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(54) Title: ANTIMICROBIAL INSULATION

(57) Abrégé/Abstract:
Insulation that exhibits antimicrobial characteristics is disclosed. A method for making the insulation is also disclosed. Suitable antimicrobial agents that may be applied to the insulation or any components thereof include propiconazole, sodium pyrithione, tolyl diiodomethyl sulfone; tebuconazole; thiabendazole; 3-iodo-2propynyl butylcarbamate; triclosan, quaternary ammonium compounds, metals, and mixtures thereof.

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ANTIMICROBIAL INSULATION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a continuation-in-part of PCT/US04/19360, filed on June 16, 2004, which claims priority from: U.S. provisional application 60/525,910, filed on December 1, 2003; U.S. provisional application 60/529,164, filed on December 12, 2003; U.S. provisional application 60/551,485, filed on March 9, 2004; U.S. provisional application 60/551,426, filed on March 9, 2004; U.S. provisional application 60/568,821, filed May 6, 2004; and U.S. provisional application 60/568,961, filed on May 7, 2004, each of which is incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

[0002] The present invention relates generally to insulation and methods for making insulation. In particular, the present invention relates to an efficient and economical method for producing insulation that possesses antimicrobial (e.g., antibacterial and antifungal) properties.

[0003] Insulation is a ubiquitous construction material. It is found in practically all residential and commercial construction and its importance in the construction of new structures cannot be over emphasized. The primary function of insulation is to act as a heat transfer barrier between the interior of a structure and the outside environment. Thus insulation, if properly installed, can greatly reduce heating and air conditioning costs. Insulation can also serve as a sound barrier, moisture barrier, and vapor/air barrier.

[0004] The diverse functions of insulation led to the development of many different types of insulation. Some insulation is blown loosely into attics. Other insulation consists of foam sheets nailed to walls. The present invention pertains to arguably the most common form of insulation -fiberglass batting that has one side faced with Kraft paper. This type of insulation generally comes in large rolls which are then unrolled to form a mat in attics and walls.

[0005] For the remainder of this document the term insulation will refer to paper faced fiberglass batting.

[0006] One of the problems traditionally associated with the use of insulation is the susceptibility of kraft paper to moisture absorption in damp environments. Unfortunately, insulation used in interior construction sometimes can encounter water due to leaks in roofs, windows, or plumbing. Furthermore, many geographical areas are characterized by high humidity which also provides a source of water that can be absorbed by kraft paper faced insulation. Although the fiberglass component of the insulation is not hospitable to the growth of microbes, the kraft paper facing of the insulation is susceptible to supporting microbial growth, specifically fungal and bacterial growth.

[0007] The growth of fungus and bacteria on insulation is undesirable for many reasons. First, it traps moisture in the insulation which can lead to promulgation of even more fungus and bacteria and weakening of adjacent structural members. Unpleasant odors and staining are also associated with microbial growth. More seriously, many people are susceptible to life threatening allergic responses when exposed to fungal spores. The issues created by microbial growth on insulation, especially the human health issues, drives a continuing need for insulation that is resistant to microbial growth.

[0008] To date, the patent literature has failed to address the issue of biological contamination of insulation. However, the patent literature contains several examples of attempts to address the problem of microbial growth on a somewhat related material: wallboard. Wallboard is a construction material used to form interior walls. Wallboard is somewhat similar to insulation in that it comprises a structural material (a sheet of gypsum instead of fiberglass) attached to one or two sheets of kraft paper. The kraft paper used in insulation, however, is usually thinner than that used with wallboard.

[0009] Commonly assigned US Patent Application Serial No. 10/250,143, from with this application claims priority, discusses the need to provide built-in and long-lasting antimicrobial protection to the kraft paper used in the production of wallboard.

[0010] The current invention is an extension and improvement of the work begun in the '143 application and continued in subsequent applications from which the present application also claims priority.

BRIEF SUMMARY OF PREFERRED EMBODIMENTS

[0011] The present invention derives from research directed at developing a commercially viable process for making insulation that exhibits antimicrobial characteristics. One result of this research was the development of insulation which exhibits antimicrobial characteristics and resists the growth of microbes. In broad terms, the insulation according to the invention comprises an insulating material such as fiberglass, a non-woven covering adjacent the insulating material, and an antimicrobial composition. In many embodiments the insulating material will be attached to the non-woven covering by an adhesive. The antimicrobial composition is preferably intimately associated with the non-woven covering, the adhesive or both.

[0012] The invention also encompasses a method for producing insulation that exhibits antimicrobial characteristics and resists the growth of microbes. The method comprises the steps of contacting a non-woven covering to an insulating material, and applying an antimicrobial composition to the non-woven covering. The method also comprises adding an antimicrobial composition to the insulation or to a component thereof at levels sufficient to exhibit efficacy against microbes.

DETAILED DESCRIPTION

[0013] Turning now to the specifics of the invention, in one broad aspect, the invention is insulation that exhibits antimicrobial characteristics and resists the growth of microbes. As used herein, the term microbes encompasses bacteria, fungi, and other such forms of life that are generally considered by those skilled in the art to fall within the realm of microbiology. Fungus (i.e., mold and mildew), however, is a primary concern with insulation. Accordingly, and for ease of discussion, this detailed description will often make reference to fungus and antifungal agents. This method of presentation should not be interpreted as limiting the scope of the invention in any way.

[0014] The term efficacy, as used herein, is defined as the characteristic of inhibiting the growth of a microbe on a substrate.

[0015] The term non-metallic antimicrobial agent as used herein means antimicrobial agents, other than quaternary ammonium compounds, that do not contain or utilize metal ions (e.g., Ag, Cu).

[0016] The term antimicrobial composition, as used herein, includes individual antimicrobial agents (e.g., silver, triclosan, zinc oxide, etc.) and various combinations of antimicrobial agents and other additives.

[0017] In its broadest aspects, the insulation according to the invention comprises an insulating material, a non woven covering adjacent the insulating material and an antimicrobial composition. In most instances the non-woven covering will be connected to the insulating material using an adhesive. In many instances the adhesive is an asphalt or tar-like adhesive that is well known in the industry.

[0018] The insulating material may be any of the commonly known insulating materials. Perhaps the most commonly known and used insulating material is fiberglass batting. This type of insulating material is found in most commercially available lines of insulation including the well known pink colored insulation available from Owens-Corning. Fiberglass batting is the preferred insulating material for use in the practice of the invention.

[0019] The non-woven covering used in the practice of the invention may be any type of non-woven material capable of attachment to and support of insulating material. Synthetic polymer non-woven mats are examples of acceptable non-woven material.

[0020] More preferably, the non-woven covering used in the practice of the invention is made from natural polymers such as cellulose. Kraft paper is the non-woven material of choice used in the insulation industry. Accordingly, a particularly preferred non-woven covering for use with the invention is kraft paper.

[0021] The antimicrobial composition and the various methods of applying the antimicrobial composition to the non-woven covering represent the most diverse

aspect of the invention. If synthetic polymer non-woven material is used then the antimicrobial composition can be added to the polymer melt prior to formation of the non-woven mat. Furthermore, the antimicrobial compositions that may be used in the conjunction with synthetic polymer non-woven coverings include all of the antimicrobial agents, or combinations of agents, commonly used with synthetic polymers. Such agents include, but are not limited to chlorinated phenols (e.g., triclosan), quaternary ammonium compounds, azoles, and metals (e.g., silver zeolites, silver ions). Those skilled in the art are well versed at adding such agents to polymers and can choose the appropriate agent and loading levels for the polymer of interest without undue experimentation.

