

Integrated Chemistry 1

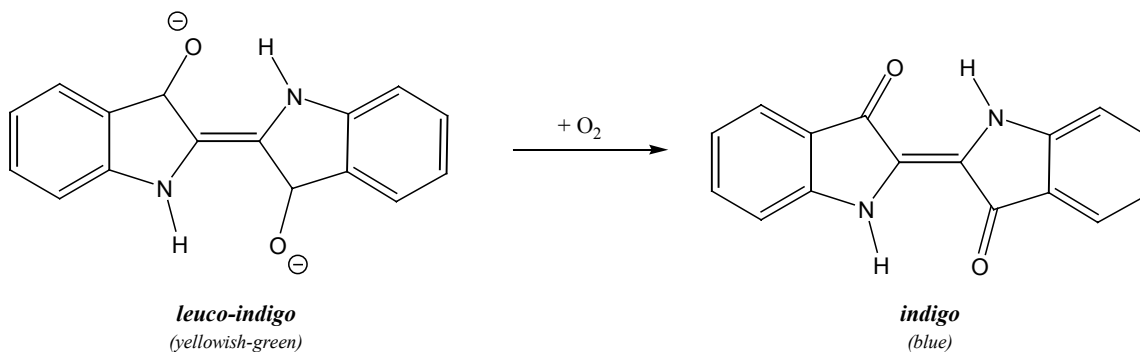
Lab 1: Dyeing Cotton with Synthetic Indigo

September 3, 2008

Background. Indigo is a vat dye, meaning that the colorant itself (that is, pure indigo) is not soluble in water and therefore cannot be used directly to color fabric. This is because a dye must penetrate the fibers of a material in order to produce an effective color; they cannot be simply applied to the surface like a paint. So to use indigo to dye fabrics, it must be converted to a compound that readily dissolves in water. In traditional dyeing procedures, the reaction to produce the soluble form of the dye took place in open vats, hence the term, vat dye.

The soluble form of indigo, known as leuco-indigo, is a yellowish-green material. When fabric is immersed in a solution of leuco-indigo, the molecules of this compound penetrate the fibers but are not “bound” or fixed to them in any way; they would wash out easily if rinsed immediately. But if the treated fabric is allowed to stand in the open air while still wet, the leuco-indigo reacts with oxygen to form the deep blue indigo precipitate. These particles of indigo are then trapped in the fibers and, since they don’t dissolve in water, are not easily washed out. They can be gradually removed mechanically, however, and this gives blue jeans the familiar faded appearance after several washings.

In chemical terms, the reaction between leuco-indigo and oxygen is described by the following equation.



Procedure.

Safety Notes: This laboratory includes thermal and chemical burn hazards; wear safety goggles at all times and latex gloves when handling chemicals. Avoid breathing vapors from the reaction mixture, as they can be irritating.

1. Heat about 600 mL of water to 50 – 60°C. Add approximately 2 g of synthetic indigo and 10 mL of 6 M NaOH with constant stirring. Describe the appearance of the resulting suspension.
2. Add approximately 6 g of sodium hydrosulfite (Na₂S₂O₄). Monitor the appearance of the mixture over the next fifteen minutes and describe any changes that take place.

3. Using tongs, submerge your fabric sample and leave it submerged for five to fifteen minutes.
4. Carefully remove your dyed material and open it (the quicker the better, but be careful). Hang it up to dry and watch how the appearance changes over the next several minutes. Comment in your notebook and describe the changes.
5. Rinse the fabric in cold water and wring out the excess water. You can hang the sample up to dry and pick it up later or take it with you. After it has completely dried, cut off a small sample and staple it your notebook.