BIOVATION

Testing for Antimicrobial Activity in Textiles – Quick Overview

Textiles and clothing are in permanent contact with microorganisms from the environment and the human skin. Whereas in hot and wet climate major problems can arise with growth of microorganisms naturally present in the environment, which thrive and produce enzymes leading to the degradation of organic materials, e.g., the textiles. In moderate climates, major problems arise with bacteria transferred from human skin and colonize. Generally, textiles might be an excellent substrate for microbial growth, because they are made of organic materials providing a good base for biofilm attachment and the human sweat, which is retained by the textiles, provides nutrients necessary for bacterial growth. The human skin contains a complex mixture of microorganisms, even with "clean" skin having a typical population of between 100 –1000 microbes/cm^2. At these levels microbes pose neither a health or odor problem. To the contrary, their presence and balanced population is essential for human health. But when ideal growth conditions are provided, microbes rapidly multiply and can then cause problems preferentially with smell generation, loss of performance, discoloration of textiles and possibly infection. Most ideal growth conditions occur at high moisture, which is normally found under increased production of sweat. In extreme cases, microorganisms can cause serious problems, include fabric rotting, staining, unpleasant odors and health concerns ranging from simple discomfort to physical irritation, allergic sensitization, toxic responses, infection and disease. Many of the characteristic malodors associated with the human body are due to the presence of large populations of microorganisms. Also, the associated malodors are the result of these microorganisms digesting nutrients in the perspiration and releasing volatile pungent waste products[1]. Therefore the control of undesirable effects of microbes on textiles is becoming an important issue in textile industry. Currently, there is much interest in hygienic fabrics that offer an advantage in respect of cleanliness and odor prevention as a result of their antimicrobial properties or inherent reduced bacterial growth. Such fabrics include clothing, especially that worn next to the skin (lingerie, T-shirts, socks etc.), but also other domestic textiles, such as wipes, footwear and cloths.

[1] This and other significant portions of this paper are from, Linda Teufel and Bernhard Redl, "Improved Methods For the Investigation of the Interaction Between Textiles and Microorganisms", Lenzinger Berichte, 85 (2006), 54-60.

For testing of the antimicrobial activity a first overall classification of the method to be used is carried out on the basis of the kind of the evaluation of the micro-organism population. Reduction into intimate contact with an agar culture medium inoculated with the test bacteria (DIN EN ISO 20645 - 2001, AATCC 147). If a diffusible, or leaching, antibacterial activity is present, it will be possible to observe a clear zone around the treated sample comparing to the zone of bacterial growth around and the untreated control sample after the same contact time. However this method cannot be applied for non diffusible or fixed antimicrobial substances.

The Parallel Streak Method (AATCC 147- 2004) has filled a need for a relative quickly and easily executed qualitative method to determine antibacterial activity of diffusable and nondiffusable antimicrobial agents on treated textile

materials. In the “classical” Parallel Streak Method (for diffusable agents), the agar surface is inoculated making it easier to distinguish between the test organism and contaminant organisms which may be present on the unsterile specimen. The Parallel Streak Method has been proven effective over a number of years of use in providing evidence of antibacterial activity against both Gram positive and Gram negative bacteria. A modified Parallel Streak Method can be used to evaluate the antimicrobial activity of non-diffusable agents. Thereby, a piece of textile is pressed onto an agar plate and the test bacteria are inoculated over the specimen by three or four parallel streaks.

DIN EN 1650, AATCC 30, is a further semi-quantitative test for anti-mycotic properties, which shows the effectiveness of anti-microbial finishes on fungi and moulds. Samples are treated with a specific spore suspension of the target organism and incubated on agar plates. After evaluation, it is possible to establish the effectiveness of the anti-mycotic treatment. When testing resistance to moulds, it has to be considered that the incubation time must be at least twenty-one days.

Quantitative methods are based on the determination of the number of bacteria, still living after an opportune contact time. The quantitative evaluation can be differentiated reduction: qualitative or quantitative.

In the qualitative methods the test specimen and an untreated control are pressed further in other two classes according to the main test conditions. In the “Challenge Test”, a small amount of liquid culture medium is used to cover a specimen, while the fiber specimen is immersed in a larger amount of liquid culture when the dynamic “Shake Flask Test Method” is carried out. Most quantitative methods are adequately sensitive but cumbersome and time consuming for routine quality control and screening tests.

In Challenge-Tests JIS L 1902, DIN EN 1276, AATCC 100, ASTM E 2149-01, ASTME 2180-01 samples with and without antimicrobial substances are treated with a specific test germ suspension. The fluid is immediately washed off of one portion of the test bed, whilst incubation is allowed to take place on the remaining samples, before they are also washed off. The number of germs on each can then be counted and compared to quantify the effectiveness of the anti-microbial finishing. Test variants under growth conditions (nutrients supplied) and non-growth conditions (no or very little nutrients supplied) are in use.

