Antimicrobial Treatments:
Everything Product Manufacturers Need to Know

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Abstract:

The affect of microorganisms on industrial fabrics is a hot topic in today's marketplace. The ability to control bacteria, fungi, algae, and other microbes on woven, nonwoven, and coated fabrics can open the doors to marketplace opportunities. Product developers and manufacturers are investigating the use of antimicrobial treatments to meet consumer (or end-use) demand.

Microorganisms associated with industrial fabrics have a negative affect on the integrity and appearance irrespective of the fabric's end-use. They cause odor, staining, deterioration, and can contribute to human health problems. Construction textiles, for example, can be key factors in indoor environmental quality. Virtually any housewrap, insulation, sealant, soil stabilizer, and exterior or interior treatment, can create significant microbiological problems for the indoor environment or they can be a part of the solution. Medical textiles, on the other hand, take into consideration the real problems microbes can cause to the aseptic (sterile) environment where the health of the patients and workers are paramount. Since fabrics destined for outdoor wear or sporting goods are subjected to moisture and dirt on a daily use basis, they are also destined for bacteria and fungal growth and the subsequent odors, staining, deterioration, and skin related problems. In a similar way, consumer awareness to microbial problems exists for a wide variety of personal and household goods such as casual wear, outerwear, accessories, bedding, toweling, upholstery, shower curtains, and fabrics for automobiles, boats, trains, and airplanes.

Microbiological problems have been minimized by recent technology of monomers, fibers, finishes, and finished materials. Construction, in some cases, has reduced microbiological problems by chemical and physical design. But, in most cases of microbial control, active intervention with an antimicrobial agent is needed and desired by customers. Antimicrobials are not all the same and each has positive and negative attributes depending on the end-use and processing needs.

With the unending uses of textiles and the myriad of microbiological problems in processing and end-use, determining the need for control and the marketplace claims is often very challenging. Complex distribution channels and diverse consumers (retailers, brand name companies, and end users) make this even more complex. Maintaining customer focus while anticipating production and production technology needs are challenging yet attainable given the added value antimicrobial treatments offer. Adding to the complexity for the use of antimicrobials is the need for proper compliance with regulatory agencies in the countries of sale, use, and commerce.

Although the development/commercialization process seems complex, antimicrobial suppliers have positioned themselves to meet the harshest demands of product development specialists. The marketplace needs are diverse and the opportunities for extracting value from antimicrobial treatments are unending.

Introduction

This paper discusses why antimicrobial finishes are being applied to more products than ever before, the basic differences between antimicrobial technologies, and what those differences mean in safety, durability, and effectiveness.

Those responsible for product development at manufacturing facilities, retailers, or brand name companies are challenged with understanding the emotive (emotional) and engineered (performance) needs of their specific or diversified target customers. Finding features and benefits that encourage customers to make a purchase decision and to pay for the added value of these features is an unending and often complex process. Within the myriad of methodologies used for determining "needs" and "values," several common elements exist. However, none will fit every commercial situation. Once the need is established, the challenges have only begun. The process of fitting antimicrobial technology in textiles to product and customer needs is particularly complex. The complexities of textile materials, the varying manufacturing processes, and the chemistry, are complex enough, but add the complexity of antimicrobial chemistries, the science and art of microbiology, and the regulatory oversight and needs for compliance for antimicrobials and the task seems enormous.

Consumer Demand

The presence of bacteria, fungi, yeast, algae, and other microorganisms in our everyday lives is obvious to consumers at all levels. Problems of antibiotic resistant "super bugs," outbreaks of hospital acquired infections (nosocomial), *E.Coli* in foods, flesh eating bacteria, tainted water, "black mold" infesting buildings, SARS, AIDS, and the greatest unknown of these invisible pests have all become "press events" and are in front of consumers every day. As important as these microbial events are, they are only the tip of the iceberg when it comes to the real economic and human health impact of microorganisms. Microbial odors, staining, deterioration, and disease cost billions of dollars each year and take an uncounted toll in human morbidity (illness) and mortality (death).

Polls have indicated that the market is ready for antimicrobial products and the buying public has reinforced the polls with their pocketbooks. More than seven times as many anti-germ products were produced in 1998 than in 1992[1] and consumers' demands for antimicrobial products have grown dramatically since 1998. This increased demand for antimicrobial-protected products warrants increased scrutiny of the antimicrobials being put into the products.

