

# Vat dye

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**Vat dyes** are a class of dyes that are classified as such because of the method by which they are applied. **Vat dyeing** is a process that refers to dyeing that takes place in a bucket or vat. Almost any dye, including fiber-reactive dyes, direct dyes, and acid dyes, can be used in a vat dye. Cotton, wool, and other fibers can be all dyed with vat dyes. The original vat dye is indigo, once obtained from plants but now produced synthetically.<sup>[1]</sup>

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## Materials suited for vat dyeing

Although almost all dyeing can be done in a vat, the term vat dye is used to describe a chemical class of dyes that are applied to cellulosic fibre (i.e.. cotton) using a redox reaction as described below. Because of the use of caustic soda, and the very high pH of the dye bath in the dyeing process, wool cannot be dyed using vat dyestuffs. Wool is soluble in caustic soda solutions. It is possible to dye wool at room temperatures with indigo (vat blue 1) and other low substantive vat dyes using soda ash as the alkali source with very little strength loss. Vat red 10, vat violet 13 and vat orange 1 can be applied in this manner as well.<sup>[2]</sup>

## Dyeing process

Vat dyes characteristically require a reducing agent to solubilize them. The most common reducing agent is sodium dithionite ( $\text{Na}_2\text{S}_2\text{O}_4$ ), which converts the dye to its "leuco" form that is soluble. Once attached to the fabric, the leuco dye is then oxidized to the insoluble state which is intensely colored. 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. For these reasons, vat dyes are less suitable than fiber-reactive dyes for amateur use.

Indigo is an example of this dye class: it changes from yellow, in the dyebath, to green and then blue as the air hits it.

Not all vat dyeing is done with 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.

## Light-oxidized vat dyes

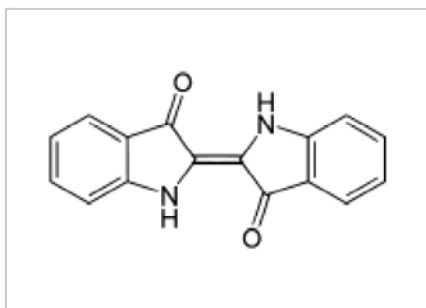
Inkodye is a type of vat dye that uses light rather than oxygen to "fix" the dye, with a wide variety of possible effects. These dyes, which are chemically similar to vat dyes, are developed by light instead of being applied in an oxygen-free bath and being developed in the fabric by exposure to oxygen. Inkodyes are true dyes, not fabric paints. A dye itself attaches to the fabric; fabric paint includes a glue-like binder, which imparts a stiffer feeling to the fabric.

## Chemical structures

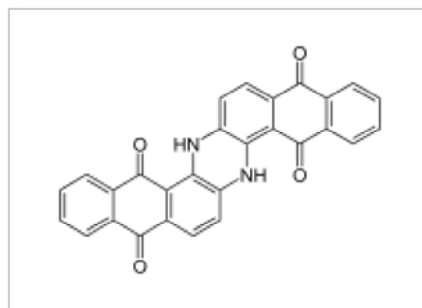
Many vat dyes are derivatives of indigo dye. For example, vat blue 2 and 3 are halogenated or methylated derivatives and so are several violets. Many other vat dyes are derivatives of anthroquinones.

[3]