[0022] Similarly, if kraft paper is the non-woven covering, the antimicrobial agents utilized in the practice of the invention may include any antimicrobial composition capable of imparting antimicrobial characteristics to insulation and particularly the non-woven (e.g., kraft paper) covering. Many of these antimicrobial agents are discussed or cited in priority document U.S. Patent Application Serial Number 10/250,143, which is incorporated herein by reference. Such agents include, but are not limited to chlorinated phenols (e.g., triclosan), quaternary ammonium compounds, azoles, and metals (e.g., silver zeolites, silver ions).

[0023] Likewise, the antimicrobial composition may be applied to the kraft paper in any of several ways. For example, the paper may be treated by adding antimicrobial compositions to the fiber/pulp slurry during formation of the paper. Although this method can be effective, it tends to be cost prohibitive. Alternatively, the paper may be surface treated with an antimicrobial composition.

[0024] Spraying the paper covering with the antimicrobial composition, either before or after contact with the insulation material, is within the scope of the invention. Those skilled in the art of papermaking are very familiar with spraybars and their use and how they can be easily adopted for use with the present invention.

[0025] Another method of treating the paper surface is to apply the antimicrobial composition as a uniform coating on one side or both sides of the paper covering as the paper covering is made. For example, the antimicrobial composition

could be applied to the paper at the calendar stack rolls using a water bath that is sometimes present in papermaking processes

[0026] In some instances the papermaking process may determine both the method of application and the antimicrobial composition used. Each papermaking process is unique in some respect and those skilled in the art can easily determine which application method and antimicrobial composition is best for their particular process.

[0027] Regardless of the manner of applying the antimicrobial composition, all embodiments of the invention contain a quantity of antimicrobial composition sufficient to exhibit efficacy against microbes and particularly various species of fungi. More specifically, the preferred embodiments of the invention contain a quantity of antimicrobial composition sufficient to inhibit microbial growth on a substrate tested in accordance with AATCC (American Association of Chemists & Colorists) Test Method 30, Part III. Those skilled in the art are familiar with this test method and its parameters.

[0028] As an aid to the reader, and to those skilled in the art, there are several preferred combinations of application methods and antimicrobial compositions for use with embodiments of the invention that employ kraft paper. (Please note that these antimicrobial compositions could also be used with synthetic polymers.) The following paragraphs will present three particularly preferred antimicrobial agents and ways of applying each. It should also be noted that the methods of application discussed herein can be used with any of the antimicrobial compositions. The following compositions and methods of application are exemplary and should not be interpreted to limit the scope of the invention.

Antimicrobial Composition #1

[0029] In one embodiment the antimicrobial composition is an antimicrobial system that comprises a first antimicrobial agent in a first carrier and a second antimicrobial agent in a second carrier. Preferably, the first and second carriers are at least partly soluble in each other. This adds to the stability of the antimicrobial system by minimizing the formation of two liquid phases.

[0030] For example and as discussed in more detail below, one antimicrobial agent suitable for use in the practice of the invention is propiconazole which is commercially available from Janssen Pharmacetica under the trade name WOCOSEN. Another antimicrobial agent suitable for use in the present invention is diiodomethyl-4-tolylsulfone which is commercially available from Dow Chemical under the trade name AMICAL. Both commercial embodiments can be obtained in carriers that are soluble in each other which improve the system's stability.

[0031] Commercially available antimicrobial agents suitable for use in the antimicrobial system can come in surfactant based carriers. Although surfactant based carriers can be used in the practice of the invention care should be taken when using such carriers to ensure that the application system does not become burdened with foam. Foam can sometimes develop if the application system provides for the agitation of the antimicrobial composition. Foam can detrimentally effect the smooth and uniform distribution of the active ingredients. In some instances a small quantity of an anti-foaming agent can be added to the antimicrobial composition to reduce the foam. Preferred anti-foaming agents are ethoxylated co-polymers of polyethylene glycol.

[0032] Testing has shown that acceptable efficacy of treated paper can be obtained by roll coating the paper using an antimicrobial system in which the combined concentration of two antimicrobial agents was less than 1000 ppm and in many instances less than 500 ppm.

[0033] Accordingly, in preferred embodiments the first antimicrobial agent used in the antimicrobial system is selected from the group consisting of propiconazole, sodium pyrithione, and mixtures thereof. Both agents are commercially available in various concentrations and can be diluted to the extent necessary by those skilled in the art.

[0034] Preferably, the second antimicrobial agent used in the antimicrobial system is selected from the group consisting oftolyl diiodomethyl sulfone; tebuconazole, thiabendazole; and 3-iodo-2-propynyl butylcarbamate, and mixtures thereof. These agents are commercially available as well.

[0035] Those skilled in the art can readily adjust the relative quantities of each of the antimicrobial agents in the antimicrobial system to achieve the desired levels of efficacy. In general, higher concentrations translate to higher efficacy. However, a preferred embodiment of the antimicrobial system is an emulsion comprising by weight about 0.1% to 0.8% propiconazole, 0.1% to 0.5% tolyl diiodomethyl sulfone, and 0.05% - 0.15% 3-iodo-2-propynyl butylcarbamate, in water.

[0036] Emulsions using 0.20% propiconazole, 0.175% tolyl diiodomethyl sulfone, and 0.10% 3-iodo-2-propynyl butylcarbamate, in water, applied to 50 lb. per square foot paper showed acceptable efficacy when applied to the surface of the paper at between about 5% and about 20% wet pickup based on the dry weight of the paper. Wet pickup between about 5% and about 7% showed acceptable results and would be preferable due to cost considerations. The quantity picked up by the paper can be adjusted in several ways known to those skilled in the art.

Examples

[0037] Various combinations of the following antimicrobial agents were thoroughly mixed together at ambient conditions in water as shown in Table 1 below.

Table 1

Combinations Formulations (ppm)

Sample	Zn Pyrithione	DITS	Propiconazole	IPBC	Total ppm
A	507	820	817	512	2656
B	0	1485	1566	0	3051
C	0	1109	1095	555	2759
D	0	0	2396	554	2950
E (comparative)	1096	0	0	0	2556

DITS = diiodmethy1-4-tolysulfone

IPBC = 3-iodo=2=propynyl butylcarbamate

An Pyrithione = Zinc Pyrithione

[0038] The formulations in Table 1 were applied to 50 lb. kraft paper stock using a wire-wound rod to control lay down. Approximate pickup was about 15%. The paper samples were tested via AATCC Method 30, Part II to evaluate the compositions for antifungal efficacy. The test organism was *A. Niger*. After incubation for seven (7) days, the samples were evaluated based upon the following scale; 0 represents no observed growth; 1 represents growth apparent only under a microscope; and 2 represents growth visible to the naked eye. In addition, there may be zones of inhibition where growth of the organisms is inhibited from growing anywhere in the vicinity of the samples. Thus, results are reported as a rating, with zones of inhibition where applicable. The results of this testing are shown in Table 2. The roman numerals identify the various combinations of ingredients.