The Antimicrobial Feature

There are hundreds and maybe thousands of chemistries on the earth that kill microorganisms. Many of these, like arsenic, lead, tin, mercury, silver, plant extracts, and animal extracts may be "natural," but can be highly toxic to people and the environment in most uses. An effective antimicrobial for the textile industry can't just kill or repel microorganisms, it must do so safely, over the life of the treated products, and without negatively affecting the other important characteristics of the textile.

The Impact of Microorganisms

Microorganisms -- mold, mildew, fungus, yeast, and bacteria -- are part of our everyday lives. There are thousands of species of microorganisms that exist are found everywhere in the environment and on our bodies and there are both good and bad types of microorganisms.

These organisms impact producers, retailers, and users of all kinds of products including entire buildings, building materials, people, equipment, processes, production of textiles, storage and transport of textiles, as well as the end users of textiles. Understanding microorganisms, who they are, where they come from, and why they grow on certain materials provides us a basis for controlling them and their negative effects. This control capability coupled with the right technology, can provide a valuable feature on a wide range of textiles.

Improving Performance & Function

This is a challenging and exciting time for the textile industry. In most geographical areas of the world, the polymer, fiber, textile, and garment

industries manufacturing base is contracting. This contraction from manufacturing exists in an economic and cultural environment where consumers are demanding better products with more features. This means that specification and quality control criteria are ever more important and features that offer the marketing edge for product differentiation, better margins, maintaining product line or corporate image, and are cost effective have an important place in every company's strategies.

Value enhancing finish technologies can be developed around fads and fashion trends, but the most enduring finish technologies are designed to improve fabric performance and function. Antimicrobial treatment is rapidly becoming a standard finish in some textile categories and should be viewed as a finish with a future, because they enhance apparel performance while meeting consumer-led feature demands.

Antimicrobials

The term antimicrobial refers to a broad range of technologies that provide varying degrees of protection for products and buildings against microorganisms. Antimicrobials are very different in their chemical nature, mode of action, impact on people and the environment, in-plant-handling characteristics, durability on various substrates, costs, and how they interact with good and bad microorganisms.

Antimicrobials are used on textiles to control bacteria, fungi, mold, mildew, yeast, and algae. This control reduces or eliminates the problems of deterioration, staining, odors, and health concerns that such organisms cause.

In the broad array of microorganisms, there are both good and bad types. Antimicrobial strategies for destructive organisms must include ensuring that non-target organisms are not affected or that adaptation of microorganisms is not encouraged.

Antimicrobial Differences

Leaching Action

Antimicrobials do not all work the same. The vast majority of antimicrobials work by migrating or moving from the surface on which they are applied. This is the mechanism used by leaching antimicrobials to poison a microorganism. Such chemicals have been used for decades in agricultural applications with mixed results. Besides the challenges of providing durability for the useful life of products, leaching technologies have the potential to cause a variety of other problems when used in fabrics. These leaching properties can allow contact with the skin and potentially affect the normal skin bacteria, cross the skin barrier, and/or have the potential to cause rashes and other skin irritations.

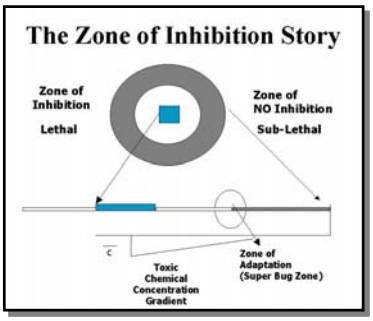
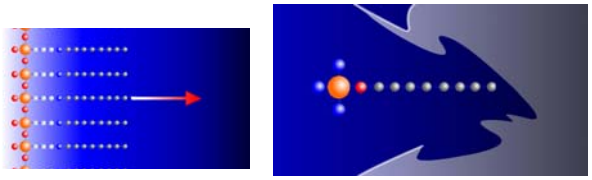


