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Saraquest

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CHEMISTRY BEHIND, GOOD FEELINGS

CONTENT

MEDICAL TEXTILES

Finishes for Personal Protective Clothing (PPE)

In the last few months, the transmission of pandemic infectious pathogens from a patient to healthcare personnel has been increasing and this has led to increase in demand of Personal Protective Equipment/Clothing (PPE). This is crucial, because using PPE is the only way that will protect the health personnel's like doctors, nurses, patients etc. from being infected. Understanding the gravity of the situation, Sarex has developed a range of Anti-microbial agents and Fluorocarbons which can be used on various textile substrates that are used in manufacturing of surgical gowns, face mask, gloves etc.

This document highlights the results of antimicrobial and repellent finishes on cotton, polyester and polyamide woven fabric which are used for various medical applications. For anti-microbial finish, Saraguard-5700 (Quaternary silane compound) & Saraguard-FL (Cationic polymeric compound) and for repellent finish, Careguard-66 (NEW) and Careguard-LTH which are based on C6 fluorocarbons were used. The treated fabric showed excellent resistance to Gram positive and Gram Negative bacteria and also showed alcohol and blood repellency. These finishes will also work on nonwoven fabrics.

Introduction

Hospital acquired infections (HAI) are a global crisis. Particularly in a hospital environment, there is increasing concern over exposure to various microorganisms that can be easily transmitted from environment to man causing different diseases. In hospital environment, there are many variables that affect the occurrence of infection to humans, no matter that hospital protocol is executed according to protocol. Therefore, there is still necessary to create innovative textile products which can act as effective barrier to reduce risk of infection which is very dangerous for people with impaired immune systems.

Medical textiles is also known as Healthcare Textiles. It is one of the most rapidly expanding sectors in the technical textile market. Recently, with the global improvement in the level of living, consumers are now showing the trend to seek healthcare or health protective products. There is an increase in the people's interest for protection against epidemic diseases like human coronavirus, H1N1, SARS etc. has been noted. It has been found that infectious pathogens can be transferred to healthcare personnel also due to their over exposure to the patients, through their respiratory organs and dermis via air and liquids (water, blood etc.), and through mucus membranes (eyes etc.) also the transfer of infection can take place, due to travelling in overcrowded trains, buses etc. Thus, respiratory, dermal and mucus membrane protection are essential for healthcare personnel.

Around the world, there are more than 53 million people working in the healthcare field. Personal protective equipment – known as 'PPE' is a critical component in the

hierarchy to protect these health care workers from infectious hazards. PPE includes gowns, respirators, face masks, gloves, eye protection, face shields, and head and shoe coverings.

Face mask, surgical gowns are identified as the most used piece of PPE, followed by gloves, in the healthcare industry. Surgical gowns address a dual function of preventing transfer of microorganism and body fluids from operating staff to the patient and also from patient to operating staff. Disposable surgical gowns offer several advantages over reusable's, but they are expensive and pose a risk of contamination outside of the hospital setting. Reusable gowns are generally made from woven fabrics and often contain cotton, polyester or a blend of these two fibres. The reusable surgical gowns are laundered and sterilized after every use in order to remove stains and kill bacteria. The greater advantage with reusable surgical gowns include less solid waste from limited disposal and more comfort to the wearer because of their better water vapor transmission. However they lose durability and barrier protection after repeated washing.

Nowadays, nonwoven fabrics are the most commonly used textiles for surgical gowns, patient drapes, laboratory coats, coveralls, and other kinds of protective clothing. Polyethylene terephthalate is a preferred textile fibre in many durable applications of nonwoven for its ease of sterilization and compatibility with other fibres. Although polyester has excellent mechanical strength and good stability but end use capacity is limited due to difficult to perform functional finishing because of lack of polar groups on the surface and poor wet ability.

