



APPLICATION OF VARIOUS OPTICAL BRIGHTENING AGENTS (OBA'S/FWA'S) FOR VALUE ADDITION OF INDIAN TEXTILES: A REVIEW

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Abstract: This review highlights the use and application of different types of Optical Brightening Agents (OBAs) or Fluorescent Whitening Agents (FWAs) in the textile industry to improve the whiteness of textiles. To avoid the yellowing of the fabric in long term applications, OBAs have a significant role to play. The type and application of OBA in combination with the bleaching application will govern the whiteness of the fabric, which are most recent advances in the field. This review represents a summary of OBA applications in textile processes. The described methods could be used to standardize this processing so as to have advantages as well as in terms of ecology as in economy.

Index Terms - Optical Brightening Agents (OBAs), Fluorescent Whitening Agents (FWAs), Yellowing, Bleaching, Enzymatic Bleaching, Whiteness Index.

1. INTRODUCTION

Natural fibres generally absorb more light in the blue region of the visible spectrum than in others because of impurities (as natural pigments) they contain. As a result, natural fibres take on an unwanted, yellowish cast. In the case of synthetic fibres the effect is not so pronounced. Whiteness in these substrates can be improved by the action of products named optical brighteners, fluorescent brightening agents or fluorescent whitening agents (FWA), by intensifying the whiteness level or the color of the material [1]. An optical brightener or fluorescent whitening agent is a compound which, when applied to a textile material, absorbs the short wavelength electromagnetic radiation (300-400 nm) which is invisible to the human eye, and converts it into visible light of longer wavelength between 400 and 500 nm, which is emitted either as violet, pure blue or greenish blue. When the radiation is combined with the more yellowish self color of a textile material, a brilliant white is produced [2]. In colored textiles, the presence of an optical brightener or fluorescent whitening agent will intensify the colors [3]. The evaluation and application of different types of OBAs with a selective procedure over textile materials has been reviewed in this study.

2. GENERAL OBA CONCEPT

The operation of whitening, i.e., bleaching or brightening, is concerned with the preparation of fabrics whose commercial value is dependent on the highest possible whiteness. In bleaching, textile process houses are concerned with the removal of colored impurities or their conversion into colorless substances. In chemical bleaching, impurities are oxidized or reduced to colorless products. Physical bleaching involves the introduction of a complementary color whereby the undesired color is made invisible to the eye in an optical manner, e.g., in blueing the yellow cast of substrates such as textiles, paper, sugar, etc. is eliminated by means of blue or blue-violet dyes. Through color compensation the treated product appears whiter to the

eye; however, it is actually greyer than the untreated material. With the aid of Optical brightening agents (OBAs), also referred to as Fluorescent whitening agents, optical compensation of the yellow cast may be obtained. The yellow cast is produced by the absorption of short-wavelength light (violet-to-blue). With OBAs, this lost light is in part replaced; thus a complete white is attained without loss of light. This additional light is produced by the whitener by means of Fluorescence. Fluorescent whitening agents absorb the invisible UV portion of the daylight spectrum and convert this energy into the longer wavelength visible portion of the spectrum, i. e., into blue to blue-violet light. Fluorescent whitening, therefore, is based on the addition of light, whereas the blueing method achieves its white effect through the removal of light.

