months and after twenty-seven months of test exposure had two sample failures and a decay rating of 7.6. After thirty-nine months of exposure three samples had failed and the decay rating was 6.3. After sixty-nine months of exposure all of the control samples had failed.

In comparison, the low retention AG samples (0.007 pcf) were rated an 8.8 after thirty-nine months with one sample failed due to decay. A second sample failed after fifty-seven months which gave an overall decay rating of 7.6. After seventy-two months of exposure no further samples have failed and the decay rating is 7.0.

The high retention of AG (0.011 pcf) is performing slightly better than the lower retention. After seventy-two months of exposure the decay rating is 7.7 with two sample failures; one after fifty-one months and one after fifty-seven months. The remaining samples are still in good condition with ratings of either 9 or 10.

The addition of a stabilizer to the AG samples improved the performance. After seventy-two months of exposure the lower AG retention (0.009 pcf) samples had a decay index of 7.7 with one sample failure occurring at the last inspection. The higher AG retention (0.013 pcf) with a stabilizer has an average sample decay rating of 9.3 with no sample failures.

The CBA-A samples are performing well with no failures and an average decay rating of 10 after seventy-two months of exposure.

The lap joint test results are given in Table 4. There was no significant insect attack on these samples so these grades are not included in the table.

Table 4: Lap-joint Decay Ratings (Average for 10 Replicates)

	Months Tested								
Pres./Ret. (pcf)	**9**	**15**	**27**	**39**	**51**	**57**	**63**	**69**	**72**
AG/ 0.007	10	10	9.7	8.8	7.5	7.6	7.8	7.5	7.0
AG/ 0.011	10	10	10	9.8	7.7	7.8	7.9	8.0	7.7
AG + S*/ 0.009	10	9.9	9.6	9.7	8.2	9.6	9.7	8.8	7.7
AG + S*/ 0.013	10	10	9.9	10	8.3	9.5	9.8	9.2	9.3
CBA/ 0.11	10	10	10	10	9.7	9.9	10	9.9	10
Unt.	10	9.9	7.6	6.3	4.8	4.4	2.6	0.0	--

* Included a stabilizer to impart water repellency

2. AWPA E9 L-joint Test – Saucier, MS

Mississippi State University (MSU) is conducting L-joint testing on a 1:1 tebuconazole: propiconazole formulation. This is a similar formulation to Wolman AG except that it does not contain the insecticide imidacloprid. Data from this test is still valuable in supporting AG because it is from an alternative geographic location subject to harsh decay conditions

The test was established using AWPA E9-87 with ten southern pine samples per treatment. Samples were pressure treated using a full-cell cycle. The lowest average retention group in the test was 0.02 pcf (range of 0.018 – 0.021 pcf). These samples were not coated prior to exposure. The samples were exposed beginning in March 1997 at a field test site described in Table 5. The inspection rating scale of 10 (sound) to 0 (failure) was adopted from AWPA E7.

Table 5: L-joint Test Site and Climate

Location	**Saucier, Mississippi (near New Orleans, LA)**
Elevation (ft/m)	140/43
Mean Annual Temp. (ºF/ºC)	68/20
Mean Annual Precip. (in/cm)	65/165
Scheffer Index	~ 100
Hazards	Decay and termite (*R. flavipes*)

Retention and inspection results are shown in the Table 6.

Table 6: L-joint Retention and Inspection Results

	Months Tested								
Pres./Ret. (pcf)	**13**	**24**	**48**	**60**	**69**	**76**	**88**	**97**	**114**
Teb-Prop 0.020	10	10	10	10	9.80	10	10	10	9.75
Unt.	9.20	8.70	7.20	6.90	6.80	5.30	5.10	4.80	4.70

The samples are performing excellently after exposure in a severe decay zone (Deterioration Zone 5) with ratings of 10 for over eight years and still averaging nearly 10 after 9.5 years. In comparison, the untreated samples have significant decay with a rating of 4.70.

3. Above Ground Decking Test – Conley, GA.

Southern Pine was obtained locally and treated by Arch Wood Protection. The lumber was clear, had six to ten rings per inch, was virtually all sapwood, and each piece measured 5/4" x 5.5" x 48". Ten pieces were pressure treated with AG using a full cell cycle to a retention of 0.008 pcf and 0.013 pcf. The retention was determined using solution concentrations and pre- and post treatment weights.

