The International Journal Of Engineering And Science (IJES)
||Volume||2 ||Issue||8 ||Pages|| 09-13||2013||
ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

The Effect of Microbes on Textile Material: A Review on the Way-Out So Far

BORYO, D.E.A.
Department of Science Laboratory Technology Federal Polytechnic, Bauchi, Nigeria

--ABSTRACT--
It is revealed that microbes survive on all classes of textiles materials comfortably and used them as source of nutrient. The outcome of this on the textile materials, environments and humans is devastating. Several attempt by researchers to minimize the effects using antimicrobial agents ended up with mixed results. However, chitosan seem to be the way out so far.

KEYWORDS: *microbes, fabrics, stain, odour, degradation, antimicrobes, chitosan.*

Date of Submission: Date 8july2013, Date of Publication: Date12 Aug2013,

I. INTRODUCTION

Biodeterioration has been defined as "any undesirable change in the properties of a material caused by the vital activities of organisms" [1]. Not all breakdowns of materials by micro-organisms is undesirable. When we discard object that we have finished with, we expect "nature" to clear away what has then become refuse. Such degradation is an essential process in the maintenance of the world in which we live, and a means of recycling many of the essential elements contained in these materials. However, when it is an unwanted process such as when textiles are affected by the microorganisms, then it can be a serious problem to manufacturers and users alike. This review will be concerned with the deterioration of textile material caused by micro-organisms and the steps taken so far to prevent or minimize their effects.

II. TYPES OF MICROBES THAT ATTACK TEXTILE MATERIALS:

Microbes are the tiniest creatures not seen by the naked eyes. They include a variety of micro-organisms like bacteria, fungi, algae and virus. An author [2] described bacteria as unicellular organisms which grow very rapidly under warmth and moisture. Further, subdivisions in the bacteria family are Gram positive *(staphylococus aureus)*, Gram negative (*E-coli*), Spore bearing or non-spore bearing type. Some specific types of bacterial are pathogenic and cause cross infection. Fungi, molds or mildew are complex organisms with slow growth rate. They are part of our everyday live and found everywhere in the environment and on our bodies.

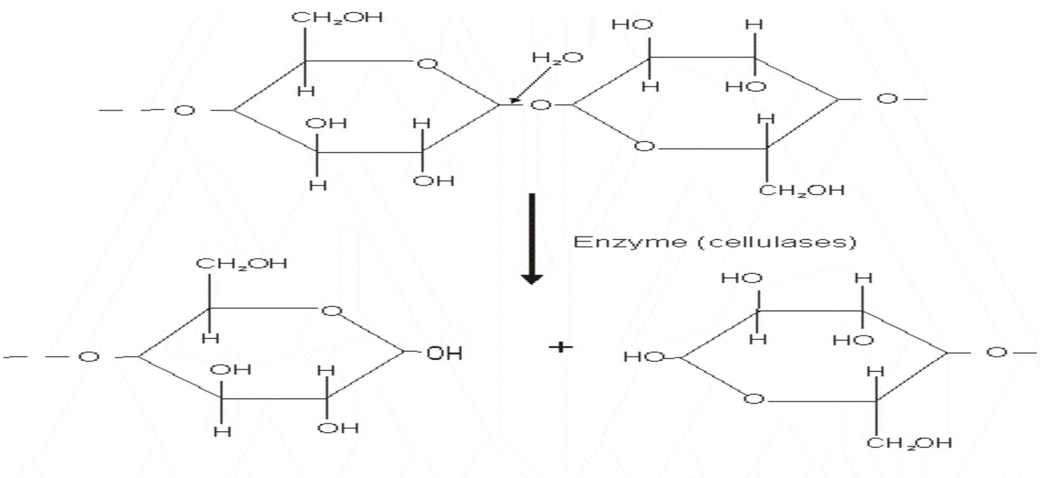
2.1 Attack Of Textile Materials By Microbes