Table 2

Table 1 Formulation	Composition	Growth Rating	Zone of Inhibition (mm)
A	III	0	3
	IV	0	-
	II	0	3
	I	0	-
B	III	0	2
	IV	0	2
	II	0	3
	I	0	-
C	III	0	6
	IV	0	3
	II	0	2
	I	0	3
D	III	0	4
	IV	0	2
	II	0	5

	I	0	1
E (comparative)	III	2	-
	IV	2	-
	II	2	-
	I	2	-
Control – no antimicrobial agents	IV	2	-
	I	2	-

(I) - Formulation of Table 1 containing water and no binder.

(II) - Formulation of Table 1 including 1% by weight silicone coating (RE 29).

(III) - Formulation of Table 1 including 1% by weight of cationic polymer having affinity for paper.

(IV) - Formulation of Table I including 1% by weight of a silane coupling agent.

[0039] As the results show, A, B, C, and D formulations showed no observed growth. The untreated controls showed no efficacy.

[0040] Additional lab tests were run to determine if efficacy could be achieved using lesser concentrations of antimicrobial agents. Several combinations of active agents were tested at various concentrations to observe efficacy. The combinations shown below were applied to 2 inch by 2 inch squares of 50 lb. kraft paper and tested using AATCC Method 30, Part III. The results are shown in Tables 3 and 4.

Table 3

Sample #	Prop. (ppm)	TDS (ppm)	IPBC (ppm)	TRI (ppm)	Growth Rating	Zone of Inhibition (mm)
1	300	100			0	9
2	300		100		0	10
3	200	100		100	0	3
4	100	100	100	100	0	9
5		100		100	0	7
6	500	100			0	15

7	500		100		0	16
8		400			0	11

Prop. = propiconazole (Wocosen Technical from Janssen)

TDS = tolyl diiodomethyl sulfone (Amical Flowable from Dow)

IPBC = iodo-2-propynyl-butylcarbamate (Polyphase CST from Troy)

Tri. = triclosan (Ingrasan DP300 from Ciba)

Table 4

Sample #	Prop. (ppm)	TDS (ppm)	TDS2	IPBC (ppm)	Teb. (ppm)	Growth Rating	Zone of Inhibition (mm)
Control	0	0	0	0	0	Macro	N/A
1	500	100	0	100	0	0	5
2	450	0	100	0	310	0	-
3	300	0	150	0	0	0	3
4	375	0	100	0	300	0	4
5	430	0	0	100	0	0	4
6	650	0	0	150	0	0	-

Prop. = propiconazole (Wocosen 250EC from Janssen)

TDS = tolyl diiodomethyl sulfone (Amical Flowable from Dow)

TDS2 = tolyl diiodomethyl sulfone (Amical 48 from Dow)

IPBC = iodo-2-propynyl-butylcarbamate (Omacide IPBC40 from Arch)

Teb. = tebuconazole (Preventol A8 from Bayer)

[0041] As the above data indicates, acceptable inhibition of microbial growth can be achieved using relatively low concentrations of antimicrobial agents. As low as 400 ppm combined active agent can achieve zero growth and a zone of inhibition.

[0042] Preferably, the antimicrobial system is applied to the non-woven covering (i.e., paper) such that the first antimicrobial agent is present in or on the non-woven covering in a concentration between about 50 ppm and about 1200 ppm, more preferably between about 200 ppm and 1200 ppm. In particularly preferred

embodiments, the first antimicrobial agent is propiconazole and is present in a concentration between about 80 ppm and 1000 ppm; more preferably between about 500 ppm and 1000 ppm.

[0043] Likewise, the second antimicrobial agent preferably is present in the non-woven covering at a concentration between about 40 ppm and 1600 ppm; more preferably between about 60 ppm and 1400 ppm. In particularly preferred embodiments, the second antimicrobial agent isolyl diiodomethyl sulfone (Amical Flowable from Dow) and is present in a concentration between about 40 ppm and 1600 ppm; more preferably between about 60 ppm and 1400 ppm.

Antimicrobial Composition #2

[0044] In another embodiment, the antimicrobial composition used in the practice of the invention comprises a microemulsion of a quaternary ammonium antimicrobial agent, a phenol, and water.

[0045] In its most basic form, this embodiment of the antimicrobial composition comprises an aqueous microemulsion. The microemulsion comprises a quaternary ammonium antimicrobial agent, a phenol, and water. Interestingly, the composition need not contain the volatile alcohols (e.g., ethanol) that are usually used to form emulsions of quaternary ammonium antimicrobial agents. Each of these elements, and other preferred and optional elements, will be discussed in more detail below.

[0046] Quaternary ammonium antimicrobial agents suitable for use in the antimicrobial composition include, but are not limited to, N-alkyldimethyl benzyl ammonium saccharinate, 1,3,5-Triazine- 1,3,5(2 H,4H,6H)-triethanol; 1-Decanaminium, N-decyl-N, N-dimethyl-, chloride (or) Didecyl dimethyl ammonium chloride; 2-(2-(p-(Diisobuyl) cresosxy)ethoxy)ethyl dimethyl benzyl ammonium chloride; 2-(2-(p- (Di isobutyl)phenoxy)ethoxy)ethyl dimethyl benzyl ammonium chloride; alkyl 1 or 3 benzyl-l-(2-hydroxethyl)-2-imidazolinium chloride; alkyl bis(2-hydroxyethyl) benzyl ammonium chloride; alkyl dimethyl benzyl ammonium chloride; alkyl dimethyl 3,4-dichlorobenzyl ammonium chloride (100% C12); alkyl dimethyl 3,4-dichlorobenzyl ammonium chloride (50% C14, 40% C12, 10% C 16); alkyl dimethyl 3,4-dichlorobenzyl ammonium chloride (55% C14, 23% C12, 20% C

16); alkyl dimethyl benzyl ammonium chloride; alkyl dimethyl benzyl ammonium chloride (100% C14); alkyl dimethyl benzyl ammonium chloride (100% C16); alkyl dimethyl benzyl ammonium chloride (41% C14, 28% C12); alkyl dimethyl benzyl ammonium chloride (47% C12, 18% C14); alkyl dimethyl benzyl ammonium chloride (55% C16, 20% C 14); alkyl dimethyl benzyl ammonium chloride (58% C14, 28% C16); alkyl dimethyl benzyl ammonium chloride (60% C14, 25% C12); alkyl dimethyl benzyl ammonium chloride (61% C11, 23% C14); alkyl dimethyl benzyl ammonium chloride (61% C12, 23% C14); alkyl dimethyl benzyl ammonium chloride (65% C12, 25% C 14); alkyl dimethyl benzyl ammonium chloride (67% C12, 24% C 14); alkyl dimethyl benzyl ammonium chloride (67% C12, 25% C14); alkyl dimethyl benzyl ammonium chloride (90% C14, 5% C 12); alkyl dimethyl benzyl ammonium chloride (93% C14, 4% C 12); alkyl dimethyl benzyl ammonium chloride (95% C16, 5% C18); alkyl dimethyl benzyl ammonium chloride (and) didecyl dimethyl ammonium chloride; alkyl dimethyl benzyl ammonium chloride (as in fatty acids); alkyl dimethyl benzyl ammonium chloride (C12-C16); alkyl dimethyl benzyl ammonium chloride (C12-C18); alkyl dimethyl benzyl and dialkyl dimethyl ammonium chloride; alkyl dimethyl dimethy benzyl ammonium chloride; alkyl dimethyl ethyl ammonium bromide (90% C14, 5% C16, 5% C12); alkyl dimethyl ethyl ammonium bromide (mixed alkyl and alkenyl groups as in the fatty acids of soybean oil); alkyl dimethyl ethylbenzyl ammonium chloride; alkyl dimethyl ethylbenzyl ammonium chloride (60% C14); alkyl dimethyl isoproylbenzyl ammonium chloride (50% C12, 30% C14, 17% C16, 3% C18); alkyl trimethyl ammonium chloride (58% C18, 40% C16, 1% C14, 1% C12); alkyl trimethyl ammonium chloride (90% C18, 10% C 16); alkyldimethyl(ethylbenzyl) ammonium chloride (C12-18); Di-(C8-10)-alkyl dimethyl ammonium chlorides; dialkyl dimethyl ammonium chloride; dialkyl dimethyl ammonium chloride; dialkyl dimethyl ammonium chloride; dialkyl methyl benzyl ammonium chloride; didecyl dimethyl ammonium chloride; diisodecyl dimethyl ammonium chloride; dioctyl dimethyl ammonium chloride; dodecyl bis (2-hydroxyethyl) octyl hydrogen ammonium chloride; dodecyl dimethyl benzyl ammonium chloride; dodecylcarbamoyl methyl dimethyl benzyl ammonium chloride; heptadecyl hydroxyethylimidazolinium chloride; hexahydro-1,3,5-thris(2-hydroxyethyl)- s-triazine; myristalkonium chloride (and) Quat RNIUM 14; N,N-Dimethyl-2- hydroxypropylammonium chloride polymer; n-alkyl dimethyl benzyl ammonium chloride; n-alkyl dimethyl ethylbenzyl

