Chemistry of optical brighteners and uses in textile industries

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Introduction

Optical brighteners (sometimes called optical bleaches or fluorescent whitening agents) are fluorescent white dyes that absorb ultraviolet region (340 – 370 nm), light of electromagnetic region emit back visible blue light region (420 – 470 nm).

This property makes optical brightener effective at masking any yellowing that may be present in cotton fabric. Because the main use of these dyes in laundry detergents and Textile finishing, Optical Brightener are generally found in domestic waste waters that have a component of laundry effluent.

They are used on a variety of finishing processes and should be compatible with practically all chemicals and auxiliaries used at different stages. Furthermore, all round fastness property and is good yield are the desired properties expected from optical brightness. In addition to this, different shades of whites are desired, as white shades are subject to fashion trends.

History of OBA

Textile material (cotton, wool, linen and silk) and synthetic (mainly polyamide, polyester and polyacrylonitrille) are not completely white and have yellowish hue.

Bleaching in the sun, blueing and matter chemical bleaching of textile and other materials increased the brightness of the products and eliminated certain hues or the local impurity of the original or industrially treated materials.

Initially optical brighteners were regarded as bleaching auxiliaries which enable short or milder bleach, when used in very small quantities (approx. 0.001 – 0.05%) they were also called as optical bleaching agents.

These agents can also be improved, for example, the inner back of the horse chestnut contains aesculin or esculinic acid, a glucoside which is derivative of coumarin and which has ultra violet fluorescent. Coumarin (2H-chromen-2-one) is a chemical compound (specifically, a benzopyrone) found in many plants and animals. Then came the introduction of organic products based on Diaminostilbine sulphonic acid derivatives.

Classification of OBA

The classification of OBA can be either on the chemical structure of the brightener or on its method of application. They can be classified in to two large groups;

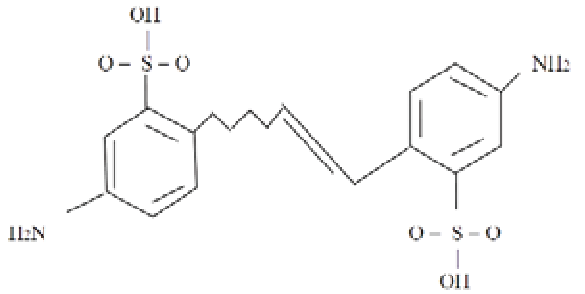
a) Direct (substantive) brightener

Direct optical brightening agents are predominantly water soluble substance used for the brightening of natural fibers and occasionally for synthetic material such as polyamide.

b) Disperse brightener

Disperse optical brightening agents are mainly water insoluble and as with disperse dyes they are applied either to colored from an aqueous dispersion on they can be used for mass coloration. They are used for synthetic materials such as polyamide polyester acetate.

From the chemical point of view they are classified according to either chemical structure. Chemical optical brightening agents are classified in to derivatives of stilbene, coumarin, 1, 3 diphenyl pyrazoline, derivative of naphthalene dicarboxylic acid, derivatives of heterocyclic dicarboxylic acid, derivatives of cinnamic acid and substance belonging to other chemical system.



Structure of Diamino stilbene sulphonic acid.

Stilbene, is a diarylethene, i.e., a hydrocarbon consisting of a trans ethene double bond substituted with a phenyl group on both carbon atoms of the double bond. The name stilbene was derived from the Greek word stilbos, which means shining. (Source: Wikipedia, the free encyclopedia)

Optical brighteners and its mechanism

Nearly 80% of all OBAs produced are derived from stilbene derivatives, the latter absorbency in the ultra violet regions at ( ) = 342 nm. All the OBAs are dyestuffs, but in place of the chromophoric system which is the characteristic for dyes, it contains a fluorescing system, and like a normal dye certain substituents which promote the affinity depending on the type of fiber on which it is applied. In this manner brighteners which are suitable for cotton are more are less substantive derivatives of diaminostilbene disulphonic acid.

This stilbene derivative can be present in two isomeric forms, i.e. in the Cis configuration and in the trans configuration. Optical brighteners in the Trans form can be made both in the powder and Liquid form. The Cis form, which is rapidly formed under the action of light from the trans form will not go on cotton and for this reason, the solution of this whitener is protected against light. Many of the optical brighteners are derived from the heterocyclic compounds containing nitrogen atoms.

Fluorescence is produced by the absorption of radiation having a high energy on the part of the molecule, which re – emits this radiation of lower energy i.e. of longer wave length, the difference in energy being transformed in to kinetic energy. To enable a molecule to fulfill this function, it must be built according to certain structure principles.

Anthranilic acid is the organic compound with the formula $C_6H_4(NH_2)COOH$. This amino acid is white solid when pure, although commercial samples may appear yellow. The molecule consists of a benzene ring with two adjacent functional groups, a carboxylic acid and an amine. For example Anthranilic acid has very strong blue violet fluorescence in the aqueous solution, but nevertheless unsuitable as a brightener. Most of the brightener will hardly fluoresce in powder form; their fluorescence will only appear in solution.