The inherent properties of the textile fibres provide room for the growth of micro-organisms. Beside the structures of the substrates and the chemical processes may induce the growth of microbes. Humid and warm environments still aggravate the problem. Infection by microbes cause cross infection by pathogen and developments of odour where the fabric is worn next to skin [2]. In addition, the staining and loss of the performance properties of textile substrates are the results of microbial attack. Garments of health care workers are important aspect of the environments that can easily become contaminated. A recent study [3] reported that 65% of nurses who had performed patient care activities on patients with methicillin-resistant *Staphylococcus aureus* (MRSA) in a wound or urine contaminated their nursing uniforms or gowns with MRSA. One critical factor for transmission of a micro-organisms from a person (patient or health care worker) to the fabrics and then to another person is the ability of that microbe to survive on that surface of the fabric. A few studies have examined the survival of gram-positive bacteria on various surface [4, 5, 6 and 7] etc. These researchers investigated the survival of these microbes and confirmed survival of days to months. Thus, act as a reservoir for these microbes. The spread of HIV and hypatitis viruses by contact of contaminated materials has created increase pressure for protection of personnel with functional clothing [8]. The author reported that an unpleasant odour develops when among other things; bacteria convert human perspiration into some foul smelling substances such as carboxylic acid, aldehydes and amines

2.2.1 Natural Fibres

Textiles made from natural fibres are generally more susceptible to biodeterioration than are the synthetic (man-made) fibres [1]. This is because their porous hydrophilic structure retains water, oxygen and nutrients, providing perfect environments for bacterial growth. Products such as starch, protein derivatives, fats and oils used in finishing of textiles can also promote microbial growth. Micro-organisms may attack the entire substrate, that is the textiles fibres or may attack only one components of the substrate, such as plasticizer contained there in, or grow on dirt that has accumulated on the surface of a product. Nevertheless, even mild surface growth can make a fabric look unattractive by the appearance of unwanted pigmentation. Heavy infestation which results in rotting and breakdown of the fibres and subsequent physical changes such as loss of strength or flexibility may cause the fabric to fail in service. The material is attacked chemically by the action of extracellular enzymes produced by the micro-organisms for the purpose of obtaining food. Plants fibres such as cotton, flax (Linen), jute and hemp are very susceptible to attack by cellulolytic (cellulose-digesting) fungi. Indeed, the complete degradation of cellulose can be effected by enzymes, produced by the fungi and known as cellulases [1].

The reaction below explains the chemical process concerned [1].



The break down of cellulose under the influence of an enzyme

The reaction illustrates cleavage of a “glycosidic” bond in cellulose (a polymer of glucose) by reaction with a molecule of water. This hydrolysis of cellulose, which would otherwise be immeasurably slow, is accelerated by the present of an enzyme or biocatalyst. The insoluble polymer is converted into soluble sugar which can then be metabolized inside the bacterial or fungal cells. This lead to the loss of the textile’s functional properties such as elasticity or tensile strength The spores of these micro-fungi are present in the atmosphere and when they settle on suitable substrates they can quickly grow under favourable condition of temperature and humidity. The characteristic growth form of these “mould” fungi is known as mildew, a superficial growth which may discolour and stain the fabric, as many micro-fungi are capable of producing pigments.

2.1.2 Animal Fibres

Animal fibres are more resistance to mildew growth than plant fibres. Pure silk is less susceptible if completely degummed. Wool decays only slowly but chemical and mechanical damage during processing can increase its susceptibility to biodeterioration. When stored under adverse condition wool will eventually rot by the action of the proteolytic (protein-digesting) enzymes secretes by many micro-fungi and bacteria [1].

2.1.3 Synthetic Fibres

Man-made fibres derived from cellulose are susceptible to microbial deterioration [1]. Viscose (rayon) is readily attacked by mildews and bacteria, acetate and triacetate are more resistant although discolouration can occur if the fabrics are incorrectly stored [1]. Fibres made from synthetic polymers (for example acrylic, nylon, polyester, polyethylene, and polypropylene fibre) are very resistance to attack by micro-organisms [1]. The hydrophobic nature of these polymers is probably an important factor determining their resistance. Although the substance of a synthetic fibre by itself will not support microbial growth, contaminants of low molecular weight (for example residual traces of the caprolactam monomer of nylon 6) and compounds such as lubricant and spinning oils used in the finishing of textiles may provide sufficient nutrient for mild surface growth of a microorganisms. In most case this will not affect the strength of the fabric but can give rise to staining and discolouration which are often difficult or impossible to remove [1].

III. THE WAY OUT SO FAR ON THE ATTACK OF TEXTILE MATERIALS BY MICROBES

It was reported [9] that three out of four Americans are conscious of germs in their daily lives. This poll indicates that 61% of the women surveyed make an extra effort to buy antibacterial or antimicrobial products. People are totally concern over the problems of odour, staining, deterioration, and human health condition such as allergies or infectious disease, see Tables 1 and 2 [9 and 8].