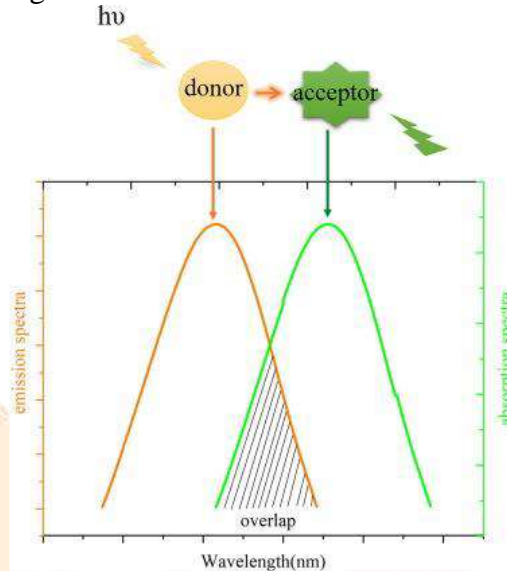


Fig 1: Absorption and Emission Spectra

A fluorescent whitener should be optically colorless on the substrate, and should not absorb in the visible part of the spectrum. In the application of OBAs, it is possible to replace the light lost through absorption, thereby attaining a neutral, complete white. Further, through the use of excess whitener, still more UV radiation can be converted into visible light, so that the whitest white is made more sparkling. Since the fluorescent light of a fluorescent whitener is itself colored, i.e., blue-to-violet, the use of excess whitener always gives either a blue-to-violet or a bluish green cast. Many chemical compounds have been described in the literature as Fluorescent compounds that provide a suitable whitening effect. Collectively these materials are aromatic or heterocyclic compounds; many of them contain condensed ring systems. An important feature of these compounds is the presence of an uninterrupted chain of conjugated double bonds, the number of which is dependent on substituent as well as the planarity of the fluorescent part of the molecule. Almost all of these compounds are derivatives of stilbene or 4, 4-diaminostilbene; biphenyl; 5-membered heterocycles such as triazoles, oxazoles, imidazoles, etc. or 6-membered heterocycles, e.g. coumarins, naphthalimide, s-triazine, etc [4]. Textile substrates of natural or synthetic fibers are contaminated in the raw state by substances of varying degrees of yellowness. Bleaching is required to remove the yellowish cast. Chemical bleaching agents destroy the yellow coloring matter in fibers. However, even if bleaching processes are carried to the technically acceptable limits of damage to the fibers, they never succeed in completely removing this intrinsic color. To produce the color-white, it is necessary to dye with a fluorescent whitener.

OBAs used in textiles can be divided into three categories viz;

1. Products containing sulfonic acid groups, corresponding to acid dyes, for cotton, wool, and polyamides;
2. Cationic whiteners that behave in the same way as basic dyes, for polyacrylonitrile fibers; and
3. Whiteners containing no solubilising groups, corresponding to disperse dyes, for polyester and secondary acetate fibers.

3. CONCEPT OF YELLOWING

Yellowing of textile fabrics is one of the oldest and most widespread quality problems known. The yellowing can be seen directly in the case of market whites, pastel shades or even after washed denims. However, shade change noticed in darker colored fabrics can often be attributed to chemical change or degradation of the fiber or some chemical agent either purposely applied to the fabric in finishing or inadvertently absorbed by the fabric in its storage and shipment to market or during its end use.

3.1 Causes of Yellowing

All types of textile products have been subject to yellowing including those made from natural fibers such as cotton wool or silk, as well as those composed of synthetic fibers such as polyester, nylon, or spandex. It should also be noted that in the cases of blended fabrics, at times only one fiber in the blend may be affected by the yellowing. However, at other times several or all fibers in the blend are affected. Specifically, the cause of the yellowing often determines which fiber(s) in the blend exhibit the yellowing. This fact can be used as a diagnostic tool to help determine the source of the observed yellowing and aid in the development of a strategy to prevent future problems. In recent years, the various causes of these yellowing issues have been studied extensively with the subsequent publication of numerous technical papers and reports [5,13]. Generally, the causes can be grouped into the following broad categories with the understanding that there can be crossover or combinations of causes that yield observed fabric yellowing:

- a. **Fiber Degradation** – Destruction, decomposition, internal change of the fiber structure due to chemical or biological degradation, exposure to excessive heat, intensive or long term exposure to light radiation and/or fiber aging are all primary causes of fabric yellowing. Additionally, specific fiber blends may actually increase the occurrence of these problems.
- b. **Chemical Additives or Auxiliaries** – It is well known that the overuse or misuse of chemical finishes such as softeners, lubricating oils, resins, optical brightening agents, or metallic salts can lead to unwanted fabric color change including fabric yellowing.
- c. **Atmospheric Pollutants** – As was stated previously, atmospheric contaminants from both natural and industrial sources can lead to pronounced fabric yellowing. The specific pollutants include, but are not limited to oxides of nitrogen, sulfur dioxide, and ozone. The mechanisms for the actual fabric contamination are numerous and varied but are normally directly related to specific fiber or fiber blend content along with fabric finishing processes.
- d. **Transferred Contaminants** – The contaminants often are contained in cardboard boxes or dividers, plastic sheets, films, or bags and in auxiliary materials such as pumice stones used for garment after-washing processes. In recent years this type of yellowing has been both frequent and also difficult to minimize.
- e. **Consumer Contaminants** – These contaminants include perspiration, chemical residues from such products as perfumes, body lotions, make-up, medical ointments, effects of commercial and domestic laundry products on various textile materials, as well as build-up of chemical additives such as cornstarch added by commercial shirt laundries. This is certainly not a totally complete listing of all the potential causes of fabric yellowing but it does cover the major sources indicated in the technical and trade literature.

