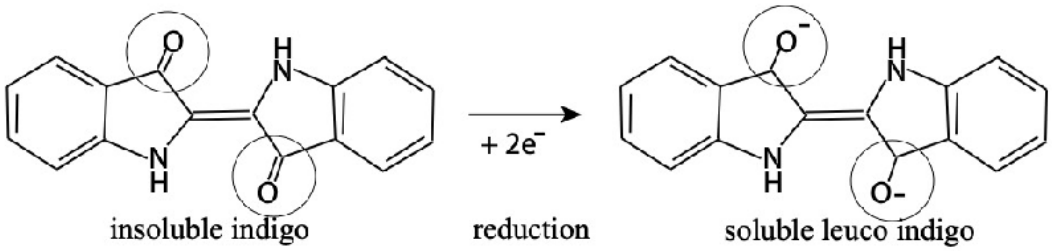
Fermented Indigo Vat: Blog Post #3:
What IS Indigo Reduction? (explained to the best of MY ability)

The chemical formula of indigo is $C_{16}H_{10}N_2O_2$

Why is reduction called "reduction"?

In the early days of chemistry, oxidation was defined as a gaining of oxygen atoms, and reduction was a loss of oxygen atoms. Indigo was said to be reduced because it lost an oxygen atom.



insoluble indigo reduction soluble leuco indigo

In actuality, there is no loss or gain of the oxygen molecule. The molecule of the insoluble indigo pigment contains double bonds to oxygen. During reduction, that molecule gains 2 electrons and, as a result, the bonds to the oxygen molecule become single bonds, thus making it soluble. This soluble indigo is referred to as leucoindigo or "indigo white". Leucoindigo is the water-soluble yellowish molecule that soaks into and dyes the textile.

This is one of the grand "mysteries" of dyeing and chemistry!

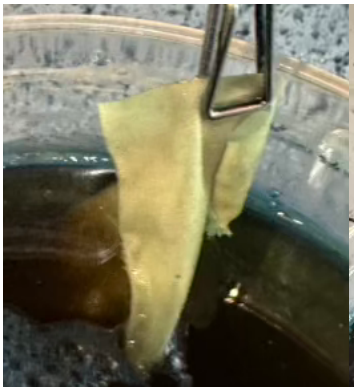
Leucoindigo is visible as the characteristic yellowish color below the surface of some vats. The leuco color of fermentation vat is more green than yellow. Once a textile is immersed in the vat it come out of that vat with the leuco color (yellow or green). The textile will turn blue through exposure to oxygen.

What is Redox?

Redox is A chemical reaction that takes place between an oxidizing substance and a reducing substance. The oxidizing substance loses electrons in the reaction, and the reducing substance gains electrons. These two things happen simultaneously, and one does not happen without the other

All indigo vats require a high alkalinity (high pH) for proper functioning. The plants, carbohydrates, sugars, or minerals used for the indigo vat are reductive, which means that they oxidize and give off electrons. In the alkaline environment of the vat, reduction is even stronger.

The indigo molecule is forced to receive the two negatively charged electrons, which is a reduction; this influences the oxygen bonds of the indigo pigment, making the indigo molecule attractive to the positively charged portion of the water molecule. In this way the indigo becomes soluble (leucoindigo). Once it is soluble, the dye can penetrate the textile. After dyeing, oxidation (exposure to air) will once again make the indigo insoluble in the textile.



Leuco color from fructose vat

Oxidized color from fructose vat

Oxidized color from fructose vat

Oxidized color from fermentation vat