ammonium chloride; n-tetradecyl dimethyl benzyl ammonium chloride monohydrate; octyl decyl dimethyl ammonium chloride; octyl dodecyl dimethyl ammonium chloride; octyphenoxyethoxyethyl dimethyl benzyl ammonium chloride; oxydiethylenebis (alkyl dimethyl ammonium chloride); quaternary ammonium compounds, dicoco alkyldimethyl, chloride; trimethoxysily propyl dimethyl octadecyl ammonium chloride; trimethoxysilyl quats, trimethyl dodecylbenzyl ammonium chloride; n-dodecyl dimethyl ethylbenzyl ammonium chloride; n-hexadecyl dimethyl benzyl ammonium chloride; n-tetradecyl dimethyl benzyl ammonium chloride; n-tetradecyl dimethyl ethyylbenzyl ammonium chloride; and n-octadecyl dimethyl benzyl ammonium chloride.

[0047] In particularly preferred embodiments the quaternary ammonium antimicrobial agent comprises a dimethylbenzyl ammonium compound such as N-alkyl dimethylbenzyl ammonium saccharinate. N-alkyl dimethylbenzyl ammonium saccharinate is commercially available from Stepan Chemical Company of Northfield, Illinois, under the trade name ONYXCIDE^{TM} 3300. This particular form of ONYXIDE^{TM} is approximately 95% active and is a solid at room temperature but will form a liquid at elevated temperature. It is light yellow-orange in color and is insoluble in water.

[0048] The phenol utilized in the practice of the invention is preferably an alkyl phenol, a styrenated phenol, or a combination of the two. Such phenols are commercially available from a number of sources.

[0049] The precise phenol utilized in the practice of the invention will likely be determined by the overall process. If it is determined that an alkyl phenol is best for a particular process, the alkyl phenol utilized in this embodiment preferably comprises at least one alkyl phenol having at least one an alkyl group selected from the group consisting of C7 alkyls, C8 alkyls, C9 alkyls, C10 alkyls, and C11 alkyls.

[0050] In most preferred embodiments the alkyl phenol comprises an alkyl phenol having a C9 alkyl group.

[0051] Alkyl phenols suitable for use in this embodiment are commercially available from a number of sources. Particularly preferred commercially available alkyl phenols include TRITON^{TM} X-207 sold by Dow Chemical Company.

[0052] In a similar fashion, the particular styrenated phenol utilized in the practice of the invention will depend upon the overall process. In preferred embodiments, the styrenated phenol is preferably non-ionic. Preferred styrenated phenols include CHROMASIST™ WEZ and STANDAPOL HS™, both of which are commercially available from Cognis Corporation whose North American office is in Cincinnati, Ohio.

[0053] Water makes up the other primary component of this embodiment of the antimicrobial composition.

[0054] The antimicrobial composition may contain other additives. Two such additives are anti-foaming agents and anti-freezing agents.

[0055] The alkyl phenols and styrenated phenols used in this embodiment of the antimicrobial composition can be susceptible to foaming depending upon the particular application. Therefore, it is envisioned that some commercial applications will contain anti-foaming agents.

[0056] For example, this embodiment of the antimicrobial composition according to the invention may be used to treat kraft paper. One method of treating this type of paper is to add the antimicrobial composition to the water box, a device toward the end of the paper process that returns a certain quantity of water to the paper after the paper has undergone heat based drying.

[0057] The water box is often agitated due to the continuous movement of paper through it. This agitation can cause foaming upon the addition of the claimed antimicrobial composition. Generally, the presence of foam is detrimental to the water box portion of a paper process. Therefore an anti-foaming agent is added to the composition according to the invention when the invention is used to treat paper at the water box.

[0058] Preferred anti-foaming agents are ethoxylated co-polymers of polyethylene glycol. In some instances, the commerical formulations of stryrenated phenols and alkyl phenols may contain a quantity of an antifoaming agent. For example, TRITON™ X-207 contains a small quantity of polyethylene glycol.

Accordingly, if TRITON™ X-207 is the source of the phenol additional antifoaming agent may not be needed.

[0059] Likewise, anti-freezing agents may be added to the composition according to the invention. The anti-freezing agents are not thought to be critical to the actual performance of the invention. Instead they are used to keep the composition from freezing or becoming too viscous during transport in cold weather. The anti-freezing agents may be left out of the composition if they are found to interfere with the addition of the antimicrobial agent in any particular process. A preferred anti-freezing agent is dipropylene glycol.

[0060] The relative quantities of each of the discussed components may vary to accommodate particular process requirements. Again, those skilled in the art are fully capable of making these adjustments without undue experimentation.

[0061] In preferred embodiments the quaternary ammonium antimicrobial agent is present in the antimicrobial composition in an amount between about 1 wt. % and 30 wt. %. In particularly preferred embodiments the quaternary ammonium antimicrobial agent is present between about 15 wt. % and 20 wt. % of the overall composition.

[0062] As an example of how the invention may be tailored to meet specific process requirements, it was determined that a composition having approximately 17 wt. % ONYXIDE™ 3300 successfully and efficiently imparted antimicrobial characteristics to kraft paper in one particular papermaking process.

[0063] Likewise, the total phenol content of the antimicrobial composition (e.g., alkyl, styrenated, or combination of the two) is between about 10 wt. % and about 60 wt. % of the total composition. Preferred embodiments utilize between about 20 wt. % to about 50 wt. % alkyl phenol and about 1 wt. % to about 10 wt. % styrenated phenol.

[0064] In one exemplary paper making process, it was determined that a combination of alkyl and styrenated phenol worked best for that particular process. Specifically, the preferred total phenol content in that embodiment was between about 25 wt. % and about 50 wt. %. Optimization of that particular process resulted in the

alkyl phenol being close to about 44 wt. % while the styrenated phenol was close to about 5 wt. %.

[0065] It is anticipated that in most applications the quantity of anti-foaming agent needed for successful practice of the invention will range between about 0 wt. % to about 20 wt. %.