The dynamic Shake Flask Test Method (BISFA) (10) is designed to evaluate the resistance of non-leaching antimicrobial treated specimens to the growth of microbes under dynamic contact conditions. This dynamic shake flask test was developed for routine quality control and screening tests in order to overcome difficulties in using classical static antimicrobial test methods to evaluate substrate-bound antimicrobials. These difficulties include ensuring contact of inoculum to treated surface (as in AATCC 100), flexibility of retrieval at different contact times, use of inappropriately applied static conditions (as in AATCC 147), sensitivity and reproducibility.

Although the methods described above have been originally developed to test the antimicrobial activity of modified fibers and textiles, they can be adapted for the assessment of bacterial colonization on various materials which have not been treated with antimicrobial agents.

Biocide Testing

For the given application and need there are several approaches to take for a biocide test as mentioned above. When it comes to textile, a quick “snapshot” is:

AATCC 100 – This antimicrobial test is a quantitative method (AATCC 100) in which assessment of antibacterial finishes on textile materials (fabric finishes, etc.) is determined by the degree of antibacterial activity intended in the use of such materials. The AATCC 100 or TM 100 is an antibacterial textile test method used to assess textiles treated with antimicrobial products as a part of the finished textile coating.

AATCC 30 – Test method to determine the susceptibility of textile materials to mildew and rot and to evaluate the efficacy of fungicides on textile materials. The AATCC TM 30 is a four part test comprising AATCC 30 part 1 to 4.4. Each AATCC 30 subpart is treated as a separate antifungal test.

AATCC 147 – The AATCC Test Method 147 is a qualitative antimicrobial test used to detect bacteriostatic activity on textile materials. This antimicrobial testing method is useful for obtaining a rough estimate of activity by the size of the zone of inhibition and the narrowing of the streaks caused by the presence of the antimicrobial agent permitting an estimate of the residual antimicrobial activity after multiple washings. The AATCC TM 147 is for testing antibacterial, bactericidal, bacteriostatic activity and provides a qualitative zone of inhibition type of result around the treated article.

AATCC 174 – This test method is designed to determine the antimicrobial activity of new carpet materials consists of three procedures. AATCC TM 174 is also a multipart test for testing antibacterial, antifungal, bactericide, fungicide performance of carpet fibers and materials.

There are also several related ISO standard used in the testing of textile resistance to bacterial and fungal growth. Determining which microbial test method is appropriate is determined by considering the use environment, antimicrobial type and application method.

A complete overview of testing protocols is given in the below table:

Agar plates, semi quantitative	Textile fabrics: Determination of the antibacterial activity	SN 195920 – 1992
	Textile fabrics: Determination of antimycotic activity	SN 195921 – 1992
	Antifungal activity, assessment of textile materials: Mildew and rot resistance of textile materials	AATCC 30 – 1993
	Antibacterial assessment of textile materials: Parallel streak methods	AATCC 147 – 1993
	Antibacterial activity of fabrics, detection of	AATCC 90 – 1982
	Antimicrobial activity assessment of carpets	AATCC 174 – 1993
Challenge test quantitative	Antibacterial finishes on textile fabrics, assessment of	AATCC 100 – 1993
	Testing method for antibacterial textiles	JIS L 1902 – 1998 and – 2002
	Textile fabrics: Determination of the antibacterial activity: Germ count method	SN 195924 – 1983
	Properties of textiles – Textiles and polymeric surfaces having antibacterial properties. Characterization and measurement of antibacterial activity	XP G39 – 010 – 2000
Dynamic shake flask test, quantitative	Testing methods for organic man-made fibers with antibacterial activity	BIFSA booklet, 2002, Chapter 4
Fouling tests, soil burial tests	Methods of test for fungus resistance	JIS Z 2911 – 1992
	Textiles – Determination of resistance of cellulose coating	ISO 11721 – 1 – 2001

Biovation Expertise

Biovation is chemical technology agnostic; meaning, Biovation does not limit itself to any particular set of antimicrobial platforms available in the commercial market. Rather, based on decades of research and development of formulations, it compounds and formulates customized and unique solutions for targeted specific applications. Hence, as part of chemical platforms available to Biovation, we can consider metals (for example, there are commercially available silver releasing powders that have obtained EPA registration status and are candidates for FDA medical devices and/or food packaging), metal compounds, surface active agents, surfactants, quaternary ammonium compounds, organic acids, inorganic acids, biopolymers, antioxidants, oxygen scavengers, carbon dioxide emitters and others provided in any combination and concentration. The combination and concentration of the various elements depends on the several factors such as the specific textile type, type of targeted end-use, the nature of the microbes to be controlled and hindered and other synergistic affects with the conditions present in the application environment.

Contact Us

Biovation's expertise is in infection control formulations and we look forward to partnering up with you. We invite you to contact us solutions@biovation.com to discuss how Biovation can help you with our portfolio of technologies and solutions.

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