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The Chemistry of Dyeing Your Hair

Dyeing your hair can be a fun way to change your look, whether you're hiding from the mob or just seeking a fresh new style. But it's also a science experiment, a chemistry lab you can do at home. Permanent hair dyeing is caused by an oxidation-reduction (**redox**¹) reaction that happens on your head.

Did You Know?

The ancient Romans dyed their hair, usually blond, and some even decorated it with gold dust.

Redox reactions happen when electrons move from one atom to another. The atom that gets electrons is reduced; the atom that loses is oxidized. You can easily remember this by thinking: **Oxidation Is Losing, Reduction Is Gaining, or OIL RIG.**

Ecobottle Sample



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Hair's natural color depends on the pigment **melanin**². There are two kinds of melanin. **Eumelanin**³ makes hair reddish brown to black. **Pheomelanin**⁴ makes hair blond to red. The amount of each type of melanin in the hair helps give us the range of natural hair color we see.

How Does Hair Dye Work?

In the 1800s, a German chemist named August Wilhelm von Hofmann made a brown dye. He mixed a chemical compound called *p*-phenylenediamine with other chemicals that made it lose electrons. Remember that losing electrons is oxidation.

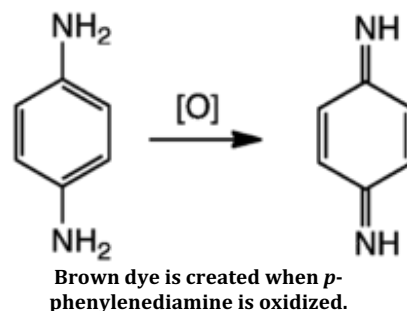
¹ **Redox reaction:** oxidation-reduction, in which an electron is transferred from one atom to another.

² **Melanin:** the pigment that controls your natural hair color.

³ **Eumelanin:** a type of melanin that makes hair reddish brown to black.

⁴ **Pheomelanin:** a type of melanin that makes hair blond to red.

Modern hair dyes use the same ingredients that have been used for decades. They are made up of four main parts – primary intermediates, couplers, ammonia, and an oxidizing agent. **Oxidizing agents**⁵ are the chemicals that take electrons in the redox reaction. In hair dye, hydrogen peroxide is almost always used as the oxidizing agent.



Ecobottle Sample



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The **couplers**⁶ are usually compounds like the primary intermediates. Primary intermediates and couplers are mixed together and then mixed with an ammonia solution. Just before putting dye in your hair, you mix in the hydrogen peroxide solution.

While hair is being dyed, three basic things are happening:

(1) The ammonia is causing each strand of hair to swell so that the cuticle scales separate. This lets the dye get to the cortex and medulla, where the pigment is located.

Ecobottle Sample



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(3) The redox reactions that make the dye by transferring electrons.

Because there are many intermediates and many couplers, there are many reactions happening at the same time. The combination of all these reactions determines the final hair color.

Dyeing your hair too many times can damage it. This should come as no surprise. We wear safety gear, like gloves, aprons, and goggles when working in a chemistry laboratory. Without them, the chemicals we use can ruin our clothes and cause injuries. Be careful when performing your own hair dyeing experiments and ask for help from an adult.

⁵ **Oxidizing agents:** chemicals that take electrons.

⁶ **Couplers:** chemical compounds like primary intermediates.

Reading Comprehension Questions

1. What is another
2. How can you remember what happens in a redox reaction?
3. What are
4. What is the pigment that determines hair color called and what are the two different types of this pigment?
5. What did
6. What four
7. Describe, in your own words, what three things happen when you dye your hair.

Extension Questions

8. If your friend said they were thinking about dyeing their hair and wanted your expert, scientific option, what would you say? Would you encourage it or try to talk them out of it? Why?
9. Create an

Ecobottle Sample



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