Need for functional finishing on PPE-Clothing

The textile materials used in PPE are frequently subjected to the human blood which consist of various pathogens and causes cross infection. Blood and body fluids are considered as the carriers of the several microorganisms and can be transferred though barrier material like surgical fabrics, drapes, bed linens by wicking of fluids, pressure or leaning on flooded area. In order to protect the patients, hospital personnel and surgical team from such cross infection, it is a primary requirement that the fabric for these applications should be waterproof and breathable (water vapor permeable) in order to provide better protection and comfort for healthcare personnel. Along with these functionality requirements, it is also necessary that the fabric used should not promote the growth of any trapped infectious microorganisms. The above finishes will also help to protect the fabrics aesthetic, physical and biological properties.

Anti-bacterial finish on PPE-Clothing

To provide such functionality to fabrics, Sarex has developed highly effective and economical antimicrobial agents like Saraguard-5700 and Saraguard-FL which are suitable for all substrates and are highly durable and effective against pathogens, viruses and bacteria's.

Saraguard-5700 is a Quaternary Silane, methanol free, non-leaching antimicrobial agent.
Saraguard-FL is a non-leaching antimicrobial agent.

Both the antimicrobial agents can be used for finishing of all types of textile substrate and can be applied by padding, exhaust, soaking and spraying methods. They are effective against broad spectrum of microbes, pathogens and viruses. It passes AATCC 100, JIS L 1902 test methods.

Saraguard-5700 and **Saraguard-FL** provides a barrier shield and ensures protection of the treated textile, passively protecting the user. They also impart freshness, comfort and ensure material protection. The concept behind this shielding technology is to reduce and prevent the colonization and multiplication of bacteria, pathogens and viruses.

Fluorocarbon Finish on PPE-Clothing

Understanding the above requirement of manufacturing environmentally friendly fluorocarbons which are suitable for application in medical textiles, and keeping in mind the requirements of PPE clothing, Sarex has developed two fluorocarbons which can provide effective protection against blood, alcohol and body fluids.

Careguard-66 (NEW) is a new generation water and oil repellent fluorocarbon based on C6 Chemistry. It is a dispersion of fluoropolymer which imparts durable alcohol and blood repellency on polyester, cotton, and their blends.
Careguard-LTH is also a C6 based, non ionic, oil and water repellent which also gives alcohol and blood repellency. Careguard-LTH is more suitable for non-woven fabrics made of synthetic fibres.

Sarex fluorocarbons are Bluesign certified and meets the stringiest ecological parameters which are required for application on medical textiles.

Materials & Methods

Application of Anti-microbial agents: 100% Cotton, 100% Polyester and 100% Polyamide fabrics were treated with Saraguard-5700 and Saraguard-FL at required concentrations, with 65% pick-up. The pH of 5.5 was maintained and the fabrics were dried at 150°C for 2 min.

Application of Fluorocarbons: 100% Cotton, 100% Polyester and 100% Polyamide fabrics were treated with Careguard-66 (NEW) and Careguard-LTH at required concentrations, with 65% pick-up. The pH of the application bath was maintained 5.5 using 0.5gpl Acetic Acid, 5gpl IPA was also added to increase the pick-up. Fabric was finished with padding application and dried at 130°C for 2 min. and cured at 160°C for cotton and 170°C for 100% Polyester and Polyamide fabric.

Test Method for testing Blood and Alcohol Repellency: The blood repellency of the sample was assessed by using Impact Penetration Test and Spray test, AATCC 22. The synthetic blood was prepared by using distilled water , a surfactant (Acrysol G 110 , Rohm and Hass Co.) and red dye (C.I. Direct Red 081) according to ASTM F 23.40.01 for testing the resistance of clothing to synthetic blood. Alcohol resistance was tested as per AATCC 193.

Impact penetration test: According to AATCC 42-2000A of impact penetration test, a volume of water/synthetic blood was allowed to spray against a taut surface of the test specimen backed by a weighted blotter. The blotter was then reweighed to determine water penetration and the specimen is classified accordingly. The specimen 178 x 330 and the blotting paper were conditioned in an atmosphere of 65+2% RH and 21°C temperature for at least 4 hours before testing.

Antimicrobial Testing: Evaluation of the finished fabrics for antimicrobial activity was performed by AATCC-100 test method against *Staphylococcus aureus, Escherichia coli* and *Klebsiella pneumoniae* also they were subjected to 25 home launderings by AATCC 135A test method.