Fig. 1 Zone Of Inhibition Story

Physical vs. Chemical Action

An antimicrobial with a completely different mode of action than the leaching technologies is a molecularly-bonded unconventional technology. The unique bound antimicrobial technology, an organofunctional silane, has a mode of action that relies on the technology remaining affixed to the substrate - killing microorganisms as they contact the surface to which it is applied. Effective levels of this technology do not leach or diminish over time. When applied, the technology actually polymerizes with the substrate making the surface antimicrobial. This type of antimicrobial technology is used in textiles that are likely to have human contact or where durability is of value. Dr. M. Bourgeois and researchers at the "Institute Textile de France" in Lyon have also accomplished this type of surface modification by electron beam grafting of acrylic monomers with quaternary ammonium compounds to hydroxyl active surfaces.[2] In either case, durability to wear and laundering with broad-spectrum antimicrobial activity have been demonstrated.



Like swords, the bound technology is a permanent part of the surface. As the organism is attracted to the surface, it is electrocuted and destroyed. The antimicrobial is not used up but stands ready to fight again.

Antimicrobial Function and Adaptation

Antimicrobials function primarily in two different ways. The conventional leaching types of antimicrobials leave the textile and chemically enter or react with the microorganism acting as a poison. The unconventional bound antimicrobial stays affixed to the textile and, on a molecular scale, physically stabs (the lipoprotein components of the membrane) and electrocutes (the anionic biochemicals in the membrane) the microorganism on contact to kill. Like an arrow shot from a bow or bullet shot from a gun, leaching antimicrobials are often effective, but are used up in the process of working, wasted in random misses, or complexed by other chemicals in the environments of use and abuse.

Some companies incorporate leaching technologies into fibers and slow the release rate to extend the useful life of the antimicrobial, even adding chemical binders and claiming they are now "bound." Whether leaching antimicrobials are extruded into the fiber, placed in a binder, or simply added as a finish to fabrics or finished goods, they all function the same. In all cases, leaching antimicrobial technologies provide a killing field or "zone of inhibition" or very slow leaching that contacts and reacts with the target microbe. This zone exists in real-world uses if it is assumed that the right conditions are present for leaching of a lethal dose at the time that it is needed. The zone of inhibition is the area around the treated substrate into which the antimicrobial chemistry leaches or moves to, killing or inhibiting microorganisms. This killing or inhibiting action of a leaching antimicrobial is witnessed when an AATCC (American Association of Textile Chemists and Colorists) 147 test or other zone of inhibition test are run. These tests are used to measure the zone of inhibition created by a leaching antimicrobial and clearly define the area where the antimicrobial had come off the substrate and killed the microorganisms in the agar. As fabrics treated with conventional leaching antimicrobials are washed, treatments are easily or slowly removed. Figure1 presents graphically a typical zone of inhibition test method. The blue area represents a textile material treated with a leaching antimicrobial. The clear zone surrounding the substrate represents the zone of inhibition and the sublethal zone is shown in gray. The area at which the zones merge is presented as the zone of adaptation. Figure 2 shows actual results on the difference between the leaching and the non-leaching antimicrobial treatments on textiles both as first treated and then after five household launderings.

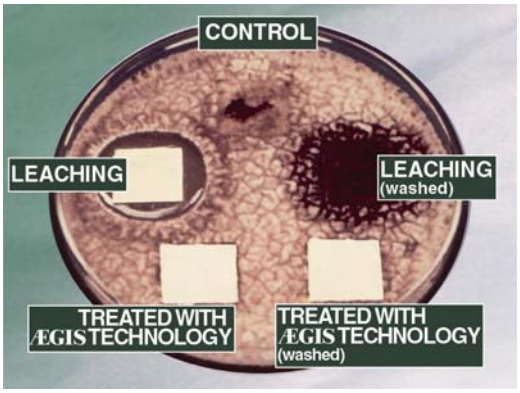
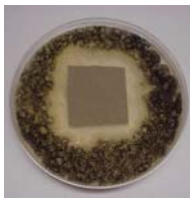


Fig. 2. Wash durability

Companies such as Microban Products, Thomson-Research, Milliken, Sanitized, X-Static, Avecia, Rhom and Haas, Dow Chemical, and others report successful use of these leaching and non-leaching products.