[0066] The remainder of the antimicrobial composition comprises water. In preferred embodiments the quantity of water present in the claimed composition will be between about 5 wt. % and about 30 wt. %, more preferably between about 10 wt. % and about 20 wt. %. Again, the exact quantity of water will depend upon the particular application and those skilled in the art a capable of making the necessary adjustments.

[0067] The invention also encompasses a method of making the antimicrobial composition.

[0068] In broad terms, the method comprises the steps of blending a phenol with a quaternary ammonium antimicrobial agent, heating the blended phenol and quaternary ammonium antimicrobial agent if necessary (some combinations of phenol/quaternary agent may not require heat), and admixing a quantity of water.

[0069] In preferred embodiments, the phenol (e.g., TRITON™ X-207) is blended with the quaternary ammonium antimicrobial agent (e.g., ONYXIDE™) in the presence of heat. The heat is applied because in many instances the quaternary ammonium antimicrobial agent is a solid at room temperature. Care should be taken not to heat the admixture of phenol and antimicrobial agent to a point where there is unacceptable volatilization of either.

[0070] If ONYXIDE™ is the antimicrobial agent, a mixing temperature of between about 65° C and about 75° C is recommended. At this temperature the ONYXIDE™ melts into the phenol to form a liquid.

[0071] Anti-foaming agents and anti-freezing agents such as those discussed previously can be added at this point if needed or desired.

[0072] Once the antimicrobial agent and the phenol are mixed the heat may be removed. As the admixture cools to room temperature water is added with stirring.

[0073] The relative amounts of antimicrobial agent, phenol, and water utilized in the method are the same as those discussed in relation to the composition. Likewise, the relative amounts of anti-foaming agents, anti-freezing agents, and additional antimicrobial agents, if used, are the same as those discussed in relation to the composition.

Antimicrobial Composition #3

[0074] The term non-metallic as used herein means antimicrobial agents, other than quaternary ammonium compounds, that do not contain or utilize metal ions (e.g., Ag, Cu).

[0075] In another embodiment, the antimicrobial composition comprises a microemulsion of a quaternary ammonium antimicrobial agent and two different types of non-metallic antimicrobial agents. The microemulsion can come in two forms. One is an aqueous microemulsion well suited for aqueous systems. The other is a non-aqueous microemulsion well suited for non-aqueous or organic solvent type systems. In the context of insulation it is expected that the aqueous microemulsion will be the more frequently used form.

[0076] Turning now to more specific embodiments of this antimicrobial composition, one embodiment is an aqueous antimicrobial composition that can impart antimicrobial characteristics to kraft paper and many different products. In its most basic form, this embodiment of the invention comprises an aqueous microemulsion. The microemulsion comprises a quaternary ammonium antimicrobial agent, a phenol, a first non-metallic antimicrobial agent, a second non-metallic antimicrobial agent, and water. Interestingly, the composition need not contain the volatile alcohols (e.g., ethanol) that are usually used to form emulsions of quaternary ammonium antimicrobial agents. Each of these elements, and other preferred and optional elements, will be discussed in more detail below.

[0077] Quaternary ammonium antimicrobial agents utilized in this composition include those listed in the previous embodiments of the antimicrobial composition.

[0078] In particularly preferred embodiments the quaternary ammonium antimicrobial agent comprises a dimethylbenzyl ammonium compound such as N-alkyl dimethylbenzyl ammonium saccharinate. N-alkyl dimethylbenzyl ammonium saccharinate is commercially available from Stepan Chemical Company of Northfield, Illinois, under the tradename ONYXCIDE™ 3300. This particular form of ONYXIDE™ is approximately 95% active and is a solid at room temperature but will form a liquid at elevated temperature. It is light yellow-orange in color and is insoluble in water.

[0079] The phenol utilized in the practice of the invention may comprise an alkyl phenol having at least one an alkyl group selected from the group consisting of C7 alkyls, C8 alkyls, C9 alkyls, C10 alkyls, and C11 alkyls.

[0080] In most preferred embodiments the alkyl phenol comprises an alkyl phenol having a C9 alkyl group.

[0081] Alkyl phenols suitable for use in the practice of the claimed invention are available commercially from a number of sources. A particularly preferred commercially available alkyl phenol is sold by Dow Chemical Company under the tradename TRITON™ X-207.

[0082] Alternatively, the phenol utilized in the practice of the invention can comprise a styrenated phenol. Two examples of styrenated phenols acceptable for use with the invention are CHROMASIST WEZ and STANDAPOL HS. Both are available from Cognis Corporation of Cincinnati, Ohio. Both are identified by CAS # 3217120. Technical data sheets indicate that the primary difference between the two is the level of ethoxylation.

[0083] The different phenols that may be employed in the practice of this embodiment of the invention are an example of both the flexibility of the invention and the choices that one skilled in the art may have to make in the practice of the invention. Those skilled in the art will recognize that one phenol may work better in

one particular paper or insulation making process The fine tuning of the invention to suit a particular process is anticipated and should not limit the scope of the invention in any way. Those skilled in the art will be able to make the small necessary adjustments to adapt the invention to their particular process without undue experimentation.

[0084] The non-metallic antimicrobial agents used in this embodiment of the invention are preferably selected from the azole family of antimicrobial agents. Generally speaking, azoles comprise a large class of compounds characterized by a five membered ring which contains an atom of nitrogen and at least one other noncarbon atom (e.g., nitrogen, oxygen, and sulphur). Certain azoles exhibit antimicrobial (i.e., antifungal) properties. Triazoles are a subclass of azoles that are often used as antimicrobial agents.

[0085] Two of the more well known antimicrobial triazoles are propiconazole and tebuconazole. The chemical name for propiconazole (CAS No. 50207-90-1) is 1 [[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-1H-1,2,4-triazole. The chemical name for tebuconazole (CAS No. 107534-96-3) is α-[2-(4-chlorophenyl)ethyl]-α-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol.

[0086] Tebuconazole is commercially available from a number of sources. A particularly preferred form of tebuconazole is available from Bayer Corporation under the tradename PREVENTOL™ A8. Similarly, propiconazole is available from a number of sources. A particularly preferred form of propiconazole is available from Janssen Pharmaceutica under the tradename WOCOSEN™ TECHNICAL.

[0087] In particularly preferred embodiments, the first and second non-metallic antimicrobial agents are propiconazole and tebuconazole. Either agent can be the "first" or "second"; the particular designation does not matter. For ease of discussion however, tebuconazole will generally be referred to as the first non-metallic agent and propiconazole will be the second non-metallic agent.

[0088] A small quantity of a glycol may be present in the composition according to the invention if desired. Glycols can add to the stability of the emulsion and provide other benefits such as retarding foam. Preferred glycols include alkyl

glycols with polyethylene glycol, polypropylene glycol, and dipropylene glycol being preferred.

[0089] Water makes up the other primary component of the claimed antimicrobial composition.

[0090] The antimicrobial composition according to the invention may contain other additives. Two such additives are anti-foaming agents and anti-freezing agents.

[0091] Some phenols used in the practice of the invention can be susceptible to foaming depending upon the particular application. Therefore, it is envisioned that many commercial embodiments of the invention will contain anti-foaming agents.

[0092] For example, this composition may be used to treat kraft paper. Such paper is used to form the outer surface on insulation. One method of treating this type of paper is to add the antimicrobial composition to the water box, a device toward the end of the paper process that returns a certain quantity of water to the paper after the paper has undergone heat based drying.