Results & Discussion

It is evident from Table 1 that treated fabrics showed excellent anti-microbial activity, while on the unfinished fabric there was heavy growth of bacteria. This is because fabrics finished with Saraguard-5700 and Saraguard-FL will bind with microorganisms to their cell membrane and disrupt the lipo-polysaccharide structure resulting in the breakdown of the cell, thus providing antimicrobial effect. Also, because of the binding capacity of the anti-microbial agents, the fabrics will show durability against home laundering. Also in addition to the below results, Saraguard-5700 will also provide protection against wide range of Gram positive and Gram negative bacterias, fungi, algae, viruses.

Table 1 : Antimicrobial activity on 100% Cotton, 100% Polyester and 100% Polyamide fabric

Recipe	% Reduction in Bacteria								
	Initial								
	100% Cotton			100% Polyester			100% Polyamide		
	SA	EC	KP	SA	EC	KP	SA	EC	KP
Unfinished	0	0	0	0	0	0	0	0	0
40g/l Saraguard-5700	99.93	99.75	99.21	99.95	99.85	99.23	99.85	99.20	99.72
50g/l Saraguard-FL	100	100	93.11	100	100	100	100	100	100
Recipe	**After 25 HL**								
	100% Cotton			100% Polyester			100% Polyamide		
	SA	EC	KP	SA	EC	KP	SA	EC	KP
Unfinished	0	0	0	0	0	0	0	0	0
40g/l Saraguard-5700	99.75	98.19	97.38	99.90	98.80	99.11	99.00	99.02	99.37
50g/l Saraguard-FL	90.08	81.53	93.54	99.93	98.34	95.50	100	99.96	99.84

SA : *Staphylococcus aureus*, EC : *Escherichia coli*, KP : *Klebsiella pneumoniae*

Table 2 shows the results of Blood repellency, Alcohol repellency and Spray test on 100% Cotton, 100% Polyester and 100% Polyamide fabric. The treated fabric shows excellent repellency for all the above three parameters and passes the test method.

Table 2 : Blood and Alcohol repellency on various substrates

Finishing agent	Blood Penetration Test (AATCC 42)			Alcohol repellency test (AATCC 193)			Spray Test (AATCC 22)		
	100% Cotton	100% Polyester	100% Polyamide	100% Cotton	100% Polyester	100% Polyamide	100% Cotton	100% Polyester	100% Polyamide
Unfinished	Fail	Fail	Fail	Fail	Fail	Fail	0	0	0
50g/l Careguard 66 (NEW)	Pass	Pass	Pass	Pass	Pass	Pass	100	100	100
60g/l Careguard-LTH	Pass	Pass	Pass	Pass	Pass	Pass	90	100	100

Healthcare associated infections (HAIs) have been part of health care delivery since antiquity and are major causes of morbidity and mortality. In the current fight against Corona virus, we believe that PPE will be at forefront in protecting our healthcare personnel's. The PPE-clothing like gowns, face mask, gloves etc. treated with Sarex fluorocarbons and anti-microbials are believed to protect the wearers from getting infected. The bacterial and blood barrier properties of treated and untreated fabrics have been assessed and it strongly implies for the development of bacterial and blood barrier materials for PPE clothing. Also the fabrics which are treated with both, the fluorocarbon and anti-microbial will meet the requirement of ISO 16603 and ISO 16604 Class 3 which are also required for medical application, we will be discussing more on this test methods in the forthcoming articles.

SARAGUARD-5700

Anti-Microbial Agent for Healthcare and Hygiene Textiles

Health care-associated infection (HAI) is an infection that is acquired in a hospital or any health care facility, including hospitals, ambulatory surgical centers, nursing home, rehabilitation facility, outpatient clinic, diagnostic laboratory or other clinical settings. Healthcare associated infections continue to trouble the healthcare industry. Unfortunately for hospitals, they are a great breeding ground for infections. *Clostridium difficile, Staphylococcus aureus, Escherichia coli*, fungi, viruses, or other, less common pathogens are responsible for HAIs. These unanticipated infections develop during the course of health care treatment which may results in significant patient illnesses and deaths. The infection can originate from the outside environment, another infected patient, staff that may be infected, or in some cases, the source of the infection cannot be determined.