4. Physical Requirements for Brighteners

Requirements for optimally effective brighteners are as follows:

- Brighteners should absorb as much UV light as possible and should have little inherent color. This means that the absorption maximum should lie in the 350-375 nm range, the extinction coefficient should be high, and the absorption band should decrease steeply near 400 nm.
- Fluorescence should be as intense as possible and produce maximum whiteness. The fluorescence maximum should be between 415 and 445 nm depending on the preferred shade (violet-blue to greenish blue) and the fluorescence band should decrease rapidly as possible on the long wavelength side.
- The brightener distribution in the substrate should be monomolecular, even high concentrations, because aggregates of brightener molecules show dramatically lowered quantum yields and often different spectra.

5. Industrial Requirements for an ideal Optical Brightening Agent (OBA)

- The brightener should have good solubility in water and should not have its own color. As most of the fabric is washed with water, the brightener should have good solubility in water and should not possess its own color as that may affect the fabric brightness.
- The brightener should have good light and water fastness. Almost, all the brighteners should have these properties so that the brightness on the fabric surface is retained longer.
- It should have good rate of strike on substrate. A good strike refers to good substrate deposition which in turn enhances the fabric appearance for a longer time.
- It should give stable effect of temperature on exhaustion and should have good build up property.
- The brightener should be least affected by the hardness of the water.
- An Optical Brightener should have good levelling and penetration property on the fabric sample.
- An Optical Brightener should be stable and fast to common oxidative and reductive bleaching chemicals and bleaching systems.

6. TYPES OF FLUORESCENT WHITENING AGENTS

i) Carbocycles

Carbocyclic brighteners gained new impetus after 1959 when the trialkylphosphatethylenation process developed by Horner became available. This process features high yield and selectivity for the E-isomers needed for brightening. The important compounds in this category are the distyrylarenes and divinylstilbenes.

Stilbene Derivatives

Most commercial brighteners are 1, 3, 5-triazinyl derivatives of 4, 40-diaminostilbene-2, 20-disulfonic acid. The usual compounds are symmetric; preparation begins with reaction of 2 moles of cyanuric chloride derivatives with 1 mole of 4, 40-diaminostilbene-2, 20-disulfonic acid. Asymmetric derivatives can be synthesized via 4-amino-40-nitrostilbene-2, 20-disulfonic acid. The principal effects of structural variations are changes in solubility, substrate affinity, acid fastness, etc. The bistriazinyl compounds are not stable toward hypochlorite; however, some compounds show some fastness after application to the fiber. Mono(azol-2-yl) stilbenes arose from efforts to find hypochlorite-stable products with neutral fluorescence. About 40 triazinylaminostilbene brighteners are currently on the market. They have high whitening effects, good efficiency and adequate light-fastness. They have only partial fastness to bleach and none to chlorite solution. The bistriazinyl brighteners are employed principally on cellulosic, such as cotton or paper. Some products also show affinity for nylon at the weakly alkaline pH of most commercial detergents. Stilbenyl-2H-triazoles are used as highly chlorine and chlorite stabilizers for cotton and polyamides Bis(1,2,3-triazol-2-yl) stilbene brighteners have high efficiencies, good light-fastness, and are very resistant to chemical bleaches. An example is 4,4'-bis(4-phenyl-1,2,3-triazol-2-yl) stilbene-2,2'-disulfonic acid di-potassium salt [5].

(1) Distyrylbenzenes

1,4-Bis(styryl)benzenes are obtained by the Horner modification of the Wittig reaction, eg, 1,4-bis(chloromethyl)benzene is treated with 2 moles of triethylphosphite and the resulting phosphonate reacts with 2 moles of o-cyanobenzaldehyde to yield compound. These compounds are brighteners with a very high whiteness and good efficiency for plastics and synthetic fibers.

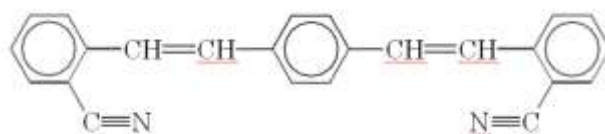


Fig 3: 1,4-Bis(styryl)benzenes

(2) Distyrylbiphenyls

4,40-Bis(styryl)biphenyls are also obtained by the Horner-Wittig reaction of the phosphonate derived from 1,4-bis(chloromethyl)bi-phenyl and triethylphosphite with benzaldehyde-o-sulfonic acid, giving the corresponding bisstyrylbiphenyl disodium salt structure. Anionic distyrylbiphenyls are used in washing powders for brightening cotton to a very high degree of whiteness with improved hypochlorite stability. Nonionic and cationic compounds have also been developed.