Microbes are Living Organisms

Like any living organism, microbes will take extreme measures to survive. Microorganisms can be genetically mutated or enzymatically induced into tougher "super-strains" if they are exposed to sublethal doses (exposed to - but not killed) of an antimicrobial agent. This ability of microorganisms to adapt to potential toxicants has been recognized in the medical community for years. Sublethal levels of antibiotics are generated in patients who discontinue taking antibiotics once their symptoms subside instead of continuing through to the end of the period prescribed by the physician. The exposure of the microbe to a sublethal dose of an antimicrobial can cause mutation of their genetic materials allowing for resistance that is then replicated through the reproductive process creating generations of microorganisms that are no longer affected by the chemistry. This phenomena is of serious concern to the medical community and food processing industries and should be a serious consideration for the textile industry as it chooses the antimicrobials to which it will be exposing the public and their workers.



As with any chemistry that migrates from the surface - a leaching antimicrobial is strongest in the reservoir, or at the source, and weakest the farther it travels from the reservoir. The outermost edge of the zone of inhibition is where the sublethal dose can be found—this is known as the zone of adaptation (Fig. 1). This is where resistant microbes that have been produced by leaching antimicrobials are found. The ongoing

challenge for leaching technologies is the control of the leach rate from their reservoir such that a lethal dose is available at the time that it is needed.

This is demonstrated in the following images from experiments where a microbe sample was taken from the outer edge of the zone of inhibition of a common leaching antimicrobial from treated carpet fiber (Fig. 3a) and used to inoculate a new test plate. This second test plate (Fig. 3b) shows the adapted microorganisms growing within the zone of inhibition. The adapted organism is taken from the second plate and used to inoculate a third plate (Fig. 3c). The microorganism used to inoculate this plate is fully adapted to the leaching antimicrobial and has overgrown the fabric. The ghost zone indicates the organism being slowed but not controlled by the leaching toxicant. All this occurred within just two generations of the test organism under these test conditions.

Figs 3a, 3b, and 3c The microbial adaptation story

A significantly different and much more unique antimicrobial technology used in the nonwovens and woven textiles industries does not leach but instead remains permanently affixed to the surface on which it is applied. Applied in a single stage of the wet finish process, the attachment of this technology to surfaces involves two means. First and most important is a very rapid process, which coats the substrate (fabric, fiber, etc.) with the cationic species (physisorption) one molecule deep. This is an ion exchange process by which the cation of the silane quaternary ammonium compound replaces protons from water or chemicals on the surface. The second mechanism is unique to materials such as silane quaternaryammonium compounds. In this case, the silanol allows for covalent bonding to receptive surfaces to occur (chemisorption). This bonding to the substrate is then made even more durable by the silanol functionality, which enables them to homopolymerize. After they have coated the surface in this manner, they become virtually irremovable, even on surfaces with which they cannot react covalently.[3] (Fig. 4)

Once polymerized, the treatment does not migrate or create a zone of inhibition so it does not set up conditions that allow for adapted organisms. Because this technology stays on the substrate, it does not cross the skin barrier, does not affect normal skin bacteria, nor causes rashes or skin irritations. This organofunctional silane technology has been used for over two decades to treat surfaces from leather and foams to virtually all types of fabrics and is not consumed by the microorganism. It does not poison the microorganism. When a microbe contacts the organofunctional silane treated surface of the fabric, the cell is physically ruptured by a sword-like action and then electrocuted by a positively charged nitrogen molecule (Fig. 5). This antimicrobial technology as the ÆGIS AEM 5700/5772 (silanequat) has been verified by its use in consumer and medical goods including

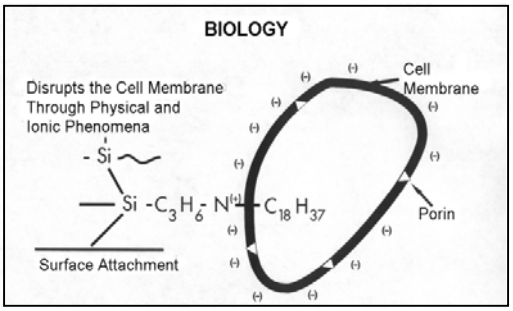


Fig. 4. Bonded chemical

socks, surgical drapes, and carpets in the USA, Asia, and other areas in the world. This technology has been used for nearly twenty-five years without any human health or environmental problems inside manufacturing facilities or in actual end-use situations.