Table 1: Some Common microbes and their influence

Kinds of Microbes		Odour	Influence on human body	Garment mostly stained		
				Hosiery	Under Wear	Trousers
Bacteria	*Staphylococcu*	+	Acute	+	+	-
	Bacillus subtilis	-	Conjunctivitis	+	+	+
	Escherichia coli	+	Ulcer	+	+	+
	Pseudomonas	-	thorax, otitis			
	Aeruginosa		Media	-	+	+
	Proteus vulgaris	+		+	-	-
	Klebsiella					
	Pnuemoniae			-	+	+
Yeast	*Candida*					
Fungi	*Albicans*		Thrust	+	-	-
Mold	*Trichophyton*		Cause of athlete's foots			
	Interdigital		Weakness and			-
	Aspergilillus		Decoloration of clothing			-
	Niger					

Source: [8]

Table 2: AATCC Method 100, Antimicrobials on fabric AEM 5700 Antimicrobial Treated Non woven

Sample	Microorganism	% Reduction
Untreated Control	*Staphylococcus aureus*, Gram (+) Bacteria	16
AEM 5700 Treated	*Staphylococcus aureus*, Gram (+) Bacteria	100
Untreated Control	*Escherichia coli*, Grams (-) Bacteria	0
AEM 5700 Treated	*Escherichia coli*, Grams (-) Bacteria	99.6
Untreated Control	*Klebsiella Pnuemoniae*, Gram (-) Bacteria	0
AEM 5700 Treated	*Klebsiella Pnuemoniae*, Gram (-) Bacteria	99.9
Untreated Control	*Pseuldomonas Aeruginosa* Gram (-) Bacteria	0
AEM 5700 Treated	*Pseuldomonas Aeruginosa* Gram (-) Bacteria	98.6
Untreated Control	*Saccharomyces cerevisiae*, Yeast	0
AEM 5700 Treated	*Saccharomyces cerevisiae*, Yeast	100
Untreated Control	*Candida Albicans*, Yeast	0
AEM 5700 Treated	*Candida Albicans*, Yeast	99.9

Source: [9]

1.1 Low moisture content and application of biocides in textiles

It was suggested [1] that microbial activity (mildew and rotting**)** can be minimized by keeping susceptible materials dry, as surface growth will only occur when the relative humidity is high. The question is what of those places that humidity is high or textile material used out of doors. The researcher further recommended the application of biocides in the textile industries, such as organo-copper compounds, organo-tin compounds and chlorinated phenols. These act by interfering with the energy producing processes of microbial cells. Copper naphthenate, copper-8-hydroxyquinolinate, pentachlorophenol esters, and etc extremely versatile and effective biocides. The main disadvantage is that they impart a yellow-green colour to treated textile materials (cotton, canvases, military, uniform, socks, lining for footwear, hospital material, mattress etc). These biocides, for rot and mildew - proofing is usually applied as a final finishing process by impregnation with either solvent solution (white spirit) or emulsion of the biocide. However, these products ultimately lose their protection qualities through weathering even though 70%-80% of the biocide remains chemically unchanged in the formulation. One possible reason for this is that, under the effects of heat and ultraviolet radiation, depolymerization of the resin and subsequent cross-linkage may encapsulate the biocide, preventing its migration to the surface where biodeterioration takes place. Further research is required into ways of making both natural and synthetic materials more resistance to biodeterioration by chemical modification of their structures. This is important since doubts have now been raised about the toxicity and environment persistence of some of the hitterto to well establish biocides [1].

1.2 Application of antimicrobials by leaching technology

An author [9] confirmed that the vast majority of antimicrobials work by leaching or moving from the surface on which they are applied. This is the mechanisms used by leaching antimicrobials to poison a microorganism. Such chemicals have been used for decades in agricultural application with mixed results. Besides affecting durability and useful life, leaching technologies have potential to cause a variety of other problems when used in garments. These include their negative effects because; they can contact 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. A more serious problem with their allowing for the adaptation of microorganisms.

1.3 Application of antimicrobials by molecularly bond unconventional technology

The author [9] further reported an anti-microbial with a completely different mode of action than the leaching technologies is a molecularly bonded unconventional technology. The bound unconventional technology, an organo functional silane has a mode of action that lies on the technology remaining affixed to the substrate-killing microorganisms as they contact the surface to which it is applied. That is physically stabs and electrocutes the microorganisms on contact to kill it. 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 textile that are likely to have human contact or where durability is of value. Another example of surface modification is by electron beam grafting of acrylic monomers with quaternary ammonium compounds to hydroxyl active surfaces. In either case, durability to wear or laundering and broad spectrum antimicrobial activity has been demonstrated.