Healthcare personnel comes in contact with patients infected with pandemic diseases like SARS (Severe Acute Respiratory Syndrome), AIDS (Acquired Immune Deficiency Syndrome), avian influenza (bird flu), H1N1 (swine flu), Corona virus and multidrug-resistant tuberculosis. It is necessary for healthcare personnel to wear Personal Protective Equipment (PPE) to limit morbidity and mortality of patients in their care, as well as themselves, their family members, and other members of the community to prevent a pandemic's larger societal progression. It has been found that infectious pathogens can be transferred to healthcare personnel through their respiratory organs, body fluids and through mucus membranes. Personal protective equipment (PPE) refers to physical barriers that are used alone or in combination, to protect mucous membranes, airways, skin and clothing from contact with infectious agents. Surgical gowns, gloves, masks, aprons, boots or shoe covers, cap or hair cover and related items used in operating rooms along with blankets, sheets, pillow covers, furniture covers and other products throughout the hospital and health care facilities also fall into this category. Commonly used PPE include medical masks, respirators, gloves, gowns and eye protectors. Some other types of PPE, such as face shields, are also occasionally used by healthcare workers. Among these, respiratory (medical masks, respirators etc.) and dermal (gloves, gowns etc.) protective equipment are primarily textile-based and used regularly by healthcare workers.

Nearly all textile materials that are being utilized in the hospitals viz., Healthcare workers' (HCWs) uniforms and PPE gets contaminated with bacteria and are conductive to cross infection or transmission of diseases originated by bacteria, fungi, viruses, pathogens. The existence and progression of microorganisms can be a source of health problems, odours and of course the weakening of the fabrics. Recently the outbreak of coronovirus throughout the globe has produced large stress for protecting the personals with functional clothing and materials. Antimicrobial property has thus become an important function to be incorporated in the uniforms and PPE as a means of reducing this contamination.

Sarex is therefore introducing a product Saraguard-5700 which is highly effective, durable, non leaching antimicrobial agent suitable for all substrates and effective against pathogens, viruses and bacteria's.

Mechansim of Action

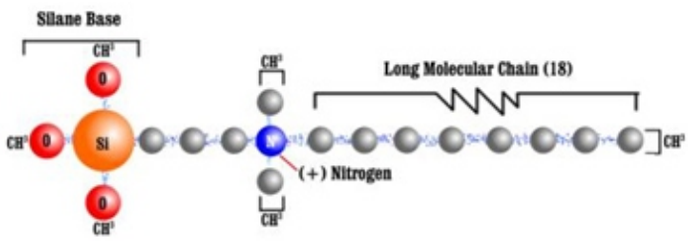


Fig. 1 Silane Quaternary Ammonium Compound in Saraguard-5700

The silanol (hydrolyzed silane) of Saraguard-5700 covalently bonds to fabric surfaces. This bonding becomes more durable by the silanol functionality, which homo-polymerizes i.e. forms chemical bonds with each other. After the molecule has homo-polymerized, it becomes an integral and permanent part of the fabric thereby imparting durable antimicrobial activity to the finished fabric.

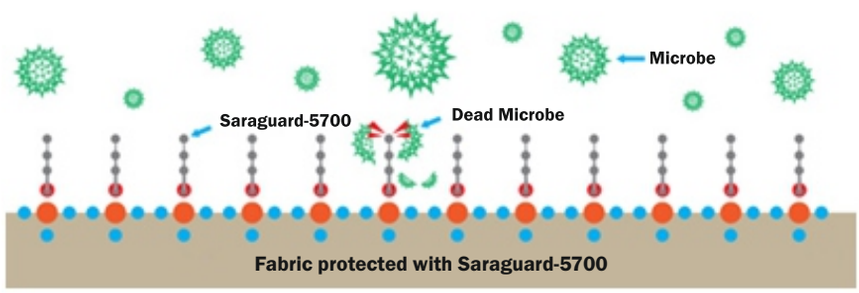


Fig. 2 Mechanism of Saraguard-5700

When a microbe contacts the positively charged organo-functional silane treated fabric surface, the cell membrane is physically ruptured by a sword like action as shown in Fig. 1 and then electrocuted by a positively charged nitrogen molecule as shown in Fig. 2. Antimicrobial activity will be effective as long as the surface of the treated substrate remains intact. Since it is not consumed and does not leach-out, the antimicrobial activity is not depleted and continues to control microbial growth.