[0093] The water box is often agitated due to the continuous movement of paper through it. This agitation can cause foaming upon the addition of the claimed antimicrobial composition. Generally, the presence of foam is detrimental to the water box portion of a paper process. Therefore an anti-foaming agent is added to the composition according to the invention when the invention is used to treat paper at the water box.

[0094] The paper can also be treated using a spraybar. Foam buildup in the spraybar can be detrimental to a process so an antifoaming agent can be used there as well.

[0095] Preferred anti-foaming agents are ethoxylated co-polymers of polyethylene glycol. In some instances, the commercial formulations of phenols may contain a quantity of an antifoaming agent. For example, TRITON™ X-207 contains a small quantity of polyethylene glycol. Accordingly, if TRITON™ X-207 is one source of the phenol additional antifoaming agent may not be needed.

[0096] Likewise, anti-freezing agents may be added to the composition according to the invention. They are used to keep the composition from freezing or becoming too viscous during transport in cold weather. In most instances a glycol will serve the function of an anti-freezing agent. A preferred anti-freezing agent is dipropylene glycol.

[0097] One of the benefits of the present composition is that it provides a novel and improved platform for taking advantage of the antimicrobial properties of various azoles and tebuconazole and propiconazole in particular. For some years now those skilled in the art have been aware ofa general synergy between tebuconazole and propiconazole. In other words, by using tebuconazole and propiconazole in combination, one can achieve a greater antimicrobial effect for a given amount of antimicrobial agent.

[0098] Tebuconazole and propiconazole are also well known for their hydrophobicity and difficulty of use in an aqueous environment. They resist forming aqueous emulsions and to the extent they can be forced into some type of aqueous emulsion the emulsions tend to be delicate and are easily destabilized (e.g., the actives form crystals in water and precipitate out or they form distinct phases with water).

[0099] The composition according to the invention, however, provides a stable aqueous emulsion of a quaternary ammonium antimicrobial agent and azoles, particularly tebuconazole and propiconazole. This composition can be as dilute as about 0.02 wt. % of combined azole (e.g., 100 ppm of tebuconazole and 100 ppm of propiconazole) or as concentrated as about 50 wt. % combined azole. This characteristic provides great flexibility in how the composition may be used.

[0100] Although Applicant does not wish to be bound by any particular theory, it is believed that the quaternary ammonium compound in conjunction with the phenol provides a stabilizing effect on the two azoles. In particular, dimethylbenzyl ammonium compounds such as ONYXIDE^{TM} 3300 have been shown to provide a stabilizing effect on aqueous emulsions having combinations of azoles such as tebuconazole and propiconazole.

[0101] Turning now to more specific embodiments of the invention, the relative quantities of each of the listed components may vary to accommodate

particular process requirements. Accordingly, each of the listed components may be present in different amounts depending upon the particular needs of the user. Again, those skilled in the art are fully capable of making these adjustments without undue experimentation.

[0102] In preferred embodiments the quaternary ammonium antimicrobial agent is present in the overall composition in an amount between about 0.33 wt. % and 20 wt. %. In particularly preferred embodiments the quaternary ammonium antimicrobial agent is present between about 2 wt. % and 16 wt. % of the overall composition, most preferably between about 3 wt. % and 9 wt. %.

[0103] Likewise, the phenol (i.e., alkyl phenol, styrenated phenol, or combinations of them) is preferably present in the overall composition in an amount between about 30 wt. % and about 80 wt. % of the total composition. In preferred embodiments the phenol is present in the composition between about 40 wt. % and about 70 wt. %, most preferably between about 45 wt. % and 65 wt. %.

[0104] The first non-metallic antimicrobial agent is preferably present in the overall composition in an amount between about 5 wt. % and about 45 wt. %, more preferably between about 12 wt. % and about 30 wt. %. As noted previously, the first non-metallic antimicrobial agent is preferably tebuconazole.

[0105] The second non-metallic antimicrobial agent is preferably present in the overall composition in an amount between about 5 wt. % and about 45 wt. %, more preferably between about 12 wt. % and about 30 wt. %. As noted previously, the second non-metallic antimicrobial agent is preferably propiconazole.

[0106] A small quantity of a glycol may be present in the composition according to the invention. Preferred glycols include alkyl glycols with polyethylene glycol, polypropylene glycol, and dipropylene glycol being preferred. Dipropylene glycol is particularly preferred. It is anticipated that in most applications the quantity of glycol will be between about 0 wt. % and about 4 wt. %. of the total composition.

[0107] As mentioned earlier, if foaming is an issue an anti-foaming agent can be added. The anti-foaming agents suitable for use with the invention include those compounds commonly used as anti-foaming agents. In preferred embodiments an

additional amount of a glycol can be added as an anti-foaming agent. The glycol used as an anti-foaming agent can be more of the same glycol discussed previously or a different glycol.

[0108] A preferred anti-foaming agent is an ethoxylated co-polymer such as polyethylene glycol which is commercially available from Cognis Corporation. It is anticipated that in most applications the quantity of anti-foaming agent needed for successful practice of the invention will range between about 0 wt. % to about 3 wt. %, more preferably between about 0.5 wt. % and 1.5 wt. %. The quantity of antifoaming agent can be adjusted upwards or downwards depending upon the particular application. Those skilled in the art can readily determine the appropriate quantity of antifoaming agent to use without undue experimentation.

[0109] The remainder of the composition according to the invention comprises water. In preferred embodiments the quantity of water present in the claimed composition will be between about 0 wt. % and about 15 wt. %, more preferably between about 3 wt. % and about 9 wt. %. Again, the exact quantity of water will depend upon the particular application and those skilled in the art are capable of making the necessary adjustments.

[0110] Further embodiments of the invention include those products that incorporate the claimed antimicrobial composition. Indeed, one of the novel aspects of the invention is that it serves as a very versatile tool for incorporating antimicrobial agents into a variety of diverse products. For example, the antimicrobial composition according to the invention has been shown to be particularly effective at imparting antimicrobial characteristics to paper used in the production of wallboard and insulation.

[0111] Preliminary work also indicates that the antimicrobial composition according to the invention is an excellent tool for providing antimicrobial protection to products such as paint and polymers, with latex exterior paints and extruded vinyl (e.g., vinyl siding, vinyl windows) being particularly suitable for use with the invention. It is also anticipated that the antimicrobial composition according to the invention can be added to other solids such as ceramics and cementitious binders to impart antimicrobial characteristics.

[0112] The invention also encompasses a method of making an antimicrobial composition. In broad terms, the method according to the invention comprises the steps of blending a phenol with a quaternary ammonium antimicrobial agent. Heat may be necessary during this blending step and particularly if the phenol is an alkyl phenol and the quaternary agent is an N-alkyl dimethylbenzyl ammonium compound. To this phenol/quaternary mixture is admixed a quantity of a first non-metallic antimicrobial agent then a quantity of a second non-metallic antimicrobial agent. The first and second non-metallic agents can also be mixed together prior to mixing with the phenol/quaternary mixture. Toward the end of the process a quantity of water is added with mixing. Heat may be added to any step if needed.

[0113] In preferred embodiments that use an alkyl phenol, the alkyl phenol (e.g., TRTION™ X-207) is usually blended with the quaternary ammonium antimicrobial agent (e.g., ONYXIDE™ 3300) in the presence of heat. The heat is applied because in many instances the quaternary ammonium antimicrobial agent is a solid at room temperature. If the quaternary ammonium antimicrobial agent is a liquid or available as a flowable composition heat may still be used to aid in the mixing. Care should be taken not to heat the admixture of alkyl phenol and quaternary antimicrobial agent to a point where there is unacceptable volatilization of either. In preferred embodiments the temperature is kept below about 200 °C.