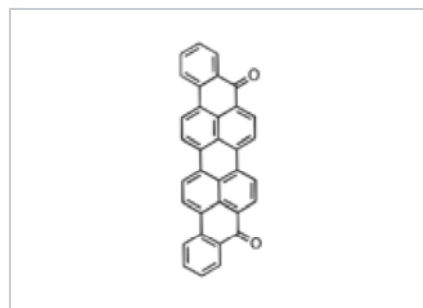
### Blue vat dyes



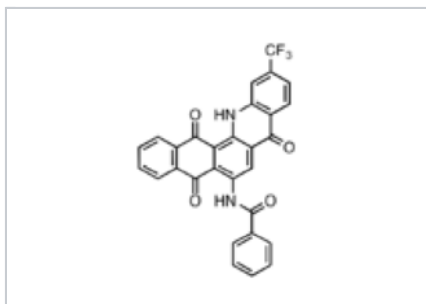
Vat Blue 1



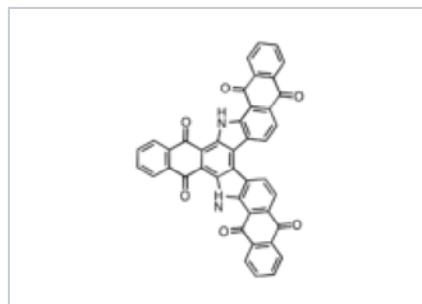
Vat Blue 4



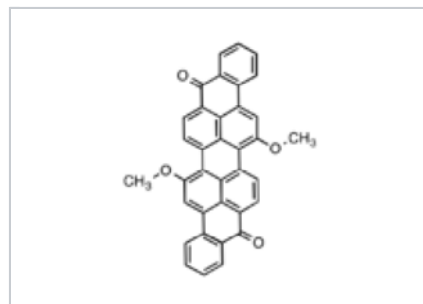
Vat Blue 20



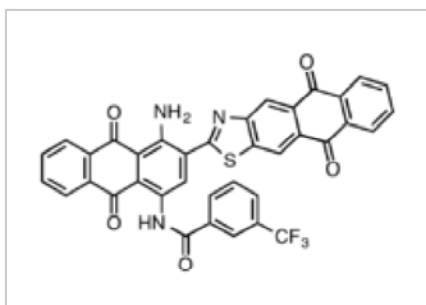
Vat Blue 21



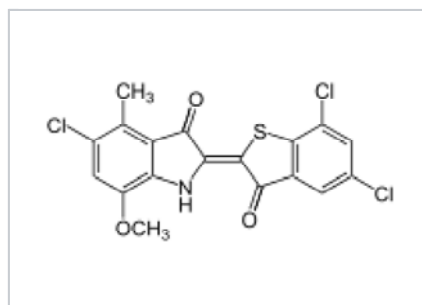
Vat Blue 25



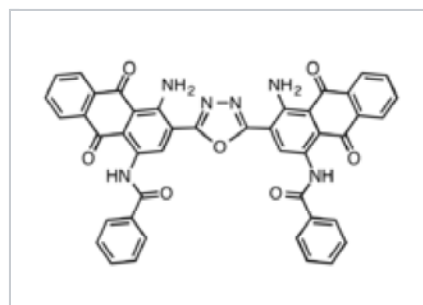
Vat Blue 26



Vat Blue 30

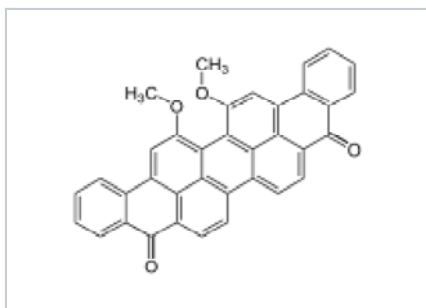


Vat Blue 36

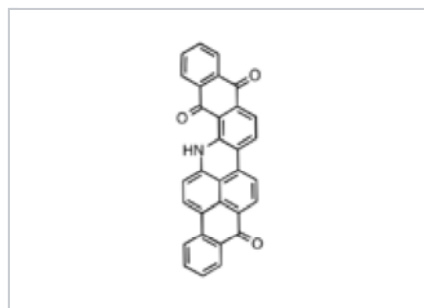


Vat Blue 64

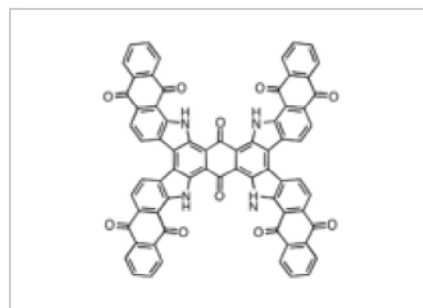
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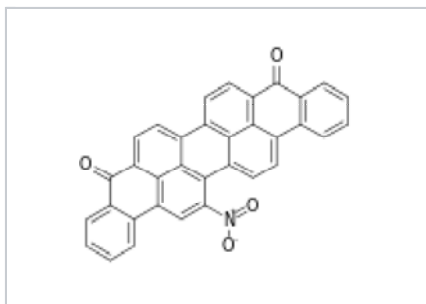
Vat Green 1