Unique Key Features

- Methanol free, Silane based, Non-leaching Anti-microbial agent.
- Effective against broad spectrum of microbes, pathogens, bacteria, viruses, algae, mold, yeast.
- It is highly suitable in Medical textiles, Healthcare and Hygiene textiles, Apparel fabrics and Personal Protective Equipments (PPE).
- It is highly suitable in medical textiles, healthcare and hygiene textiles and Personal protective equipments (PPE). PPE refers to protective clothing, helmets, gloves, face shields, goggles, facemasks and/or respirators or other equipment designed to protect the wearer from injury or the spread of infection or illness.
- Applicable on all types of textile substrates including woven, non-woven and composites. It is also applicable on non-textile substrates viz., glass, table top, flooring, cartons etc.
- Can be applied by padding, exhaust, soaking and spraying methods.
- Durable to multiple home launderings.

Effective against following microbes : Bacteria, Fungi, Yeast, Mold, Algae, Viruses

Bacteria		Fungi	Yeast	Algae	Mold	Viruses
Gram positive	Gram negative					
• *Staphylococcus aureus* • *Bacillus subtilis* • *Streptococcus faecalis*	• *Escherichia coli* • *Klebsiella pneumonia* • *Samonella typhosa* • *Mycobacterium tuberculosis*	• *Aspergillus niger* • *Aspergillus terreus* • *Aspergillus flares* • *Chaetonium globosum*	• *Saccharomyces cerevisiae* • *Candida albicans*	• *Cyanophyta oscillatoria* • *Cyanophyta anabaena* • *Chlorophyta selenastrum gracile*	• *Black mold*	• *Influenza A2* • *Influenza B* • *Adenovirus*

End application includes

- ☑ Surgeon Gowns
- ☑ Caps
- ☑ Faces Mask
- ☑ Gloves
- ☑ Bandages
- ☑ Bed Linens
- ☑ Patient Drapes
- ☑ Cover Cloths
- ☑ Ambulance Blankets
- ☑ Stretchers
- ☑ Filter Materials
- ☑ Diapers
- ☑ Bedding
- ☑ Blankets
- ☑ Pillow Cases
- ☑ Hospital Uniforms
- ☑ Incontinence Diapers
- ☑ Wipes
- ☑ Surgical Hosiery etc.

Application Method

100% Cotton, Polyester and Polyamide fabrics were treated with Saraguard-5700 at required concentrations, with 65% pick-up. The pH of 5.5 was maintained and the fabrics were dried at 150°C for 2 min.