[0114] If TRITON™ X-207 is the alkyl phenol and ONYXIDE™ 3300 is the antimicrobial agent, a mixing temperature of between about 65° C and about 75° C is recommended. At this temperature the ONYXIDE™ 3300 melts into the TRITON™ X-207 to form a liquid.

[0115] The steps of admixing a first non-metallic antimicrobial agent and admixing a second non-metallic antimicrobial agent may occur separately. Alternatively, the first and second non-metallic antimicrobial agents can be admixed together then added to the quaternary ammonium antimicrobial agent.

[0116] The admixing of the non-metallic antimicrobial agents can be accomplished in the presence of heat, if needed. For example, WOCOSEN™ TECHNICAL (i.e., propiconazole) is normally a very viscous liquid at room temperature. PREVENTOL™ A8 (i.e., tebuconazole) is normally a solid white

powder at room temperature. Heating both of them will aid in the admixture to the quaternary ammonium/alkyl phenol mixture. In a preferred embodiment, the tebuconazole and propiconazole are mixed together in the presence of form a less viscous solution that can then be added to the quaternary ammonium/alkyl phenol mixture. In this embodiment the tebuconazole and propiconazole mixture is heated to between about 65 °C and 75 °C with stirring.

[0117] Heating can continue during the admixture of the non-metallic antimicrobial agents and the quaternary ammonium antimicrobial agents if needed. Glycols and any anti-foaming agents or anti-freezing agents such as those discussed previously can be added at this point.

[0118] Once the quaternary ammonium antimicrobial agent, phenol, and non-metallic antimicrobial agents are mixed heat may be removed. As the admixture cools to room temperature water is added with stirring.

[0119] If styrenated phenols are used in place of the alkyl phenols the method according to the invention is very similar to that recited above. The primary difference in using a styrenated phenol is that less heat may be required during mixing. Of course, the use of heat will always be somewhat dependent upon the precise active ingredients chosen by the practitioner.

[0120] The relative amounts of quaternary ammonium antimicrobial agent, alkyl phenol, non-metallic antimicrobial agents, and water utilized in the practice of the method according to the invention are the same as those discussed in relation to the composition according to the invention. Likewise, the relative amounts of anti-foaming agents, anti-freezing agents. and additional antimicrobial agents, if any, are the same as those discussed in relation to the composition according to the invention.

[0121] An alternative embodiment of the invention is particularly well suited for use in non-aqueous systems. In this embodiment the invention comprises a non-aqueous microemulsion. The microemulsion comprises a quaternary ammonium antimicrobial agent, a first non-metallic antimicrobial agent, a second non-metallic antimicrobial agent, and a glycol. The preferred quaternary ammonium antimicrobial agent, first non-metallic antimicrobial agent, and second non-metallic antimicrobial

agent are the same as in the previous embodiment. Almost any glycol can be used in the practice of the invention but dipropylene glycol is a preferred glycol.

[0122] The preferred quantities of each element in the composition according to the invention is as follows: first non-metallic antimicrobial agent - about 10 wt. % to about 33 wt. %; second non-metallic antimicrobial agent - about 10 wt. % to about 33 wt. %; quaternary ammonium antimicrobial agent - about 0.33 wt. % to about 17 wt. %; glycol - about 17 wt. % to about 80 wt. %.

[0123] The method of making this embodiment of the invention is generally similar to the method of making the aqueous embodiment. The various components are mixed together in the appropriate quantities in the presence of heat, if needed. For example, several samples of the composition according to the invention were made in the following manner.

[0124] The first non-metallic antimicrobial agent (e.g., WOCOSEN TECHNICAL) was blended with dipropylene glycol under heat (approximately 65°C) in the desired relative amounts. To this mixture was added the quaternary ammonium compound (e.g., ONYXIDE 3300) while maintaining heat. The second non-metallic antimicrobial agent (e.g.. PREVENTOL A8) was then added with heat and mixing. The entire mixture was then stirred under heat until a clear microemulsion was formed.

[0125] The above non-aqueous embodiment of the invention is well suited for imparting antimicrobial characteristics to products produced in a non-aqueous environment.

Example

[0126] The following formulation, made in accordance with the above method, has shown commercially acceptable efficacy against the proliferation of microbes on kraft paper. All percentages are weight percentages.

[0127] Tebuconazole (WOCOSEN™ TECHNICAL)	19%
[0128] Propiconazole (PREVENTOL™ A8)	18.5%

[0129] Quaternary Ammonium (ONYXIDE™ 3300)	9.5 %
[0130] Alkyl Phenol (TRITON™ X-207)	43 %
[0131] Glycol (dipropylene glycol)	5%
[0132] Water	5%

Adhesive

[0133] The adhesive that attaches the fiberglass batting to the non-woven covering may also serve as a carrier for antimicrobial compositions. Several types of adhesives may be used depending upon the physical and chemical characteristics of the insulation and the non-woven covering. In preferred embodiments, however, the adhesive is an asphalt or tar-like compound such as those that are commonly used in the manufacture of insulation.

[0134] In most instances, the antimicrobial compositions can be added to the adhesive prior to application of the adhesive to the non woven covering. Simple mixing or blending of the antimicrobial agent with the adhesive will probably be the most effective method of addition in most instances. Other methods of combining the antimicrobial composition with adhesives will be readily apparent to those skilled in the art.

[0135] The antimicrobial compositions that can be used in combination with the adhesive include all of those discussed previously, including the preferred antimicrobial compositions. Preferred embodiments utilize an antimicrobial composition that includes agents selected from the group consisting of triclosan, propiconazole, sodium pyrithione, tolyl diiodomethyl sulfone; tebuconazole; thiabendazole; 3-iodo-2-propynyl butylcarbamate, metal ions, n-octyl-isothiazolinone, quaternary ammonium compounds, and mixtures thereof. N-octyl-isothiazolinone (OIT) and silver ions or silver zeolites are particularly preferred.

[0136] The weight percent of antimicrobial composition in the adhesive may vary from very little (e.g., less than 100 ppm)to very great (e.g., over 5000 ppm). The exact amount will depend upon the particular use of the insulation and the amount of antimicrobial composition used in conjunction with the non-woven covering.

Method

[0137] The invention also encompasses a method of manufacturing insulation which exhibits antimicrobial properties. The various examples set forth above discuss several methods of manufacture (e.g., spraying the non-woven covering). The above discussed methods are exemplary only and should not be interpreted as limiting the scope of the invention.

[0138] In very broad terms the method according to the invention comprises the steps of applying an antimicrobial composition to the non-woven covering and contacting a non-woven covering to an insulating material. The order of these steps may be reversed if such reversal is better suited to the overall process.

[0139] The step of contacting the non-woven covering to the insulating material includes any contacting step currently used in the industry. Such steps could include melt pressing synthetic polymer non-woven coverings to insulation or coating a non-woven covering with an adhesive then contacting the non-woven covering to the insulation. The use of tar like adhesives to contact paper coverings to fiberglass batting is probably the most commonly used method in the industry.