The treated samples were installed in an above ground decking application at the exposure site in Conley, GA. A similar type of decking test is currently being considered for standardization by AWPA Subcommittee P-6. In this test, the treated samples were installed by pre-drilling the samples and using decking screws to attach them to joists that were approximately 2 feet above ground and spaced 16 inches on center. Two deck screws were installed for each board at each of the four joists that it rested on. The boards were installed on the joists in groups of ten that coincided with the treated sample retentions. Table 7 provides the charge number and AG average retentions.

Table 7: Conley Deck Board Treatments

Charge Number	Average Gauge Retention		
	Tebuconazole and Propiconazole (pcf)	Imidacloprid * (pcf)	Total AG (pcf)
8100	0.0079	0.0002	0.0081
8101	0.0129	0.00032	0.0132

* Imidacloprid retention was one-half of current proposed level in AG

The treated deck samples were exposed at the Conley, Ga. Field Test Site in October 2002. All treating data and installation data was witnessed by Timber Products Inspection. The decks were then inspected by Timber Products Inspection for decay and insect attack in August 2007 after approximately five years of field exposure. The rating scale used is adopted from AWPA E7-93 and is shown in Table 8. A rating of 10 indicates no deterioration due to decay and/or insect attack and a rating of 0 indicates failure due to decay and/or insect attack.

Table 8: Rating System for Decking Evaluations

	Condition of Deck Sample	
Rating	Fungal Decay	Insect Attack
10	Sound	Sound
9.5	Suspicion of Decay	Suspicion of Attack
9	≤ 3%	≤ 3%
8	3% - 10%	3% - 10%
7	11% - 30%	11% - 30%
6	31% - 50%	31% - 50%
4	51% - 75%	51% - 75%
0	Failure	Failure

The average climatic temperatures and rainfall for Conley, Ga. is shown below:

Location:	south of Atlanta, Ga.
Mean Annual Temperature (°F/°C):	62/17
Mean Annual Precipitation (in/cm):	49/124
Scheffer Index:	~100
Hazards:	Wood Decay Fungi and Termites

The AG treated decking samples treated to retentions of 0.0081 and 0.0132 pcf respectively, were completely sound with no signs of decay or insect attack after 58 months of exposure in Conley, Ga. Typically, in this region, untreated wood will be severely attacked and completely destroyed by decay in this same period of exposure. Insect or termite attack was not seen or expected in this test since the material was in an above ground exposure.

The results of the deck inspections after five years of exposure are shown in Table 9.

Table 9: Treatment and Decay Ratings after 58 Months Exposure in Conley, Ga.

Treatment/Chg. No.	Retention (pcf)	Avg. Decay Rating	Avg. Insect Rating
AG/8100	0.0081	10	10
AG/8101	0.0132	10	10

4. Termite Ground Proximity Tests – Hilo, HI

Ground proximity tests were conducted by MTU on treated southern pine specimens to determine the effectiveness of the treatments against Formosan termite and decay. The tests were conducted at MTU's Alae Field Termite Test Site near Hilo, from August 2000 to November 2003.

The southern pine solid wood samples were selected and treated according to AWPA E7-93 by Arch Wood Protection. The samples were clear, straight grained sapwood with six to ten rings per inch. Two or three mother stakes (2" x 1.5" x 36") were treated with AG or Copper Azole (CBA-A) using a full cell cycle. Retentions were determined from solution concentration and pre- and post treatment weights. Treatments and retentions are shown in Table 10.

After treatment the mother stakes were cut into individual specimens measuring 2 x 1.5 x 3.5 inches long. Five replicates per treatment/retention were put on exposure. The exposure consists of placing the samples horizontally on a plastic grid sitting on the ground. Untreated aspen feeder strips are interlaced between the treated samples on top of the grid as well as placed into the ground under the grid to attract termites. The entire assembly is then covered with a wooden box. This test protocol has been widely accepted in the industry and is likely to be a future AWPA standard.

Table 10: Treatments and Retentions on Ground Proximity Tests

Treatment	Arch ID	Average Gauge Retention (pcf)		
		Triazole*	Imidacloprid	CBA-A
AG with no Imidacloprid	T1	0.0085	--	--
Imidacloprid only	T6	--	0.0010	--
AG	T16	0.0094	0.0005	--
AG	T17	0.0101	0.0010	--
CBA-A	T45	0.0043	--	0.22
Untreated	T55	--	--	--

*Triazole = Total Propiconazole and Tebuconazole for T1, T16 and T17. T45 is tebuconazole only.