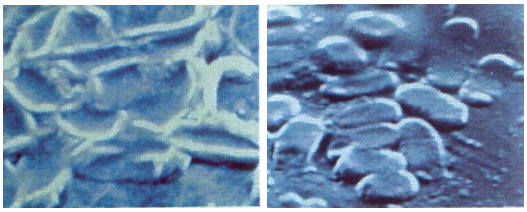


Fig. 5. Ruptured and healthy organisms on ÆGIS AEM 5700 treated (left) and untreated (right) nonwoven.

Application Methods

Antimicrobial technologies are quite varied and the demands for application are equally varied. Depending on the technology, the intended end-uses, and the mode of antimicrobial activity, one or another application point and procedure are favored. Adding to the fiber polymer melt, to the fiber during processing, or to the fabric or finished goods, are all available alternatives.

Addition to the polymer melt is fraught with problems that must be evaluated if this application point is being considered. The performance challenge presented by creating a toxicant reservoir inside of a fiber when the contact with the microbe will be on the surface is dependent on the solubility constant of the antimicrobial, the way that it is embedded into the polymer matrix, the chemicals ability to move in the polymer matrix, and the nature of the environment around the fiber during use. Other challenges revolve around the need for uniform mixing and subsequent dose release of the antimicrobial, changes in fiber properties, negative effects on color or reflectance, blocking of process filters, build-up on process equipment, odor, fuming, efflorescence or surface salting problems, or chemical conversion problems considering probable process temperatures of 230°C for 2-3 minutes. Also of concern is the health and environmental issues for personnel, users, and the environment. Cost of such a strategy must be considered because of the need to use levels of chemical in the reservoir suitable for providing a useful and effective dose during the life of the end-use product. Even with these challenges, a variety of chemistry have been reported in the literature and are commercially available. These include some bis-chlorinated phenol products and silver based technologies.

After a polymer is extruded into the fiber form, antimicrobials can be added with the drawing oils or spin finishes. This method has many merits if the issues of compatibility and uniformity can be solved and that properties of the spin finish are maintained. The fiber treatment must also be able to survive all of the downstream processing without interfering with the fiber processing or present any hazards to the workers, process equipment, or the environment.

In a similar fashion and with all of the same cautions, the antimicrobial treatment may be able to be added in one of the post drawing processing points. Adding at the crimper with or without the crimper oil can take advantage of the heat setting process to assure curing and durability of the antimicrobial binder or, in the case of the silanequat antimicrobial, enhance the bonding reactions needed to maximize durability.

Some antimicrobials, as reactive treatments or ones that are in binders, can be added to a spun bonded product, to the fiber batt, or to fibers or fabrics by spraying or pad bath. This can be done at the fiber processing plant or as a pre-step at the converters. This method allows for the treatment to be on the surface of the fiber yet still provides all of the needed compatibility and safety properties consistent with the process and the end-use. Simple deposition of the antimicrobial, although still practiced by some, is not a good alternative considering increased environmental and human sensitivities as well as concerns over sublethal antimicrobial doses allowing for microbial adaptation.

A final alternative is adding the antimicrobial on the final textile substrate. This can be done with spraying technology, exhaustion batch treatment processes, or with a pad bath. Foam applications have also been used effectively with the silanequat antimicrobial onto nonwoven batts or woven textile flat goods. Again, all of the needed compatibility and safety properties consistent with the process and the end-use must be assured.

Safety Profile

It is critical to review all uses of chemicals used in textiles in light of the intended use and the toxicological profile of the chemical. This is especially relevant as one remembers that antimicrobials, by definition and function, inhibit and/or kill living things. The mode of biological involvement needs to be fully understood so that a proper balance between risks and benefits can be made. Compliance with the regulatory agencies such as the US EPA or with criteria set up by review organizations such as Oekotex in Europe can provide certain degrees of assurance regarding safety to humans and the environment. For example, the following safety profile on the ÆGIS AEM 5700/5772 Antimicrobial can be considered a minimum profile of needed data for qualifying antimicrobial treatments for use on textiles.

