

# Vat Dyes

## Vat dye

Any of a large class of water insoluble dyes, such as indigo and the anthraquinone derivatives, that are used particularly on cellulosic fibres. The dye is applied in a soluble, reduced form to impregnate the fibre and then oxidized in the fibre back to its original insoluble form.

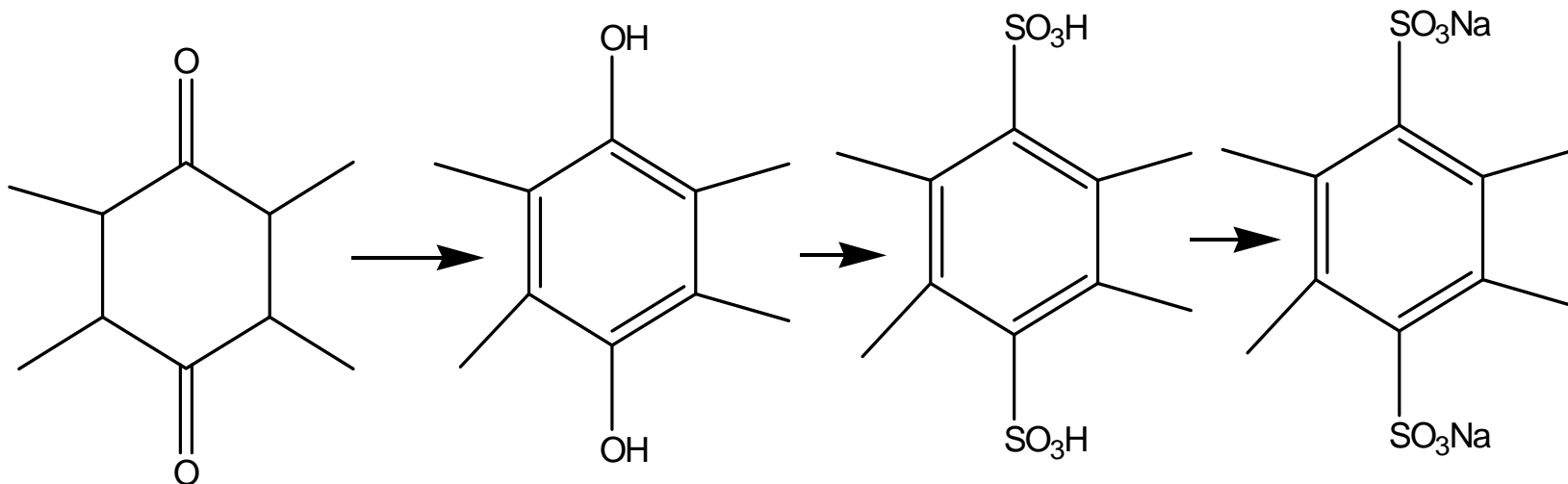
Vat dyes are especially fast to light and washing. Brilliant colours can be obtained in most shades. Originated in medieval Europe, vat dyes were so named because of the vats used in the reduction of indigo plants through fermentation.

## What are Vat dyes

Vat dyes are most important dyes for dyeing and printing on cotton and cellulosic fibres. They have excellent all round fastness, which includes- washing, light, perspiration, chlorine and rubbing fastnesses.

Vat dyes are insoluble in water and have to be dissolved in water by using sodium hydroxide and sodium hydrogen sulphite usually at 50 degrees for 15-20 mins.

In their soluble forms they behave like direct dyes and hence can be dyed on cotton. They remain in the soluble form in the presence of excess of Sodium hydrosulphite and sodium hydroxide, they should be present in the dyebath in sufficient quantity to keep the dye in the soluble form. On exposure to air this soluble leuco form of the dye gets converted to colored insoluble form of the dye.



**Vat dye**

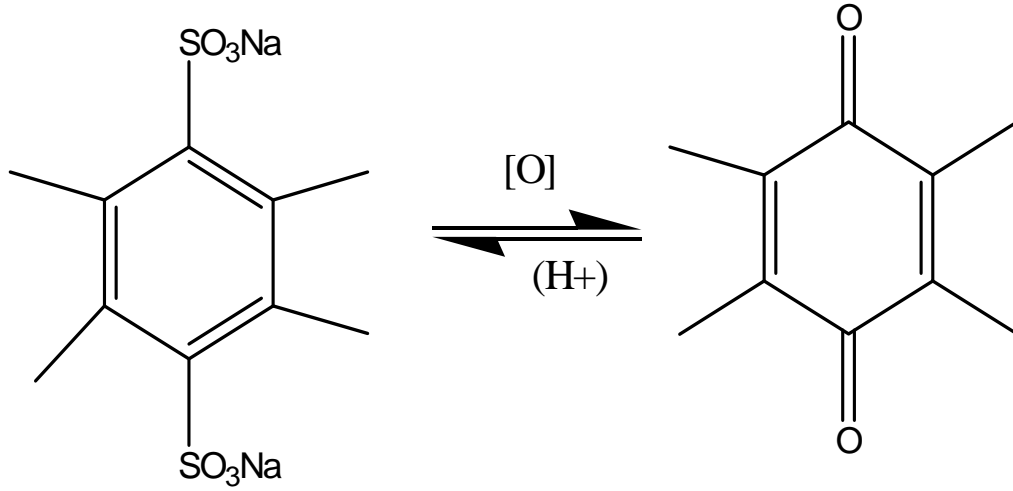
**Leuco dye**

**Sulphuric ester of Leuco**

**Sodium salt of**

**vat dye**

Before the application of vat dyes they have to be solubilised ( vatted) by adding sodium hydrosulphite and sodium hydroxide These are solubilised vat dye- sulphuric esters of leuco vat dyes When they are dissolved, they do not generally produce the same color as their parent vat dyes Like direct dyes they ionise in water They have affinity for cotton and cellulosic fibres and they can be exhausted by the addition of common salt to the dye bath



**Solubilised Vat dye**

**Vat dye**

The solution of sodium nitrite and sulphuric acid provides acidic, oxidising conditions which are needed for the regeneration of the original vat dye

The powder form of the solubilised vat dyes are stable to storage, if properly stored away from sunlight and air( moisture, oxygen and carbon dioxide).