1.4 Adaptation and mutation of antimicrobes by microorganism

Microbes are living organisms and like any living organisms will take extreme measures to survive. 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 allowing for reproduction process creating generations of microorganisms that are no longer affected by the chemistry. This phenomenon is of serious concern to the medical community and should be a serious consideration for the textile industry as it chooses the anti microbial to which it will be exposing the public and their workers. Further research shows the adapted microorganisms growing within the zone of inhibition and over growing the fabric.

1.5 Natural and safer way out so far for textiles

A variety of antimicrobial finishes have been developed for application to textiles. All the active chemicals are designed to kill microbes and pests but the issue or otherwise to the humans continue to be area of concern.A researcher [8] reported that the most recent trend therefore appears to be a search for and development of technologies for use of unconventional natural materials such as chitosan for imparting antimicrobial finishing to home and medical textiles. Chitin is one of the most aboundants natural polymers in the world and its derivative, chitosan, is refined from shells of shrimp, crab and other crustaceans [10]. Biodegradable non-allergenic and non-toxic, chitin and chitosan have binding properties that work as excellent flocculants to clarify liquids; helps heal wounds quickly, form strong, permeable films and function effectively as drug-delivery gels for topical application of a variety of treatments [10]. This chitosan is a very specialized product. Its other benefit is that when applied to cellulose by cross linking, it gives both antimicrobial and moisture control properties. The technology for chitosan finishing has been successfully tested in Japan by UK based Specialty Textiles Products and is undergoing trials in Europe [8]. Another research in line with the use of chitosan is reported [2]. This author confirmed that chitosan is the most suitable finishing agents for medical wears with barriers against microorganisms. To carve a niche for textile materials, this kind of value adding finishes are the need of the hour.

IV. CONCLUSION

All classes of textiles materials are always subjected to microbial attack. There have been several investigations to the way out of the mess of microbes on textiles materials. It could be concluded that chitosan technology is the way out so far. This is most suitable and reliable for the fabric, user and the environment with respect to the conventional methods. Personal hygiene is another way out.

REFERENCES

[1]. F.H. Paul. Talking rot ---and mildew. *Textiles*, North West fungus Group. *19*, 1997, 46-50.

[2]. T. Ramachandran ., K. Rajendrakumar., and A. Rajendran. Anti- Microbial textiles-an overview *IE(1) Journal-TX*. Cornabatore. *84*,2004, 42-46.

[3]. A.N. Neely and P. Maley. Survival of Enterococci and staphylococci on Hospital Fabric and Plastic. *Journal of Chemical Microbiology* American Society for microbiology. 36(2),2000, 724-726.

[4]. J.A. Martinez, R. Ruthazer, K. Hansjosten, L. Barefoot and D.R. Syndman. Rde of Environmental Contamination as a Rist Factor For Acquisition of Vancomycin- Resistant Enterococci in Patients Treated in a Medical Intensive Care Unit. *Br J Anacsth. 163*, 2003, 1905-1912.

[5]. K.J. Hardy, P.M. Wawkey, F. Geo and B.A. Oppenheim. Methicillin resisitance *Staphylococcus* aureus in the critically Ill. *Br J Anaesth. 92*, 2004, 121-130.

[6]. G. Kampf and A. Kramer. Epidemiologic Background of Hand Hygiene and evaluation of most important Agents for Scrubs and Rubs. *Chemical Microbiaal*. Rev. *17*, 2004, 863-893

[7]. A.A.. Ramadlan and E. Hugedus. Survivability of Vancomycin resitance enterococci and fitness cost of Vancomycin resistance acquisition. *J. Chin. Pathol*. *58*, 2005, 744-746.

[8]. G. Deepti, *Antimicrobial Finishing of Textiles*. Resil Chemicals PVT Ltd, Delhi. 2001, Pp 1-4

[9]. W.W Curtis, A.M. Robert, W.K. James and V. Patrice, *A Comparison of Antimicrobials for the Textile Industry*, AEGIS ASIA PTE ltd, Easlink Building Singapore. 2000, 20-25

[10]. W. Raymond. *Chitin and Chitosan- Based products, Ingredients and Applications.* Vanson and Halosource: Enhancing life through Bioscience 2002, 40-46 .