

Just what is that stuff in the brown bottle?

When you go to the grocery or drug store, particularly along the first aid aisle, you are likely to find a brown bottle. The bottle contains a very useful mixture of hydrogen peroxide and water, dihydrogen monoxide or H_2O . But just what is that stuff and what do you use it for?

The hydrogen peroxide molecule is comprised of two hydrogen and two oxygen atoms. It was discovered in 1818 by Louis Jacques Thenard while conducting reactions with barium peroxide. (Thenard was born May 4, 1777 and is one of the 72 names inscribed on the Eiffel Tower.) The “per-“ in peroxide comes from a traditional way of naming chemical compounds. The per- refers to the addition of an atom, i.e. hydrogen peroxide has one more oxygen atom over that of water. For example, bleach is sodium hypochlorite. The hypochlorite is an anion comprised of chlorine, Cl, and oxygen, O, atoms. There are four oxoanions associated with chlorine: perchlorate, ClO_4^- ; chlorate, ClO_3^- ; chlorite, ClO_2^- ; and hypochlorite, ClO_2^- . The combination of the per- or hypo- and the -ate and -ite, help to communicate the number of oxygen atoms contained in the anion. (An anion is a negatively charged ion, for example in sodium chloride, table salt, the anion is chlorine, Cl^- , and the cation, a positively charged ion, is sodium Na^+ .) While the traditional naming system is used for a variety of common chemicals, chemists now tend to follow a more intuitive naming system for more complex molecules, thus eliminating the need to remember exactly how the per- and the hypo- are used.

Back to that stuff in the brown bottle, hydrogen peroxide. It is remarkable stuff. It is used in a wide variety of applications depending upon its concentration. In the brown bottle at the drug store, it is typically at a concentration of about 3%. But, in industrial applications the concentrations are much higher, 30%, 50%, 70% or 90% plus. It is difficult to find pure hydrogen peroxide as it is very reactive and will decompose to form water and oxygen. And, it is the concentration that differentiates the material from something that you have around the house to something that must be handled with extreme care. At low concentrations, it is used for stain removal, disinfection, and a whitener for teeth or hair. In industrial applications, it is used for disinfection of drinking water or waste water, gas scrubbing (a pollution control method), and rocket fuel.

The material is colorless and odorless, but you can witness its reactivity fairly easily. For example, hydrogen peroxide is good at removing blood stains. If you pour a bit of the low concentration material from the drug store on a blood stain, you will immediately see it bubble and foam. This is a by-product of a chemical reaction. The reaction causes the bonds in the peroxide to break forming oxygen gas as a by-product of the reaction. Now, think about higher concentrations of hydrogen peroxide, the more hydrogen peroxide, the more potential oxygen and the increased risk of an adverse reaction. It is precisely this reason that it is used as the oxygen supply in rocket fuels. Another by-product of the reaction is heat. Even when using the low concentration material to remove a stain, heat is generated. The potential for combustion, i.e. fires, increases with the concentration. Thus, hydrogen peroxide is regulated as a hazardous material and requires special handling during shipment and storage.

But, back to that brown bottle. Why is it brown? It is brown because light can interact with the hydrogen peroxide molecule causing it to decompose to water and oxygen. Essentially, removing the reactive chemical from the bottle. Additionally, if the bottles are not stored properly or have been opened and exposed to air, the hydrogen peroxide may have decomposed. That old bottle under your bathroom sink that has been there for a couple of years after it was opened, it is likely to no longer

contain hydrogen peroxide. It probably just contains water, and the oxygen gas has long since gone into the atmosphere.

It is the decomposition products that makes it a popular household aid. The decomposition products are water and oxygen. It makes it safe to use on fruits and vegetables as a means killing Salmonella, or E. coli. It can also be used to disinfect dishwashers and other surfaces. It is good for removing mold and mildew as well. Yes, there is a lot of good chemistry stored away in that little brown bottle.