Early Acid Base Theories: Lavoisier and Davy

I. Antoine Lavoisier His basic idea was that acidity was caused by the presence of oxygen in the compound. In fact, Lavoisier (in September 1777) created the word oxygen. From the Greek (oxys = sour and genes = born), it means "acid maker." This idea turned out to be wrong, but it is historically important since it is the first systematic attempt to chemically characterize acids and bases. In early 1776, Lavoisier was able to write this: "It appeared proven . . . that the air we respire contains only a quarter of true air; that this true air is mixed, in our atmosphere, with three or four parts of an injurious air, a species of mophette, which causes most animals to perish, if the quantity of it is a little greater." The "true air" is, of course, oxygen and the "species of mophette" is nitrogen. The more complex nature of the atmosphere, with carbon dioxide and the noble gases became apparent later. However, it was Lavoisier that was the first to show the atmosphere was composed of more than one substance. At this time in scientific history, it was a common belief that the properties of acids could be traced back to a single substance. Lavoisier had studied the combustion of phosphorus and sulfur in 1772-73 and had proven that they combine with something in the atmosphere. He also knew that, when dissolved in water, phosphorus and sulfur oxides made acidic solutions. Also, the test Lavoisier used to demonstrate the presence of "true air" was the nitrous air test, devised by Joseph Priestley. Lavoisier knew that nitrous air combined with oxygen and the resulting compound made nitric acid in water. Hence, his conclusion (published about April 1776) was that oxygen was the component in a compound that was responsible for the generic property of acid. The other portion of the compound combined with the oxygen was called an 'acidifiable base" and was responsible for the specific properties of the compound. [Of course, as an American citizen, the ChemTeam notes the proximity of these events to the American Revolutionary War and expresses appreciation to France for its assistance during the war.] II. Humphry Davy Joseph Priestley discovered HCl (a gas) in 1772 when he reacted concentrated sulfuric acid on NaCl. When HCl was dissolved in water, a typical acidic solution was formed and it was named muriatic acid. This is from the Latin word muria, meaning brine. In 1774, Carl Scheele heated HCl with manganese dioxide (MnO2) and got a yellowish, choking gas. In sunlight, a water solution of this gas evolved oxygen and left muriatic acid in solution. This led Claude Berthollet, in 1785, to name this new substance oxymuriatic acid, even though it did not show acidic properties. (In 1810, Davy recognized oxymuriatic acid as an element and gave it its modern name - chlorine.) In 1779, Lavoisier concluded that oxygen was present in muriatic acid and that this was making it an acid. Events remained unchanged until about 1809-1810, when Davy entered the scene. He reacted many metals and non-metals with oxymuriatic acid and never obtained oxygen nor did he obtain any oxygen compounds. He heated charcol to white-hot temperatures in the presence of oxymuriatic gas and did not get a reaction, much less any oxygen evolved. Here is some of what he wrote in 1810: "One of the singular facts I have observed on this subject, and which I have before referred to, is, that charcoal, even when ignited to whiteness in oxymuriatic or muriatic acid gases, by the Voltaic battery, effects no change in them; if it has been previously freed from hydrogen and moisture by intense ignition in vacuo. This experiment, which I have several times repeated, led me to doubt the existence of oxygen in that substance." On September 23, 1809, Davy had written in a letter to a friend: ". . . the substance we took for Sulphuretted Hydrogene is telluretted Hydrogene, . . . , a substance affording another proof that Hydrogene is an oxide." Davy was reasoning that, since H2S and H2Te are acids, their common component (hydrogen) must contain oxygen, the principle of acidity according to Lavoisier. Which theory the ChemTeam might add that Davy was in the process of demolishing. Finally, in the 1810 article, Davy writes: "Few substances, perhaps have less claim to be considered a acid, than oxymuriatic acid . . . . May it not in fact be a peculiar acidifying and dissolving principle, forming compounds, with combustible bodies, analogous to acids containing oxygen, or oxides. . . . ? On this idea, muriatic acid may be considered as having hydrogen for its base and oxymuriatic acid for its acidifying principle." What Davy means by base in the last sentence is that hydrogen confers the generic property of acid, he does not mean a base in the modern sense of the word. However, the idea that hydrogen is the key component of an acid was complicated by the fact that there were many hydrogen-containing compounds that were not acids. Davy's ideas were not complete. III. Justus Liebig Liebig (a very important German chemist) proposed that an acid was a hydrogen-containing substance in which the hydrogen could be replaced by a metal. This definition proved sufficient for over 50 years until the advent of Svante Arrhenius. In fact, it is still compatible with modern definitions. Liebig had no corresponding theoretical definition for bases. There were still identified, in an empirical fashion, as substances which neutralized acids. However, no one could explain why they did so. Arrhenius will be the first person to offer a , more or less, correct explanation for acid-base neutralization.

About the Author

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