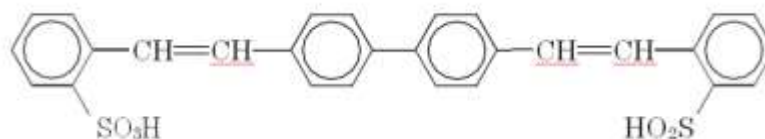


Fig 4: 4,40-Bis(styryl)biphenyls

(3) Divinylstilbenes

Polyester divinylstilbene brighteners with a very high efficiency include 4,40-bis(ethoxycarbonylvinyl)stilbene. It can be obtained by the reaction of stilbene-4,40-dicarbaldehyde with triethylphosphonoacetate in the presence of sodium methoxide. Even higher efficiency is obtained with 4,40-bis(cyanovinyl)stilbene.

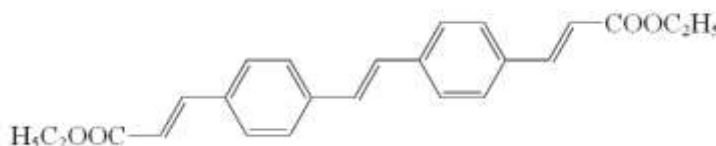


Fig 5:- 4,40-bis(ethoxycarbonylvinyl)stilbene

ii) Pyrazolines

1,3-Diphenyl-2-pyrazolines are obtainable from appropriately substituted phenylhydrazines by the Knorr reaction with either *o*-chloro- or *o*-dimethylaminopropiophenones. 1-(4-Amidosulfonylphenyl)-3-(4-chlorophenyl-2-pyrazoline) was used for brightening of polyamides in the laundry. The anionic compounds that are used to brighten polyamides do not always have adequate light fastness. Poor wet light fastness can be improved by the insertion of substituents in the 3-phenyl and pyrazole rings such as in structure. The pyrazoline ring system is not stable against oxidative bleaches, which dehydrogenate it to the corresponding pyrazole. Depending on the anion, concentrated aqueous solutions with long shelf lives can be obtained. The pyrazolines are employed for brightening synthetic fibers such as polyamides, cellulose acetates, and polyacrylonitriles.

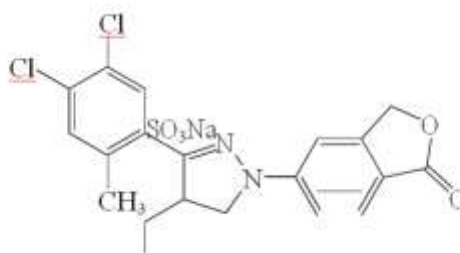


Fig 6: 1,3-Diphenyl-2-pyrazolines

iii) Benzoxazoles: Bis(benzoxazol-2-yl) Derivatives

Bis(benzoxazol-2-yl) derivatives are prepared in most cases by treatment of dicarboxylic acid derivatives of the central nucleus, eg, stilbene-4,4,0-dicarboxylic acid, naphthalene-1,4-dicarboxylic acid, thiophene-2,5-dicarboxylic acid, etc, with 2 moles of an appropriately substituted *o*-aminophenol, followed by a ring closure reaction. These compounds are suitable for the brightening of plastics and synthetic fibers. A large number of patents cover bis(benzimidazol-2-yl) derivatives. Besides being effective on cotton, compounds of this type show good affinity for nylon.

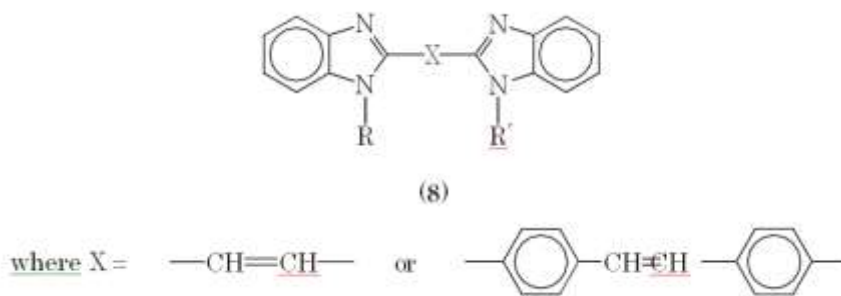


Fig 7: Bis(benzoxa- zol-2-yl) derivatives

2-(Benzofuran-2-yl)benzimidazoles may be synthesized by reaction of substituted benzofuran-2-carboxylic acid chlorides with substituted o-phenylenediamines and ring closure of the resulting o-aminoamide, followed by quaternization. Such products are brighteners for synthetic fibers, in particular those of polyacrylonitrile.

iv) Coumarins

The coumarin structure is derived from cinnamic acid via ortho-hydroxylation, trans-cis isomerization of the side-chain double bond and lactonization. By treatment of flax with esculin, a glucoside of esculetin given structure, a brightening effect was achieved; however, this effect is not fast to washing and light.

