SYNTHETIC DYES

"All dyes are coloured compounds
But all coloured compounds are not dyes"

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INTRODUCTION:

- Dyes are colored organic compounds that are used to impart color to various substrates, including paper, leather, fur, hair, drugs, cosmetics, waxes, greases, plastics and textile materials. The dyed substrate should be resistant to the action of acids, bases, laundry and stable to light.

- All dyes may not necessarily be colored substances, therefore optical brighteners or whiteners which may be called **white dyes**. They have a special property of absorbing UV light and re-emitting the visible light, so that the fabric appears bright.

Pigment: The colored substance which is insoluble in water and other solvents. It is applied in the form of a paste in a drying oil, in which it is insoluble.

- **Source:** Dyes were obtained from animals and plants sources. Today most of the available dyes are synthetic dyes, prepared from aromatic compounds (coal tar and petroleum).

REQUISITES OF A TRUE DYE:

- It must have a stable and attractive colour.
- It must be able to attach itself to material from solution or to be capable of fixed on it.

  Example: Azobenzene (yellow colour) – unable to fix itself to a fibre, not a dye.
- A dye may not be able to dye all types of materials or substrates.

  Example: Picric acid (yellow) – to dye silk or wool but not cotton.
- Thus a dye ether forms a chemical union with the substrate being dyed or it may get associated with intimate physical union.

REQUISITES OF A TRUE DYE:

- It must be soluble in water or suitable solvent to form stable and good dispersion medium.
- The substrate to be dyed must have a normal affinity for an appropriate dye and must able to absorb it from solution or aqueous dispersion. If necessary in the presence of auxillary substances under suitable conditions of concentration, temperature and P^H.
- When a dye is fixed to a substrate, it must be fast to washing, dry cleaning, light, heat etc. It must be resistant to the action of water, acids and alkalis.

COLOUR AND CONSTITUTION:

Witt's theory or Auxochrome-chromophore theory:

- According to this theory, dye is made up of two parts –
- **Chromophore:** Colour of the substance is mainly due to the presence of an unsaturated groups known as chromophores. The compounds possessing chromophores are known as **chromogens**.

  Chromophores are of two types
- i) **Independent chromophores** – single chromophore is sufficient to impart colour to the compound.

Example: Nitraso - —N═O , Nitro – —NO_2 ,

Azo - —N═N— Azoxy - —N═N→O

o-quinoid p-quinoid

- ii) **Dependent chromophores** – More than one chromophore required to impart colour.

Example: Carbonyl - $-\overset{|}{C}=O$

$CH_3-\underset{\|\atop O}{C}-CH_3$

Acetone (colourless)

$CH_3-\underset{\|\atop O}{C}-\underset{\|\atop O}{C}-CH_3$

Biacetyl (yellow colour)

Auxochrome – Certain type of groups which by themselves are unable to produce colour. But in presence of chromophore increases the depth of the colour.

Auxochromes are of two types-

- **i).Bathochromic auxochromes-** These are the groups which increases depth of the colour, shifts the absorption maxima towards higher wave lengths called red shift or bathochromic shift.

  Example: Halogens, alkyl and aryl groups

  $-NH_2$, in place of –H alkyl or aryl groups

- Yellow → orange → red → purple → violet → blue → green

- **ii) Hypsochromic shift-** These are the groups which decreases depth of the colour, shifts the absorption maxima towards shorter wave lengths called blue shift or hypsochromic shift.

  Example: $-OCH_3$, $-OCOCH_3$

- Green → blue → violet → purple → red → orange → yellow

CLASSIFICATION OF DYES

BASED ON METHOD OF APPLICATION:

This method is very useful to the dyers, who are mainly concerned with process of dyeing.

DIRECT OR SUBSTANTIVE DYES:

- The direct dyes are acidic or basic in nature
- They are used for the direct dyeing of cotton wool, silk, regenerated cellulose, paper and leather.
- The solubility of the dye in the dye bath is often reduced by adding common salt or Glauber's salt.

- The wool and silk are amphoteric in nature
- The acidic or basic group of the dye combines with acidic or basic group of fibre. Ie. Dye directly attaches them directly to the fabric to be dyed.
- Most of the dyes in this class are poly azo compounds, along with some stilbenes, phthalocyanines and oxazines.

  Example: Congo red, Martius yellow

INDIRECT or Mordant or Adjective dyes:

- The dye can be applied to the fabric with the aid of certain substances called mordants (Ex- alum, hydroxides of Al, Fe, Cr, gallic acid, tannic acid etc) which forms an insoluble complex with the dye within the fabric.
- A dyeing process is carried out by 1st soaking the fibre in solution of mordant.
- Then in a basic solution followed by solution of dye. An insoluble complex is formed on the fibre called "LAKE".

Example: Mordant dyes, Alazarin

INGRAIN OR Developed or Azoic dyes:

- In this method the dye is synthesized on the fabric itself, hence the dye need not be soluble in water.
- The fabric is dipped in a solution of diazonium salt.
- Impregnated in an alkaline solution of phenol.
- An azo dye is formed with in the hollow fibres of the fabric.
- Example: Azo dyes – Para red, Methyl red

VAT DYES:

- These are insoluble and made soluble by means of a reducing agent.
- The fabric is then impregnated with the reduced dye (leuco compound).
- Oxidised by exposed to air.
- An insoluble dye is precipitating with in the fabric.

Example: Indigo

Reactive dyes:

- This class of dyes form a stable true compounds with the fibre, dissolves in water and readily passes into the fabric.
- Dyes do not interfere with each other in solution, hence it is possible to use mixtures and obtain various shades.
- Cannot be removed by the strong detergents.
- These are made by combining a coloured amino compound with cyanuric chloride($C_3N_3Cl_3$).
- Example: Chlorotriazyl dyes, Vinyl sulphonic derivatives.

Synthesis of Congo red:

- Synthesised by coupling diazotised benzene with two molecules of naphthanoic acid (1-aminonaphthalene-4-sulphonic acid. The sodium salt is used as a dye.
- Chromophores – Azo groups
- Auxochromes – amino groups
- Binding sites to the fibre – amino and sulphonate groups.

Uses:

- As an indicator in acid – base titrations, alkaline media-red, acid media – blue
- Congo paper – for testing acidity of the solution
- For dyeing cotton directly.

Synthesis of Malachite green:

- Prepared by condensing benzaldehyde with 2 moles of dimethyl aniline at 100^0c in presence of con.H_2SO_4 or $ZnCl_2$.
- The leuco base produced is oxidised with PbO_2 in a solution of acetic acid having HCl.
- Chromophore – quinonoid group
- Auxochromes – Amino groups

Uses:

- Dye silk and wool directly.
- Cotton mordanted with tannin to deep green.

Synthesis of Alazarin:
(1,2-dihydroxy anthraquinone)

- Prepared by heating phthalic anhydride with catechol in presence of con.H_2SO_4 or anhy $ZnCl_2$ at 180^0c.
- Chromophore – quinone
- Auxochrome – OH groups

Uses:

- To dye cotton and wool.
- In making printing ink.

Synthesis of Indigo:(Indigotin)

- It occurs in plants of indigofera group in the form of glucoside – INDICAN.

Uses:

- To dye cotton by vat process.
- In making printing ink.