After thirty-nine months of exposure, all treatments with AG and Copper Azole performed well against decay while the imidacloprid alone and untreated samples had moderate to heavy decay, respectively. With respect to Formosan termite attack, all Wolman® AG treatments with imidacloprid and the Copper Azole samples performed well. Wolman® AG with no imidacloprid and the untreated control samples had heavy termite attack. Table 11 provides a summation of the decay and termite ratings for the ground proximity tests.

Table 11: Summary of Average Decay and Termite Data – Ground Proximity

Arch ID	9 Months	15 Months	21 Months	27 Months	33 Months	39 Months
	Decay/Ter	Decay/Ter	Decay/Ter	Decay/Ter	Decay/Ter	Decay/Ter
T1	10/5.3	10/5.4	10/3.6	10/4.4	10/4.0	10/4.0
T6	10/10	9.0/9.8	8.8/9.8	7.6/9.4	7.2/9.2	7.2/9.3
T16	10/10	10/10	9.8/10	10/10	10/10	10/10
T17	10/10	10/10	10/9.4	10/9.8	10/10	10/10
T45	10/10	10/10	10/10	10/10	10/9.8	10/9.8
T55	9.7/9.1	9.2/5.8	6.7/2.4	3.4/1.5	4.0/0.0	--

Future Testing with Wolman® AG

In addition to the efficacy test discussed, other field testing has been initiated over the last several years. These tests are focusing on variations in the formulation of Wolman® AG. These tests have been set up using different above ground exposure test methodologies with different wood species. In addition, these tests are set up in different locations and climate indexes in North America. This information will be useful in developing next generation formulations that are tailored for the species and locations where the treated product will be used. Included are decking tests on white spruce and pacific silver fir in both coastal British Columbia and Ontario.

Appearance and Weathering

The Wolman® AG treating solution is colorless, however, there are several different options to enhance the appearance and weathering properties. One option is to apply a factory, mildew resistant pre-stain or post-stain. Stains will perform similarly on AG treated wood and untreated wood. Another option is to add colorants to the treating solution and apply them during the pressure process. Arch Wood Protection has sold colorants for different preservative systems for many years and these technologies have been useful in developing different colors and systems for the non-metal, colorless AG preservative.

Arch has also developed an in-cylinder water repellent additive or stabilizer for use with Wolman® AG. This additive is formulated to be chemically and shear stable in Wolman® AG treating solution and permits good penetration in easier to treat pine species. The stabilizer provides excellent water repellency and improves dimensional stability of the treated product. In field tests the stabilizer has demonstrated the ability to significantly enhance the performance of the treated product against decay.

Product Approvals

ICC-ES in Evaluation Services Report 1477 has been issued on Wolman® AG treated wood. There are thirty plants listed on this report for treating with Wolman® AG. Applications acceptable for treatment are in Use Category 1 – Use Category 3B out of ground uses only. Examples of commodities in these use categories are decking, fencing, lumber, specialties, plywood, millwork, siding, outdoor furniture and other above ground applications. Wolman® AG is approved to treat a wide variety of species including southern, mixed southern, Caribbean, radiata, red and ponderosa pine, hem-fir, Douglas fir, redwood, and western red cedar.

Wolman® AG also has recently received WMDM Hallmark Certification. Both AWPA and CSA standardization are also being pursued.

Quality Control

Each plant treating with Wolman® AG is required to be in compliance with specific Quality Control Procedures. They must have a HPLC or GC for conducting solution analyses on every charge. They are required to check penetration on every charge to meet the required depth of penetration. Since there is no specific indicator for the active ingredients in Wolman AG a penetration surrogate is used to determine penetration. Each plant is also required to either analyze wood samples from every charge at the plant or send the samples to the Arch Wood Protection laboratory for analysis. The plants use a standard spreadsheet to correlate gauge retentions to wood assays to provide them

guidance on meeting the retention requirements. All plants are monitored by a 3rd party inspection program.

There is also a plant quality control program for the stabilizer additive which is 3rd party monitored. This QC procedure requires maintaining a mix log that shows a minimum retention of stabilizer was used per cubic foot of wood treated. The stabilizer usage is further verified by comparing actual inventory of stabilizer used vs. the wood treated.

Product Commercialization

Commercial treatment with Wolman® AG was started in February 2006. Currently there are seven commercial facilities treating with several more expected before the end of 2007. At this time the plants are treating mostly southern pine with one doing some ponderosa pine. Both stabilizers and colorants are being added to the Wolman® AG treating solutions to improve the appearance and weathering of the treated product.