Their solutions are also stable if properly stored If they come in contact with acidic fumes or oxygen a part of the dye is wasted.



## Vat dyes properties

- The vat dyes have high color fastness which is uncommon in other dye classes. On the other hand, vat dyes tend to have poor rubbing fastness, but this can be mitigated with special treatments to the fabric.
- Indigo is subject to major crocking (i.e., rubbing the dye off onto other items) unless it is applied carefully. This means use a weaker dyebath, and dipping many times, rather than a single strong dipping.

## Vat dyeing

After dyeing in a bath containing the vat dye + sod. hyrosulphite + sod. Hydroxide- exhaustion of the dye on to the fabric, the dyed material is removed, squeezed and exposed to air when the leuco vat dye is converted to insoluble dye form.

Sometimes other oxidising agents like sodium borate, hydrogen peroxide or potassium dichromate may be used to hasten the oxidation.

At the end of this treatment, the dyed material is washed, soaped at the boil with a solution of detergent and soda ash for 10-15 mins, washed and dried.

# Vat dyes

- Most vat dyes, which require a reducing agent to solubilize them, are less suitable than fiber-reactive dyes for amateurs. Chemical reactions such as oxidation, reduction, pH control are often necessary; even the dissolution process necessitates measuring out appropriate quantities of caustic soda and sodium hydrosulphite in order to achieve reduction.
- The dye is soluble only in its reduced (oxygen-free) form. The fiber is immersed repeatedly in this oxygen-free dye bath, then exposed to the air, whereupon the water-soluble reduced form changes color as oxygen turns it to the water-insoluble form.
- Indigo is an example of this dye class: it changes from yellow, in the dye bath, to green and then blue as the air hits it.

## Details about Vat dye classes

Unlike direct dyes, which are dyed at the boil, vat dyes are dyed at lower temperatures

According to the temperature required for dyeing vat dyes are classified as:-

Cold dyeing dyes( II class) 20-30 degree

Warm dyeing dyes(IW class) 30-40 degree

Normal dyeing dyes(IN class) 40-50 degree

Special dyeing dyes ( IK special class)

The dyeing time is usually 45- 60 mins

## Cold and warm dyeing of vat dyes

In the case of cold dyeing and warm dyeing dyes the exhaustion of the dyebath is usually low and hence they need exhausting agents like common salt or Glauber's salt to be added to the dyebath after the dyeing has proceeded at the appropriate temperature for some time.

On the other hand the rate of dyeing of the normal dyes is so fast at 50 degrees that their dyeing has to be retarded by the retarding agents also called as levelling agents such as Dispersol VL/ Tinegal CV

## Trade names of Some vat dyes

- Amaranthrene
- Benzanthrene
- Calconoid
- Carbenthrene
- Indanthrene
- Navidon
- Navinon
- Solanthrene
- Supranthrene

## Dyeing with Indigo

Since dyeing is carried out at low temperature a good preliminary scour is necessary to make the cotton easily permeable. The dye vessel is filled with soft water and the dissolved oxygen is removed by the addition of 1 oz / 100 gallons of sodium hydrosulphite.

The required amount of reduced indigo is added from the stock vat and the goods are immersed in the dye liquor at 20 to 25 ° C ( 68 to 77 ° F ) and agitated for 15 minutes. It is important that a machine or method of handling should be used in which the goods are totally immered to prevent premature oxidation from taking out, the excess which are exposed to the air. At the end of 15 minutes the goods are taken out, the excess liquor is squeezed back, and leuco compound is oxidized by exposure to air. The first dip will only give a pale blue and the sequence of operations is repeated 2, 3, 4 or 5 times until the necessary depth of shade is obtained.

Cellulose has not great affinity for the leuco compound of indigo and heavy shades must therefore be built up by successive immersions because an excessive concentration of the dye in the liquor leads to unsatisfactory rubbing fastness. Exhaustion can be improved by the addition of 5 to 40 percent of common salt.

According to the depth of shade and the liquor ratio. Deep shades are built up by successive in a series of liquor of increasing indigo and thus the first bath might, for example, contain 0.3 g./l of reduced indigo and concentration would increase until, in the sixth, it is 3 to 4 g / l. a counter flow system may be used, the first bath being certified from the second , and so on, all addition of reduced indigo being made to the final liquor.

When the dyed goods have been exposed to air for large enough for oxidation to be complete, they are second through to remove any insoluble indigo blue deposited on the surface of the fibers.



## Light fastness of Vat dyes

- Vat dyes are as a class, the most light fast of all dyes. However, not all individual vat dyes are equally resistant to light.
- The following are lightfast S/NO Color name Color Index name Lightfastness rating ( out of 8)

1 VD01 Yellow Vat yellow 2 5

2 VD02 Orange Vat orange 2 5

3 VD03 Red Vat red 13 7

4 VD04 Blue Vat blue 6 7 – 8 ness rating for the unmixed dyes.

## Wash fastness of Vat dyes

- The wash fastness rating of vat dyes is about 4 – 5 .The excellent wash fastness of textile material, colored with vat dyes is attributed to the large vat dyes molecule as well as its aqueous insolubility.
- The large vat dye molecule is trapped within the polymer system of the fiber because of its size and aqueous insolubility and it is absorbed within the fiber system by vanderwals forces.