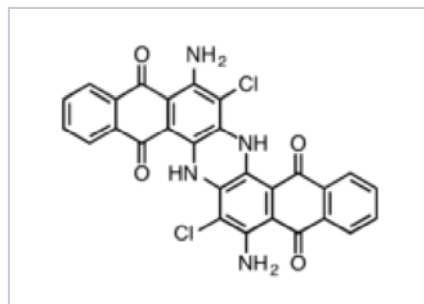
Vat Green 3



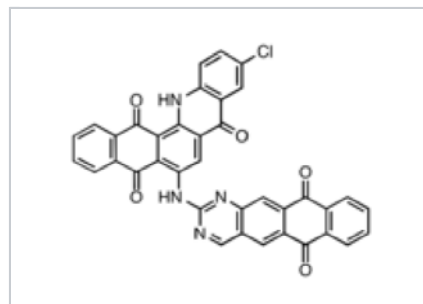
Vat Green 8



Vat Green 9

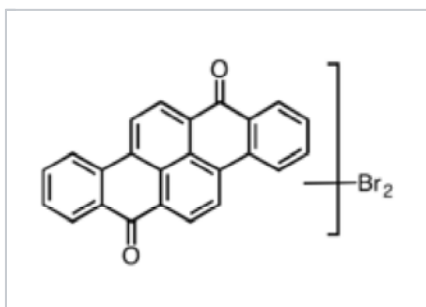


Vat Green 11

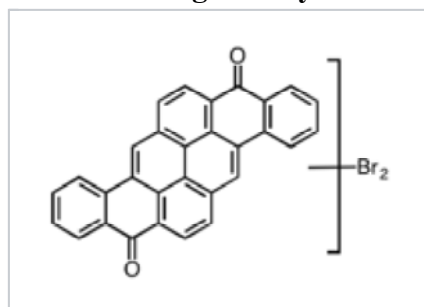


Vat Green 12

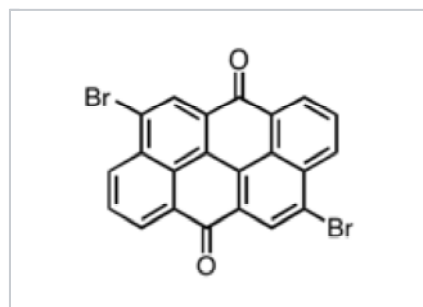
**Orange vat dyes**



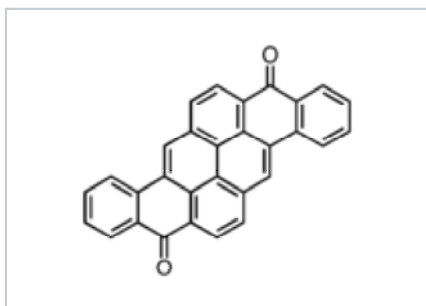
Vat Orange 1



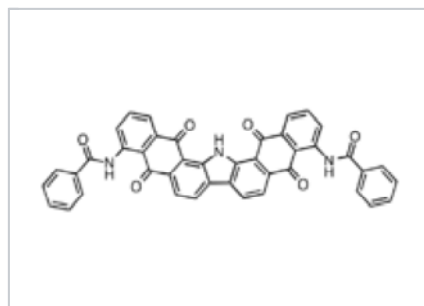
Vat Orange 2



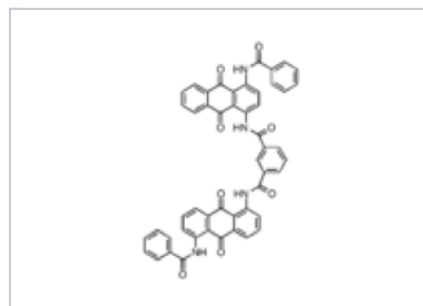
Vat Orange 3



Vat Orange 9

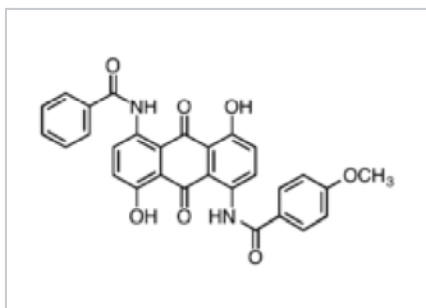


Vat Orange 15

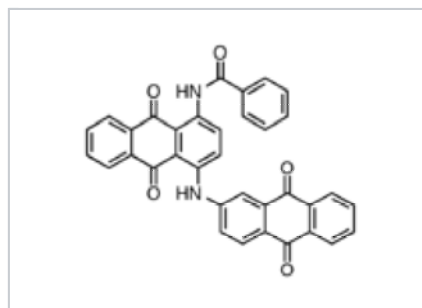


Vat Orange 17

**Violet vat dyes**

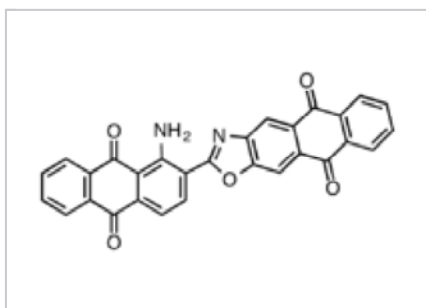


Vat violet 15

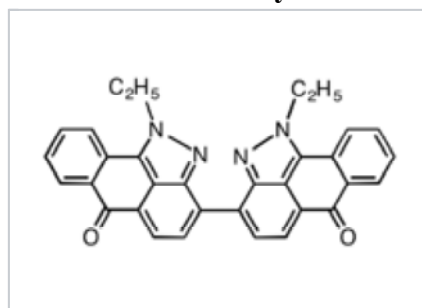


Vat Violet 18

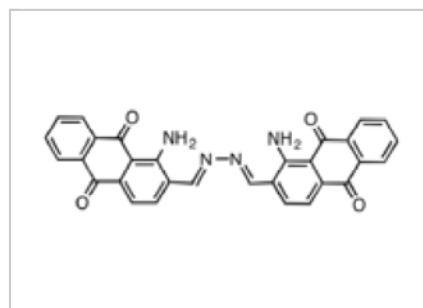
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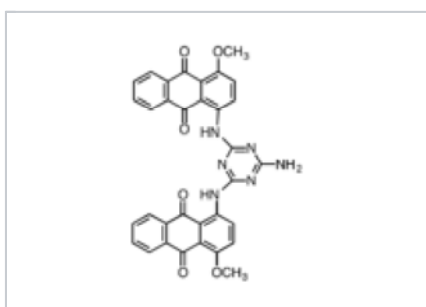
Vat Red 10