There are some types, which will not fluorescence in solution and will only show this property after they have been applied on the fiber. Thus, it can be concluded that fluorescence is not only depends on the structure of the molecule, but also on its condition. Whether a fluorescent substance is suitable as brightener can only be determined after it has been applied to the textile fiber. Apart from this the product must meet certain demands in respect of properties such as fastness to washing and light, etc.

On comparering different textile fabrics treated with different brighteners and processing approximately the same brightness difference in hue can be detected, since the human eye is particularly sensitive to difference in whiteness. If an optically brightened fabric with reddish white shade is compared with another fabric having a greenish white shade both of which appear to be equally brilliant, if viewed in daylight which is incident from a northerly direction, it will be seen that the greenish shade will appear more brilliant then the reddish one in bright sunlight.

Properties

1. Whiteness and brightness

To the trained observer, even bleached materials are white textile material has a slight yellow tinge. This small amount of yellow can give the impression of slight soiling and may detract from their aesthetic appeal the presence of slight amount of blue gives the impression that the textile material is whiter. Before advent of OBAs. Improved whiteness was obtained using a laundry blue, which is a blue pigment.

The development of OBAs had meant that this slight addition of blue can be obtained through the light reflected by the OBAs in the presence of ultraviolet radiation. This makes white textile whiter and brighter. Colored textile materials tend to appear brighter. OBAs are present in most domestic applications, but these are usually only suitable for cellulosic textile material.

2. Light fastness

There is a large variation in the light fastness rating of these compounds, and when applied to cellulosics and protein fibers their light fastness range 1 to 2, and in some instance may reach 3. It should be pointed out that this poor light fastness is not an important aspect in the cause of cellulosic's, since any loss of OBAs effect due to sunlight will be replaced in subsequent laundering with domestic detergent. Fluorescent brighteners on Nylon can reach a light fastness rating 4 with selected OBAs, a rating as high as 7 for polyesters, and in this class of acrylic fibers a light fastness of about 4 – 5.

The poor overall light fastness of fluorescent brighteners is due to their continuous absorption and emission of light which results in their chemical degradation.

3. Washing fastness

The washing fastness rating of fluorescent brighteners is about 3. The fair washing fastness of fluorescent brighteners is partly due to their lack of substantively of textile materials and their gradual degradation by exposure to sunlight.

The fair washing fastness may not be noticeable in cellulose, due to the presence OBAs in domestic detergents, when fluorescent are used on other fibers they are applied in the manufacturing situation and brighteners are chosen which will last the expected life of the textile article.

4. Metameric effect of OBA

What is metamerism? A normal phenomenon relating to how the human eye perceives color. It occurs when "two different color objects have the same color appearance to normal human viewer under one light source (metameric match), but look different under another light source (metameric mismatch)" to a print marker, this means that the painstakingly precise color information applied to each print will be compromised whenever that print in viewed under a different light source. Thus, one primary goal of any print marker should be to avoid metamerism in order to validate the time spent on color management and to uphold the integrity of the reproduction. Now that we understand metamerism and why it should be avoided, how do OBAs fit into the picture? When OBAs are exposed to UV light, the treated paper appears brighter and whiter.

When OBAs are not exposed to UV light (in the evening), the OBAs "lose activity" causing your eye to actually see the paper color without OBAs. This will look creamy or somewhat yellowed. This amount of "OBAs activity loss" will vary constantly depending upon how much exposure the paper has to UV light. Picture the lightening condition inside of an art gallery and how they will change depending upon the time of day.

This will have subsequent effect on the art itself. It a case like this, where there is a high UV component, ink jet papers that contain OBAs will strongly fluoresce and will appear bright white. However, in the evening when the same print is displayed with low or non – existent UV component (or incandescent tungsten illumination), the OBAs will not fluoresce, making the paper appear yellow, therefore causing your eyes to see the image color differently.

References

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United States cotton crop statistics

According to the U.S. Department of Agriculture, cotton production in the U.S. will rise 37% amid an increase in harvested acreage. The output is expected to increase to 16.7 million bales in the year that begins Aug. 1, from 12.2 million bales in the current season. (A bale weighs 480 pounds, or 218 kilograms)

Acreage will be 10.5 million, up 15% from this season, according to USDA planting intentions survey. United States the world's largest cotton supplier, may export 13.5 million bales next year, up 13% from 12 million in the year ending in July, the USDA said. Stockpiles at the end of next season will be 3 million bales, the lowest in 15 years, the agency said.

Global stockpiles may fall to 50.1 million bales from an estimated 52.8 million at the end of July, as consumption rises in countries including China, the world's largest user, the USDA said.

World output will reach 113.9 million bales, up from 102.9 million bales in the current marketing year, the agency estimated. World consumption may rise to 119.1 million bales next season from an estimated 115.9 million, the USDA said.◆