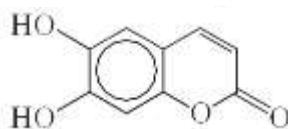


Fig 8: Coumarin Ring Structure

Patents for the use of 6-methylumbelliferone and similar compounds appeared for use as brighteners. The only compound from this class still in market is 7-diethylamino-4-methylcoumarin. Despite its poor light fastness, its good optical properties make it useful for brightening wool, cellulose acetate rayon, and polyamides. This compound is made by cyclocondensation of 3-diethylaminophenol with ethyl acetoacetate in the presence of zinc chloride.

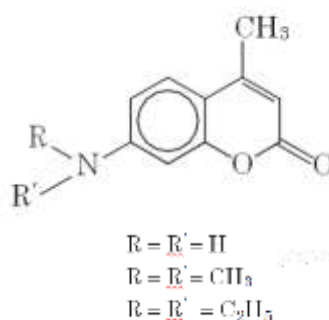


Fig 9: 7-dialkylamino-4-methylcoumarin

A further development in the coumarin series is the use of derivatives of 3-phenyl-7-aminocoumarin (where R, or substituted amines) as building blocks for a series of light stable brighteners for various plastics and synthetic fibers, and, as the quaternized compounds, for brightening polyacrylonitrile. 3-Phenyl-7-aminocoumarin is obtained by a Knoevenagel reaction of substituted salicylaldehydes with phenylacetic acid or benzyl cyanide. Further synthesis of the individual end products is carried out by usual procedures. These have been superseded by the use of 3, 7-bis [(hetero) aryl] coumarins.

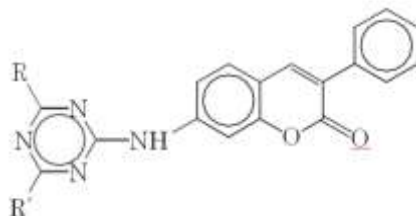


Fig 10: Cationic coumarins (water soluble)

v) Benzimidazoles

2,5-Di(1-methylbenzimidazol-2-yl) furan was one of the first cationic benzimidazole brighteners. More recently cationic benzimidazoles have been developed as brilliant, chlorine fast, lightfast brighteners for polyacrylonitrile and cellulose acetate. They are marketed in the form of cold- and heat-resistant concentrated solutions with long shelf lives. In the synthesis of compound 4-methoxysalicylaldehyde is condensed with 2-chloro-methyl-1-methyl-5-methyl sulfonylbenzimidazole, ring closure is effected and the product is quaternized with dimethyl sulfate. To enhance water solubility, the methyl sulphate anion is converted to acetate anion.

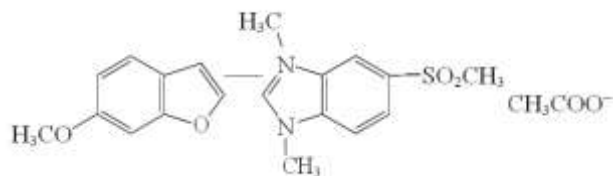


Fig 11: 2,5-Di(1-methylbenzimidazol-2-yl) furan

vi) Naphthalimides

Naphthalimides, where $R' = -NHCOR$, are derivatives of 4-aminonaphthalimide and are used in plastics. The alkoxy-naphthalimides $R_0 = OCH_3$ with alkoxy substituents at the 4- or 4, 5-positions are brighteners with good light fastness for polyester substrates and good chlorine fastness for polyacrylonitriles. The first commercial product was 4-methoxy-N-(n-butyl) naphthalimide. Naphthalimides are prepared from naphthalic anhydride obtained from naphthalene-1,8-dicarboxylic acid, i.e., the oxidation product of acenaphthene or its derivatives, by reaction with amines. They are utilized for synthetic fibers such as polyesters.

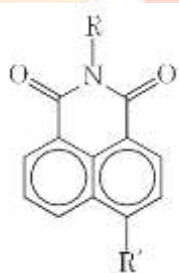


Fig 12: Naphthalimide Ring Structure

A further group of whiteners was found in the acylamino (R, R_0) derivatives of 3,7-diaminodibenzothiophene-2,8-disulfonic acid-5,5-dioxide. The preferred acyl groups are alkoxybenzoyls. These compounds give a greenish fluorescence and are relatively weak in comparison with stilbene derivatives on cotton; however, they show good stability to hypochlorite.