The ability of the silanequat, when properly applied, to chemically bond to the textile substrate and still provide for the broad-spectrum control of microorganisms, makes it well suited to the safety challenges encountered in the full range of applications used in the nonwovens industry. This could be comforting but verifying safety studies were still needed. In a similar way "all natural" materials need to be evaluated in standard tests.

The following studies have been conducted with the silanequat: (a) acute oral, (b) acute ocular, (c) acute and subacute dermal, (d) acute vapor inhalation, (e) primary skin sensitization and irritation, (f) sub-acute vaginal irritation, (g) four-day static fish toxicity, (h) teratogenic evaluation, (i) sub-acute human wear test (socks), (j) human repeated insult patch test, (k) in-vitro Ames Microbial Assay with and without metabolic activation, (l) in-vitro mammalian cell transformation in the presence and absence of exogenous metabolic activation, (m) in-vitro Host-Mediated Assay and (n) a percutaneous absorption study. Although certain handling cautions are indicated by data from the above tests, no untoward effects are notable regarding treated substrates.

Further to these studies, Olderman reported on studies done by American Hospital Supply (Baxter Health Care), for a surgical drape that had been treated with the silanequat treatment. These studies included the following pre-clinical biocompatibility tests that are considered appropriate for skin contact medical products: (a) Tissue culture (cytotoxicity), to determine if a tissue culture medium (with serum) eluate of the test material can induce a cytopathic effect on monolayers of human (WI-38) cell, (b) Acute systemic toxicity to evaluate the potential of a single injection of an extract of the test material to produce a systemic toxicity response, (c) Intracutaneous irritation to evaluate the potential of a single injection of the test material extract to induce tissue irritation, (d) Eye irritation to determine the response of the rabbit eye to the instillation of specific extracts of the test material, (e) Hemolysis to determine if a substance can be extracted from the material which is capable of inducing hemolysis of human red blood cells, (f) Human Repeated Patch Test to determine if the test material is capable of inducing skin irritation and sensitization under controlled patch test conditions and (g). Extensive leachability studies to evaluate the durability and non-leaching potential of the chemically modified fabric when exposed to copious amounts of physiological saline, water and simulated human sweat.

The final results of these biocompatibility studies from the Olderman report indicated that the silanequat treated fabric is non-toxic, non-irritating and non-sensitizing to human skin, and has a permanent antimicrobial capacity that cannot be extracted in use. These pre-clinical studies provide sufficient information to allow us to predict the biocompatibility of the finished products and support their safe clinical use. As such, the treated fabric was considered safe for use in surgery. Years of clinical use with no untoward effects also support the suitability of the treated fabric for its intended use. [4]

In a similar way and to varying degrees, other antimicrobial technologies have been tested in such ways.

Fig. 6. Bromophenol Blue Assays

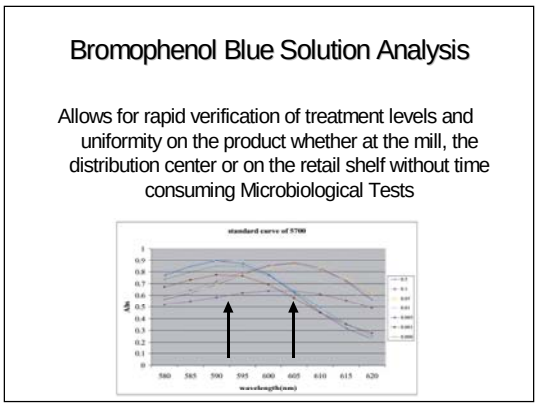


Fig. 7. Bromophenol Blue Solution Analysis

Antimicrobial Treatment Verification

Another important property of a useful antimicrobial is that its presence should be verifiable. In effect, it is the only way to know that an antimicrobial is really on the product. There is no easy way to tell whether leaching antimicrobials are present on a product. The only known verification technique for a leaching chemistry is to use exacting laboratory tests, which take days or weeks to perform. Yet, with the bound silanequat antimicrobial technology, a simple staining test can be performed in a matter of minutes at the mill or in a store to verify proper treatment of a fabric or other surface. This is a very important part of a quality assurance program that gives manufacturers, retailers, and consumers' confidence that a feature, normally invisible to the senses, can be seen and is actually on the product providing the protection for which they have paid.