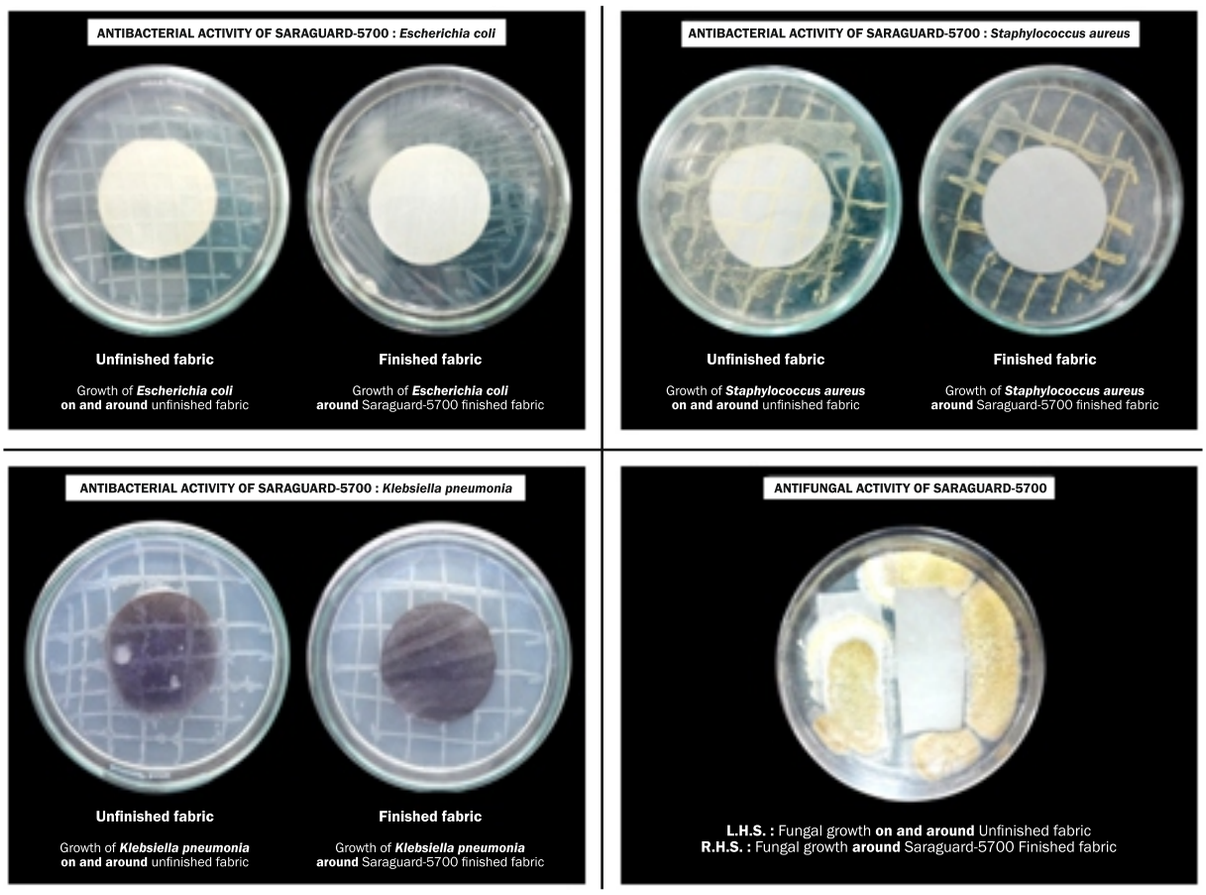
Evaluation

The finished fabrics were taken further to study their antimicrobial activity. Following test methods were followed to study the efficacy of product.

- Assessment of antibacterial finishes on textile materials : AATCC 100
- Assessment of Antifungal activity on textile materials : AATCC 30
- Durability Study : AATCC 135

Results & Discussion

Representation of Antimicrobial Activity



Antibacterial Activity on various fabrics – 25 HL

40g/l Saraguard-5700	Reduction in Bacteria (%)					
	100% Cotton fabric		100% Polyester fabric		100% Polyamide fabric	
	Initial	25 HL	Initial	25 HL	Initial	25 HL
Staphylococcus aureus	99.93	99.75	99.95	99.90	99.85	99.00
Klebsiella pneumoniae	99.21	97.38	99.23	99.11	99.72	99.37
Escherichia coli	99.75	98.19	99.85	98.80	99.20	99.02
Methicillin-resistant Staphylococcus aureus (MRSA)	99.96	90.13	99.99	87.33	98.19	89.33

HL : Home Laundering

From the photograph of the antimicrobial activity and the results tabulated above, Saraguard-5700 proved its efficacy as an effective antimicrobial agent. Also the silanol (hydrolyzed silane) of Saraguard-5700 covalently bonds to the fabric surfaces and also homo-polymerizes i.e. forms chemical bonds with each other thereby imparting durable antimicrobial activity to the finished fabric.

HELAR (CONC)

Potassium Permanganate Neutralizer

Denim, a strong and durable fabric, is a type of cotton twill textile known for its use in blue jeans and other clothing's. Denim has risen to be a fashion icon and is being adorned by fashion models. Denim garments are looked at as a major trend setter by the youth. With changing times, many new variants of denim came into existence. Denim became most popular for its special finishes and different washes. Washing has such an important part in the denim chain because of the umpteen effects that consumers look for in their jeans. A better washed product ensures a higher standard of denim. Denim washes is an important textile operation for adding value to denim/jeans fabrics and making them attractive to younger customers, particularly by equipping them with a faded or worn fashion look.