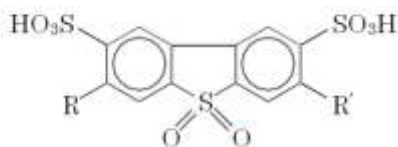


Fig 13: 3,7- diaminodibenzothiophene-2,8-disulfonic acid-5,5-dioxide

The pyrene derivative is obtainable by the Friedel-Crafts reaction of pyrene with 2,4-dimethoxy-6-chloro-s-triazine, and is used for brightening polyester fibers.

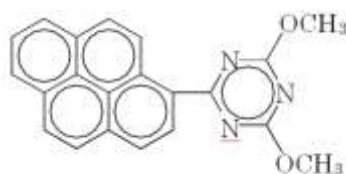


Fig: 14-(4,6-dimethoxy-1,3,5-triazin-2-yl)pyrene

7. MEASUREMENT OF WHITENESS:

Whiteness is defined as a measure of how closely a surface matches the properties of a perfect reflecting diffuser, i.e. an ideal reflecting surface that neither absorbs nor transmits light, but reflects it at equal intensities in all directions. For the purposes of this standard, the color of such surface is known as preferred white [7].

- i. **ASTM E313** – measuring procedure and settings are described in the same standard (ASTM E313: whiteness and yellowness of paper) like the Yellowness indices. This method is based on the use of colorimeter readings B and G. The idea was that chromaticity factor G-B required three times the weighting of the lightness factor G of the lightness.
 - a. The equation is:

$$WI=G-4(G-B) = 4B-3G$$

- ii. **CIE Whiteness** – Some disadvantages of the previously-mentioned indices is that a whiteness that is calculated with this formula does not differ if the measured sample has a color drift or is just less white. To make the white weighting more informative, the CIE recommended in 1981 a formula that is today known as —CIE Whiteness. These indices specified by the CIE for the D65 and illuminant C in combination with either 2° or 10° observer function. However, the equation is commonly used with other illuminants; therefore the value shown will depend on the primary illuminant you have chosen.

8. BLEACHING:

i. Conventional Way

Primarily one of restoration i.e., generally a cosmetic procedure used to diminish discoloration which severely interferes with the visual integrity or original tone of the object, but which cannot be diminished in any other relatively safe manner. Less frequently, bleaching might be used to remove staining material which is contributing to accelerated deterioration of the object (e.g., stains containing iron, oils, etc.)

- ii. **Oxidizing Bleaches:** Oxidizing bleaches are chemicals which increase the oxidation state of staining materials and support, thereby increasing the solubility of stains and decreasing color intensity. The pH of the bleach (and consequently that of the artefact) has great influence on working properties of the bleach and on the chemical and physical effects of the treatment on the object. (E.g. Hydrogen Peroxide etc)
- iii. **Reducing Bleaches:** Reducing bleaches work by chemically reducing stains and/or oxidized sites on cellulose thereby making them colorless and/or increasing their solubility; can be used with ligneous fibers, unlike the chlorine based oxidizing bleaches. (E.g. Sodium Dithionite, etc)
 - a. Most of the textile fibers exhibit by nature a pronounced yellow color and also on exposure to light, alkali or by microbial degradation. Commercially, bleaching is carried out using either an *oxidative or a reductive method*, or a *combined oxidation/reduction* method.

9. Enzymatic Bleaching

Enzymes are secretions of living organisms which catalyze biochemical reactions. Conventional processing methods consume more energy and time of one full processing cycle for a product; however enzyme treatment might be able to reduce the processing time. Enzymes can be used in bleaching to accelerate the rate of reaction and produces better results than the conventional method. Enzymes such as Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases, Ligases, etc are generally used for the purpose [6,14].

9.1 Factors affecting the rate of enzymatic reaction

- i. **Concentration of substrate:** Rate of enzymatic action increases with the increase in the concentration of the substrate.
- ii. **Concentration of enzyme:** Rate of enzymatic reaction is directly proportional to the concentration of the enzyme.
- iii. **Potential of Hydrogen (pH):** Enzymes are susceptible, when there is change in pH i.e. H⁺ concentration at which the enzymes react at maximum speed and has more stability.