Specific analytical tests designed to easily identify the antimicrobial agent concentration and uniformity have been developed. (Figs. 6 and 7)

This practice of employing fast, reproducible laboratory tests to give an indication of real-life activity is now commonplace, but the absolute relationship between laboratory performance and real-life performance is not indicated solely with one test. The goal of every test method is to determine the effectiveness of any given chemical agent against a variety of microorganism in the shortest amount of time.

In studying test design and implementation there are many levels of controllable and uncontrollable variables. (Fig. 8) Real-life tests can include wear trials, odor panel studies, weathering, and other end-use applications. To perform these type of tests on every antimicrobial product is impractical, expensive, and in some cases, impossible due to the number of samples needed to be statistically significantly and provide a product to the marketplace in a reasonable amount of time. Laboratory tests have been designed to give the highest degree of confidence to the end user that their treated article will perform as indicated on the products registrations and listings. These laboratory tests could include direct activity against microorganisms or simply indirect activity by virtue of the presence of the antimicrobial agent at specific levels. Whether the laboratory tests are indirect chemical assays or direct microbiological assays, the relationship towards real-life activity is still required. Once a link between laboratory data and real-life activity has been established, quick and reliable testing on newly produced material can be easily obtained.

The uncontrollable variables found in real world studies are enormous. The variables with

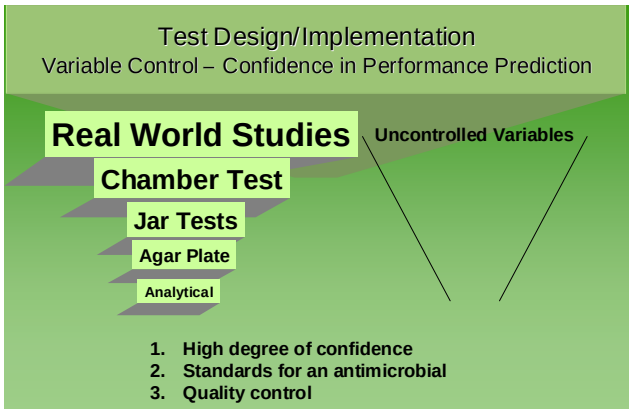


Fig. 8. Test Design/Implementation

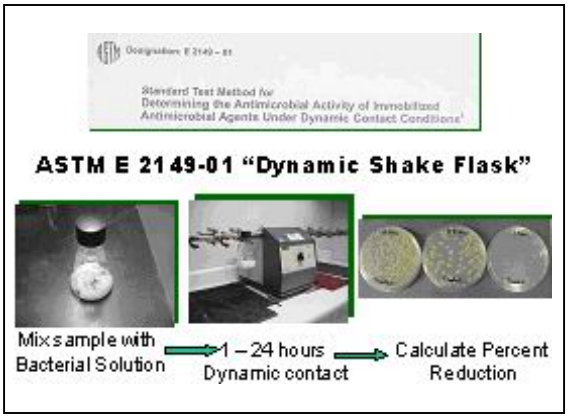


Fig. 9. "Dynamic Shake Flask"

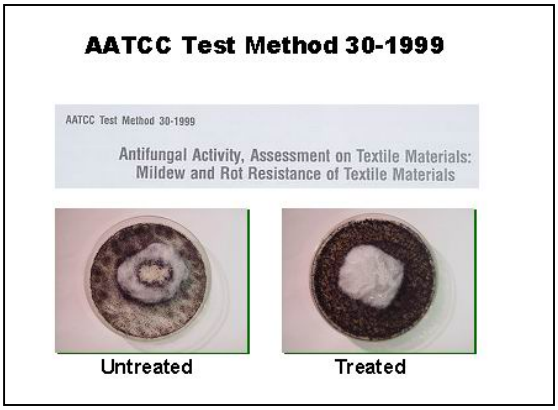


Fig. 10. AATCC test Method 100-1999

laboratory tests can include the type of organism used and concentration (dose), temperature, time, and eventually the test operator. As we develop test methods directly demonstrating real-life activity or laboratory activity we must focus on reducing the uncontrollable variables.