[0140] Likewise, the step of applying an antimicrobial composition to the non-woven covering comprises any of the methods discussed above including spraying, coating, dipping, etc. or otherwise contacting the antimicrobial composition to the non-woven covering. Adding the antimicrobial composition to an adhesive prior to or concurrent with contacting the non-woven covering to the adhesive is also included in the scope of this step.

[0141] Lastly, the antimicrobial compositions utilized in the method according to the invention include all of those antimicrobial compositions capable of providing a commercially acceptable level of efficacy against the microbe of concern. Particularly preferred embodiments of the method include the specific antimicrobial compositions discussed above.

That which is claimed is:

1. Insulation which exhibits antimicrobial characteristics and resists the growth of microbes, the insulation comprising:

an insulating material;

a non-woven covering adjacent said insulating material; and

an antimicrobial composition.

2. Insulation according to claim 1, wherein said insulation material comprises fiberglass.

3. Insulation according to claim 2, wherein said non-woven covering comprises kraft paper.

4. Insulation according to claim 3, further comprising an adhesive composition between said kraft paper and said insulating material, wherein said adhesive composition comprises an antimicrobial composition.

5. Insulation according to claim 4, wherein said adhesive composition comprises asphalt and said antimicrobial composition comprises an antimicrobial agent selected from the group consisting of triclosan, propiconazole, sodium pyrithione, tolyl diiodomethyl sulfone; tebuconazole; thiabendazole; 3-iodo-2-propynyl butylcarbamate, metallic antimicrobial agents, n-octyl-isothiazolinone, quaternary ammonium compounds, and mixtures thereof.

6. Insulation according to claim 5, wherein said antimicrobial agent is n-octylisothiazolinone.

7. Insulation according to claim 5, wherein said antimicrobial composition comprises a metallic antimcicrobial agent and said agent is silver.

8. Insulation according to claim 3, wherein said antimicrobial composition comprises an antimicrobial system having at least a first antimicrobial agent and a

second antimicrobial agent wherein said first and second antimicrobial agents are present at levels sufficient to exhibit efficacy against microbes.

9. Insulation according to claim 8, wherein said antimicrobial system comprises a first antimicrobial agent present in a first carrier and said second antimicrobial agent present in a second carrier and wherein said first and second carrier are soluble in each other.

10. Insulation according to claim 9, wherein said antimicrobial system is an emulsion of said first and second antimicrobial agents.

11. Insulation according to claim 10, wherein said first antimicrobial agent is selected from the group comprising propiconazole, sodium pyrithione, and mixtures thereof.

12. Insulation according to claim 10, wherein said second antimicrobial agent is selected from the group consisting of tolyl diiodomethyl sulfone; tebuconazole; thiabendazole; and 3-iodo-2-propynyl butylcarbamate, and mixtures thereof.

13. Insulation according to claim 3, wherein said antimicrobial composition comprises:

a quaternary ammonium antimicrobial agent,

an alkyl phenol,

a styrenated phenol, and

water.

14. Insulation according to claim 13, wherein said quaternary ammonium antimicrobial agent comprises an alkyl ammonium compound.

15. Insulation according to claim 13, wherein said alkyl phenol comprises at least one alkyl phenol having an alkyl group selected from the group consisting of C7 alkyls, C8 alkyls, C9 alkyls, C10 alkyls, and C11 alkyls.

16. Insulation according to claim 13,

wherein said quaternary ammonium antimicrobial agent is between about 1 wt. % and about 30 wt. % of the total composition,

said alkyl phenol is between about 20 wt. % to about 50 wt. % of the total composition, and

said styrenated phenol is between about 1 wt. % and about 10 wt. % of the total composition.

17. Insulation according to claim 13, wherein said quaternary ammonium antimicrobial agent comprises an alkyl ammonium compound.

18. Insulation according to claim 17, wherein said quaternary ammonium antimicrobial agent comprises an N-alkyl dimethylbenzyl ammonium compound.

19. Insulation according to claim 3, wherein said antimicrobial composition comprises:

a quaternary ammonium antimicrobial agent,

a phenol,

a first non-metallic antimicrobial agent,

a second non-metallic antimicrobial agent, and

water.

20. Insulation according to claim 19 wherein

said quaternary ammonium antimicrobial agent is between about 0.33 wt. % and about 20 wt. % of the total composition;

said phenol is between about 30 wt. % to about 80 wt. % of the total composition;

said first non-metallic antimicrobial agent is between about 5 wt. % and about 45 wt. % of the total composition;

said second non-metallic antimicrobial agent is between about 5 wt. % and about 45 wt. % of the total composition; and

said water is between about 0 wt. % and about 9 wt. % of the total composition.

21. Insulation according to claim 20, wherein said quaternary ammonium antimicrobial agent comprises an alkyl ammonium compound.

22. Insulation according to claim 20, wherein at least one of said first and second non-metallic antimicrobial agents are selected from the group consisting of azoles.

23. Insulation according to claim 22, wherein said first non-metallic antimicrobial agent comprises tebuconazole and said second non-metallic antimicrobial agent comprises propiconazole.

24. Insulation according to claim 20, wherein said phenol comprises an alkyl phenol having an alkyl group selected from the group consisting of C7 alkyls, C8 alkyls, C9 alkyls, C10 alkyls, and C11 alkyls.

25. Insulation according to claim 1, wherein said antimicrobial composition is present in an amount sufficient to prevent macroscopic growth on the wallboard in accordance with AATTCC Test Method 30 Part III.

26. Insulation according to claim 3, wherein said antimicrobial composition comprises a quaternary ammonium antimicrobial agent, a first non-metallic antimicrobial agent, a second non-metallic antimicrobial agent, and a glycol.

27. A method of manufacturing insulation which exhibits antimicrobial properties, the method comprising:

contacting a non-woven covering to an insulating material, and

applying an antimicrobial composition to the non-woven covering.

28. The method according to claim 27, wherein contacting the non-woven covering to the insulating material comprises application of an adhesive to the non-woven material or the insulation material or both.

29. The method according to claim 28, wherein applying an antimicrobial composition to the non-woven covering comprises adding the antimicrobial composition to the adhesive prior to application of the adhesive.

30. The method according to claim 27, wherein applying an antimicrobial composition to the non-woven covering comprises spraying the non-woven covering.

31. The method according to claim 27, wherein applying the antimicrobial composition to the non-woven covering comprises coating the non-woven covering.

32. The method according to claim 27, wherein the antimicrobial composition comprises an antimicrobial system having at least a first antimicrobial agentand a second antimicrobial agent wherein said first and second antimicrobial agents are present at levels sufficient to exhibit efficacy against microbes.

33. The method according to claim 32, wherein said antimicrobial system comprises a first antimicrobial agent present in a first carrier and said second antimicrobial agent present in a second carrier and wherein said first and second carrier are soluble in each other.

34. The method according to claim 33, wherein said first antimicrobial agent is selected from the group comprising propiconazole, sodium pyrithione, and mixtures thereof; and said second antimicrobial agent is selected from the group consisting of tolyl diiodomethyl sulfone; tebuconazole; thiabendazole; and 3-iodo-2-propynyl butylcarbamate, and mixtures thereof.

35. The method according to claim 27, wherein said antimicrobial composition comprises:

a quaternary ammonium antimicrobial agent,

an alkyl phenol,

a styrenated phenol, and

water.

36. The method according to claim 35, wherein said antimicrobial composition comprises:

a quaternary ammonium antimicrobial agent,

an alkyl phenol,

a first non-metallic antimicrobial agent,

a second non-metallic antimicrobial agent,

a glycol, and

water.