- iv. **Temperature:** Each enzyme has its own optimum temperature i.e. the temperature at which the conversion of substrate into products in a unit time will be high. The rate of an enzyme catalysed reaction increases with increase in temperature (upto its optimum temperature) and suddenly decreases due to deactivation of active sites.
- v. **Concentration of the reaction products:** The presence of the higher concentration of products can decrease in the rate of decomposition of enzyme-substrate complex. It is due to the formation of staple product-enzyme than of enzyme-substrate complex which blocks the active centres in certain proportion of the enzymes.
- vi. **Time:** Enzymes react at a shorter time in an optimized condition and the processing time not given sufficient consideration in discussing factors that affect the rate of enzyme action.
- vii. **Activators:** Some specific bivalent metal cation act as activators, by stabilizing the enzyme substrate complex, and so sensitized the substrate to the attack of enzyme.
- viii. **Additives:** Inorganic salts such as Mg ions or complex organic molecules can be used as co-enzymes, which bind tightly to a special site on the enzyme in order to improve its reactivity.
- ix. **Inhibitors:** Molecules chemically similar to the substrate molecules react with enzyme and blocks the active sites, which cannot be available to normal substrate. Heavy metals such as copper, mercury, lead, iron etc. are lethal to enzymes.

10. STANDARD INDUSTRIAL APPLICATION PROCESS OF ALL SYNTHESIZED OBA ON TEXTILE MATERIALS

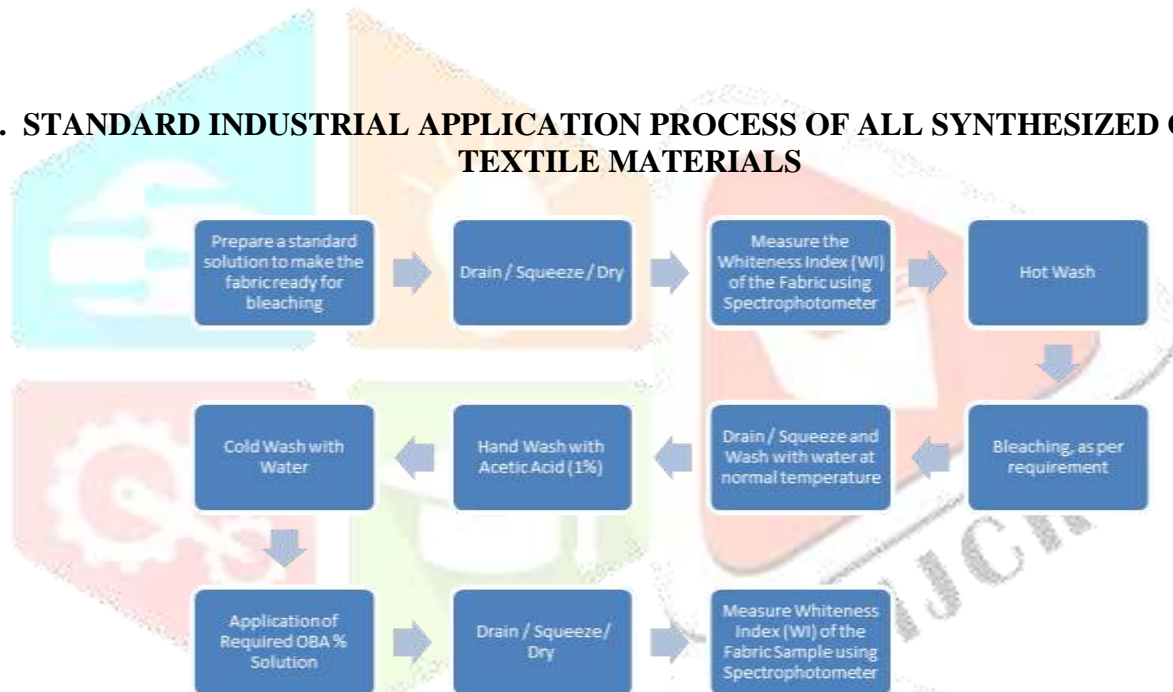


Fig: Flowchart for application of OBAs on textile materials.

11. APPLICATIONS OF OBAS/FWAS:-

Initially, fluorescent whitening agents (FWAs) were used exclusively in textile finishing; the detergent and paper industries followed thereafter. These products are also used in fiber spinning masses, plastics, and paints. The major use of fluorescent whitening agents is by the detergent industry and accounts for 40% of total. The paper industry follows at 30%, textiles account for 25%, and synthetic fibers account for 5%.

i. Detergents

The primary function of FWAs in the laundry process is to whiten fabric load and maintain the original appearance of the white, laundered articles. Laundering is characterized by repeated application to the same item. Fluorescent whiteners used in this repetitive process have to compensate for the reduction in whiteness and contribute toward prolongation of the useful life of the textile material.

ii. Paper Industry

Derivatives of diamino stilbene disulfonic acid are most used in the paper industry because of their fastness properties. The paper industry needs FWAs to obtain high degrees of whiteness at reasonable cost, especially if the FWAs are combined with shading dyestuffs. Most papers are whitened by addition of FWA to both the pulp and surface coating.