Most antimicrobial laboratory tests methods cannot, by themselves, give a prediction of real life activity. However, if a direct correlation between real life activity and laboratory activity can be established, routine laboratory tests can efficiently predict real-life activity. For example, the durable organofunctional silane technology provided by ÆGIS Environments has been proven to be effective in many real-life situations. These tests include odor panels, retrieval studies, wear studies, and *In Vitro* and *In Vivo* biomedical implantation studies. In direct relation, these real-life samples have been tested in the laboratory using the ASTM E2149-01 and AATCC100 antibacterial tests (Figures 9 and 10), AATCC30-III and ASTM G21 antifungal tests (Figure 11). As this link has been established for real-life activity and application concentration, the confidence that laboratory test results are an

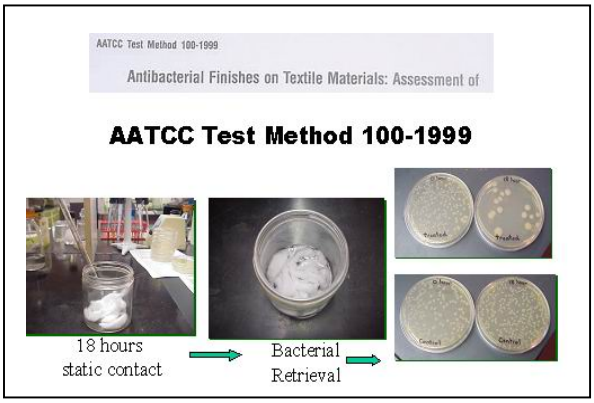


Fig. 11. AATCC test Method 30-1999

accurate indication of real-life activity increases. With the reduction of uncontrolled variables in laboratory test methods, confidence and significance in test results increases.

Antimicrobial Regulation

As we've discussed, not all antimicrobials are alike. There are technical differences between antimicrobials that affect their life, performance, safety, and costs. But, one thing is true for all antimicrobials and sometimes the treated products. The US Environmental Protection Agency, the EEC Biocide Directives, or other regulatory agencies around the world regulate all antimicrobials. Antimicrobials must be registered with the EPA, the EU, and other regulatory bodies for the specific uses. In some cases, antimicrobials have been misapplied. In other cases, antimicrobial products have made errant claims resulting in fines, sometimes totaling in the hundreds of thousands of dollars. Products exported to regulated areas with unregistered treatments or errant claims were turned back and supply dates were missed and retailers were left without goods on the shelves.

Conclusions

A manufacturer's antimicrobial of choice should be specifically registered for use on the end product being manufactured (i.e., an antimicrobial that is only US EPA registered for use in shoes should not be used for treating socks).

To benefit from the consumer demand for antimicrobial/antibacterial products as well as the antimicrobial/antibacterial performance needs of the construction textile world, manufacturers have a choice. In choosing, they should utilize a treatment that provides for a microbial control claim and an antimicrobial finish for their textile products consistent with their claims and the needs of their target consumers. This selection should be done by considering the following:

1.) Adopting a non-leaching antimicrobial that doesn't pose the risk of crossing the skin barrier or negatively affecting the normal microbial flora of the skin. If it creates a "zone of inhibition" or must integrate into the all to have function, it leaches or moves and has the potential to cause problems to people and the environment.

2.) Adopting an antimicrobial technology with a proven history of use. This will help shorten the timelines in bringing products with an antibacterial/antifungal/odor-reducing, antimicrobial feature to market.

3.) Adopting a non-leaching antimicrobial that doesn't pose the risk of creating adaptative resistant microorganisms.

4.) Adopting an antimicrobial technology that is registered with the EPA, the EU, and other regulatory agencies for the specific product it is applied to.

5.) Adopting an antimicrobial technology that can be tested for proper application at the mill or at the retailers. A verifiable quality assurance program should be a key component of any application process.

6. Adopting an antimicrobial technology that has technical and marketing support.

Numerous retail buyers have stated that the antimicrobial/antibacterial "feature" is quickly moving to a standard requirement for the products that they buy. Manufacturers that don't currently treat fabrics with a durable antimicrobial finish should consider shielding their products from eroding value by incorporating microbial control. As manufacturers look to enhance the value of their products they should recognize antimicrobial finishes as a "feature with a future," and the future is now.

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