Denim garments such as jeans, jackets and skirts are considered by many to be more fashionable once they have attained a faded, worn appearance. Accordingly, denim fabrics and/or garments are frequently subjected to a bleaching to give them a bleached, super-bleached, rifled or white washed appearance. Potassium permanganate is very desirable for such an oxidative bleach treatment. Potassium permanganate spray is done on jeans to obtain a bright effect on sand blast area. Potassium permanganate spray appears pink on garment when fresh and turns to muddy brown on drying.

The garment is hanged in open to dry after potassium permanganate spray and when the potassium permanganate turns its colours completely then it is considered to ready for next process.

After reaching the desired bleaching effect the rest of unconsumed potassium permanganate and the formed brown manganese oxide hydrate have to be removed thoroughly. When applied in a solution an even fading is obtained. Unfortunately, dark colored, insoluble manganese oxide is deposited on the denim resulting in a dirty, stained appearance. As a result of the chemical reaction, manganese oxide is formed which needs to be eliminated by neutralization after the bleaching process is finished. The manganese oxide can be removed by a neutralization process where in the manganese oxide is converted into soluble manganous salts. Usually bleaching is done with the water ratio at 1:8 to 1:10, the pH slightly acid at 4.5 – 5.5, the temperature not higher than 40 °C.

Latest after 15 min the process is finished and neutralization should be done for about 10 min. Sarex has developed a product Helar (Conc) which is a potassium permanganate neutralizer. Below mentioned are its unique key features.

Unique features of Helar (Conc)

- It removes dirty brown stains after potassium permanganate bleaching.
- Makes fabric look whiter and brighter.
- The neutralization effect of this product is superior and clean.
- The dosage of this product is very small as it is a concentrated product.
- There is no harmful substance and no bad odor in the treated garments after use.

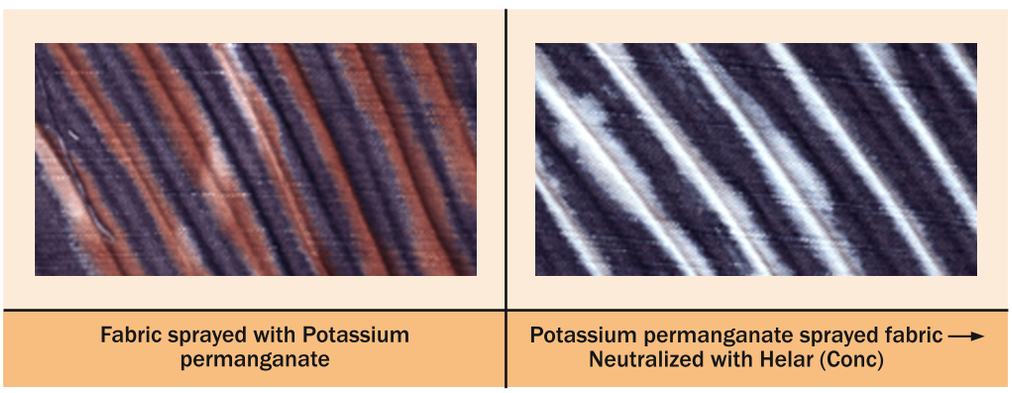
Mechanism of Helar (Conc)

Helar (Conc) neutralizes the Potassium permanganate present on the fabric and removes the formed brown stains which are caused due to Manganese oxide which is formed during bleaching of denim, thus it gives brighter and whiter look to the garment.

Application process:

Helar (Conc)	: 0.2-0.5%
Bath pH	: 4.5-5.5
Bath temperature	: 30-40°C
Time	: 15-20 min.

Performance data of Helar (Conc)



Fabric sprayed with Potassium permanganate

Potassium permanganate sprayed fabric → Neutralized with Helar (Conc)

Helar (Conc) is an effective potassium permanganate neutralizer results of which could be clearly seen from the performance data photographs.

Sarex

Sarex stands for quality products!

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