iii. Textiles

Textile substrates of natural or synthetic fibers are contaminated in the raw state by substances of varying degrees of yellowness. Bleaching is required to remove the yellowish cast. Chemical bleaching agents destroy the yellow coloring matter in fibers. However, even if bleaching processes are carried to the technically acceptable limits of damage to the fibers, they never succeed in completely removing this intrinsic color. To produce the color white, it is necessary to dye with a fluorescent whitener. FWAs used in textiles can be roughly divided into products containing sulfonic acid groups, corresponding to acid dyes, for cotton, wool, and polyamides; cationic whiteners that behave in the same way as basic dyes, for polyacrylonitrile fibers; and whiteners containing no solubilising groups, corresponding to disperse dyes, for polyester and secondary acetate fibers. This is not a strict division since non-ionic FWAs can whiten polyacrylonitrile and polyamide, and certain cationic FWAs produce effects on polyester. The second generation of synthetic fibers includes types that have been acid- or base- modified and consequently displaying different dyeing characteristics. For dyeing fiber blends such as viscose–polyamide, polyamide–spandex, or polyester–cotton, only compatible FWAs may be used that do not interfere with one another or have any detrimental effect on fastness properties[4].

In contrast to dyes, fluorescent whiteners are not applied exclusively in special processes, but often in combination with bleaching and finishing steps. Fluorescent whiteners used in such processes must be stable and should not interfere with the operation. The most common chemical bleaching procedures are hypochlorite bleach for cotton; hydrogen peroxide bleach for wool and cotton; sodium chlorite bleach for cotton, polyamide, polyester, and polyacrylonitrile; and reductive bleaching with dithionite for wool and polyamide. Whitening in combination with the finishing process is used primarily for woven fabrics of cellulosic fibers and their blends with synthetic fibers. Anionic FWAs, preferably with sulfonic acid groups are used to brighten cellulosic fibers. Polyamide FWAs, in increasing order of fastness, are diaminostilbenes, pyrazolines, distyryl biphenyls, and bis(triazoystilbenes). Benzimidazoles are used for brightening polyacrylonitriles, Dispersions of nonionogenic FWAs are used to brighten polyester. For cellulose or triacetate fibers, pyrazoline derivatives are used. Typical polyamide brighteners are used for wool. Novel bis(triazinylamino) stilbenes that are suitable as UV absorbers and fluorescent whiteners for textiles materials that also brings about an increase in treated textile material has been reported.

iv. Synthetic Fiber and Plastics

In the synthetic fibers and plastics industries, the substrate itself serves as the solvent, and the whitener is not applied from solutions as in textiles. In the case of synthetic fibers, such as polyamide and polyester produced by the melt-spinning process, FWAs can be added at the start or during the course of polymerization or poly-condensation. However, FWAs can also be powdered onto the polymer chips prior to spinning. The above types of application place severe thermal and chemical demands on FWAs. They must not interfere with the polymerization reaction and must remain stable under spinning conditions. In the case of solvent spinning, i. e., secondary acetate, polyacrylonitrile, and poly (vinyl chloride), the FWA is added to the polymer solution. An exception is gel-whitening of polyacrylonitrile, where the wet tow is treated after spinning in a wash-bath containing FWA. In the case of poly (vinyl chloride) plastics, the FWA is mixed dry with the PVC powder before processing or dissolved in the plasticizing agent. Polystyrene, acrylonitrile–butadiene–styrene (ABS), and polyolefin granulates are powdered with FWA prior to extrusion.

Some Commercially Available OBA's which are currently used for Natural Fiber/Fabric

- Blankophore
- Calcafour
- Uvitex, etc

12. CONCLUSION:-

We can see that as soon as white textile materials coming in contact to external environment becomes yellow in colour, the reasons are already discussed. For that an external shield is required to stop the fiber degradation which is called Optical Brightening Agent/Fluorescent Whitening Agent. Also there are various types of OBAs/FWAs which are available commercially. The selection of these OBAs can be done with respect to the fiber origin and the need type.

Bleaching plays an important role in textile whitening. Various types of bleaching agents are available as per the need of the end use, basically classified into Oxidative, Reductive, redox (both oxidative and reductive) and Enzymatic Bleaching. Enzymatic bleaching is an eco-friendly process and is non-hazardous to human touch. Enzymes also play an important role in bleaching booster, especially with oxidative bleaching.

From all the above discussions, it can be concluded, various causes of yellowing and subsequent use of optical brightening agents (OBAs) which are available. Also there should be conscious decision of selecting a type of OBA as per the compatibility, bleaching process and application. It has to be noted that the emission in the range of 400-700nm will give the optimum results on textiles.

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