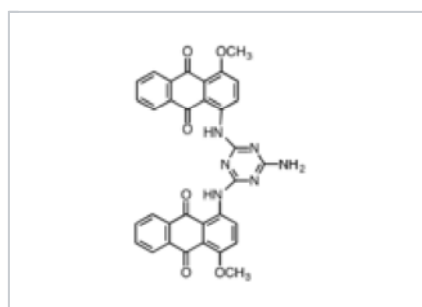
Vat Red 13



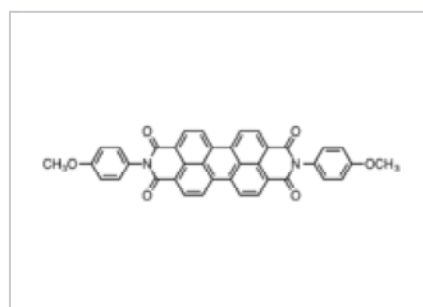
Vat Red 18



Vat Red 28

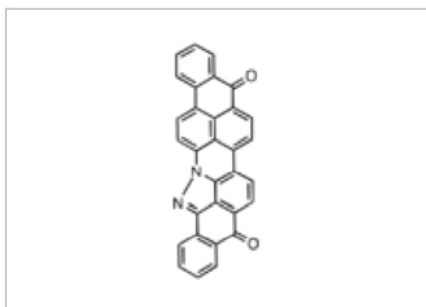


Vat Red 28

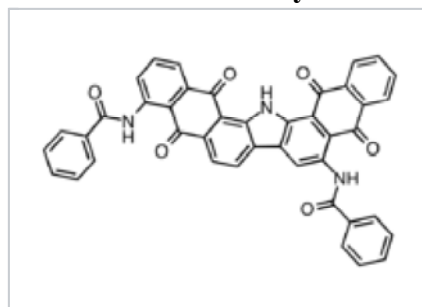


Vat Red 29

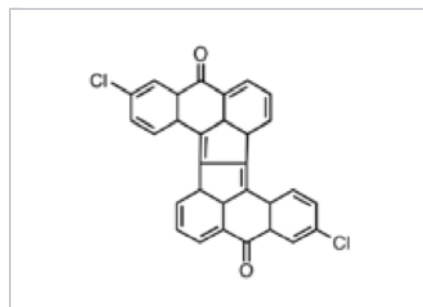
**Brown vat dyes**



Vat Brown 1

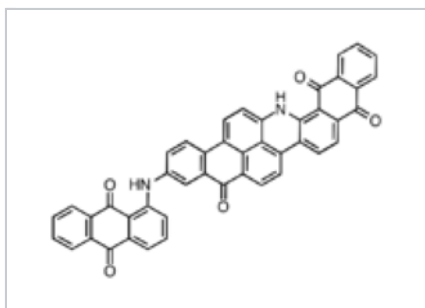


Vat Brown 3

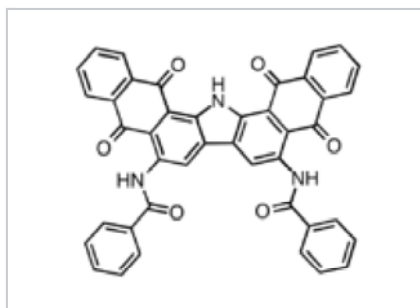


Vat Brown 45

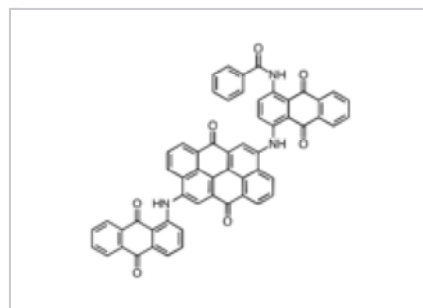
**Black vat dyes**



Vat Black 25

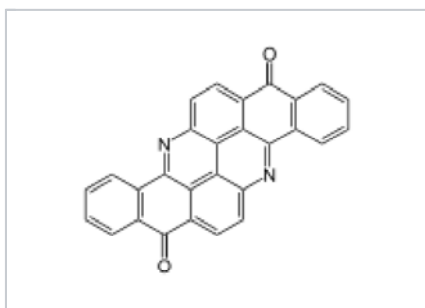


Vat Black 27

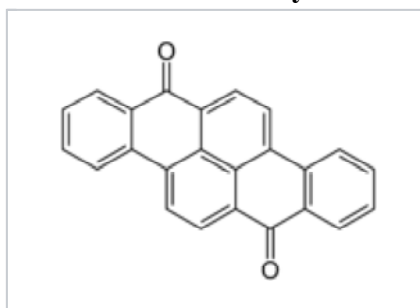


Vat Black 29

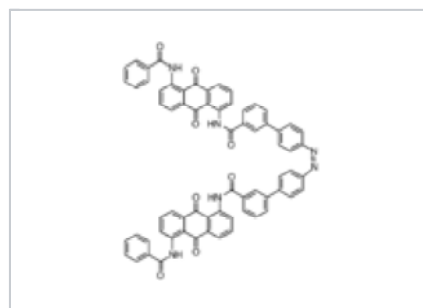
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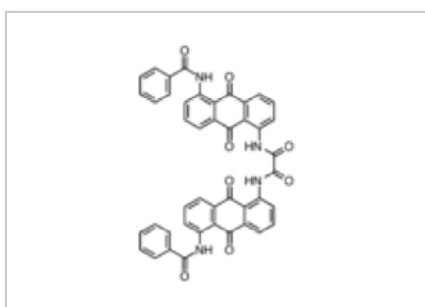
Vat Yellow 1



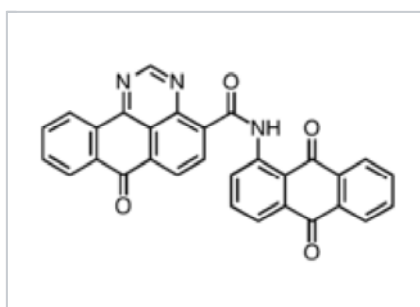
Vat Yellow 4



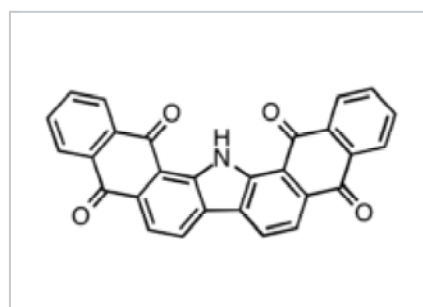
Vat Yellow 10



Vat Yellow 12



Vat Yellow 20



Vat Yellow 28

## References

1. Booth, Gerald (2000). *Dyes, General Survey*. Wiley-VCH. doi:10.1002/14356007.a09\_073.
2. *The Chemistry of Vat Dyes* by Dianne Epps
3. Bien, H.-S.; Stawitz, J.; Wunderlich, K. (2005), "Anthraquinone Dyes and Intermediates", *Ullmann's Encyclopedia of Industrial Chemistry*, Weinheim: Wiley-VCH, doi:10.1002/14356007.a02\_355

*Imagery on Fabric* by Jean Ray Laury

## External links

- Inkodye - Light-sensitive vat dye (<http://www.inkodye.com>)

- PRO Chemical & Dye - Vat Dye Instructions (<http://www.prochemical.com/directions.htm#Vat%20Dyes>)
- - Vat Dye Application techniques (<http://www.thesmarttime.com/processing/application-of-vat-dyes.htm>)
- Archive for the 'Vat Dyes' Category (<http://www.worlddyevariety.com/category/vat-dyes>)

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Categories: Vat dyes

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