Are you positive about why you are positive?

Figure 0104

Electrolysis of water and the historical terms associated with it.

In a May 25, 1747, letter to Peter Collison, Franklin describes the current thinking about electricity (the "electrical fire") as having opposite types that enable the explanation for the observation of attraction and repulsion of electrified objects. Sometimes the electrical fire is built up (has an over-quantity relative to the surroundings) and is "electrised positively" or "plus" with a repulsion of the electrical fire (a high pressure of the electrical fluid); while a deficiency of the electrical fire means it is "electrised negatively" or "minus" with an attraction of the electrical fire (a low pressure area).

1747: Assigning Signs

Benjamin Franklin assigns "+" and "-" to throwing off or drawing in the electrical fire.

⊕ ⊖

Thomson was fortunate enough to be creative, insightful, and a prolific writer of great clarity. He advanced chemistry in the late 1700s by introducing the first system of using symbols. More importantly, through conversations he recounts in his 1830 *History of Chemistry*, he was completely sold on Dalton's view of atomism and nearly singlehandedly popularized it in the 1807 (third edition) of his "System of Chemistry." More than a mere reporter, Thomson took the ideas he encountered and ran with them. Fifty years after Franklin introduced "+" and "-" into the world, the first voltaic piles (batteries) were being made and, in addition to making frog legs twitch, the effects of electricity to be able to decompose chemical substances became the first comprehensive theory for what had been called chemical affinity (the reason for atoms to cling together).

1830: Elemental Charges

Thomas Thomson teaches the world about chemistry.

⊕ O^- electro-negative

⊖ H^+ electro-positive

Recounting experiments by Davy and others from 1800–1803, Thomson (1830) writes: "Thus it was demonstrated that water was decomposed by the action of the pile and that the oxygen was extracted from the positive pile and the hydrogen from the negative." Atoms were seen as being coated by either the positive or negative form of electricity, and so oxygen and others were assigned as being "electro-negative" for their observed appearance at the previously labeled positive pole; whereas hydrogen and others were assigned to be "electro-positive."

The electrolysis (to analyze or break down with electricity) of water is representative of the broader observation of electrical decomposition and contains the inference about the electrochemical nature of chemical affinity. Faraday needs new words to convey his ideas about how and why the "electro-negative" (i.e., electrically deficient in the Franklin sense) oxygen atoms move from being part of water and picking up (in 1834 thinking) some current, to become oxygen gas.

For Faraday, the "determining force" does not lie in the battery, but within the body that is decomposing, with the battery being a conduit. The need to tell the story and for language to be useful is a keen lesson in science.

Faraday (1834) writes: "To avoid confusion, and for the sake of greater precision of expression than I can otherwise obtain, I have deliberately considered the subject with two friends, and with their assistance and concurrence in framing them, I purpose henceforth using certain other terms, which I will now define."

1834: Using New Words

Michael Faraday creates explanations with mobile atoms and needs some new words.

⊖ ⇦ H^+ O^- ⇨ ⊕

In an emerging age of specialization, Whewell was one of the last great polymaths, publishing contributions in areas of mathematics, poetry, economics, theology, physics, astronomy, and geology. But by far, we owe Whewell thanks for his mastery of language. A noted wordsmith, he consulted with many colleagues to work through ideas of what to call something. Among others, he is credited with coining the terms scientist, physicist, and linguistics.

Faraday consulted with Whewell (and gives credit) for the terms introduced in 1834 related to the electrical decomposition of substances, and they are probably more important in chemistry today than they were then.

Rather than using the term "pole" for positive and negative ends of the voltaic pile, the term "electrode" was created to represent the place where current entered and left from the decomposing material (whereas the earlier notion of the pole was the place where positive and negative electrical density were being built up for discharge). Faraday wanted to establish a convention of representing the current traversing the decomposing body from "East to West" (as in the apparent motion of the sun) so the East is where the current enters the decomposing body (the positive electrode, the way up; where electricity is built up) and exits the decomposing body in the West (the negative electrode, the way down; where the decomposing body deposits its electricity). Hence, the positive electrode was called the anode (the "an" representing the way up, same as its use in biology as anabolism), and the negative electrode was called the cathode, signifying "descent" or "the way down" (as in catabolism). The individual atoms, charged as they were either electro-negative or electro-positive, would separate from one another and move to their complementary electrode. The collective term for these moving particles was "ion" (meaning "to go"), and correspondingly, then, the electro-negative ion moved to the (positive) anode and was to be called an "anion" while the electro-positive ion, moving to the (negative) cathode, was to be called a "cation."

1834: Building New Words

William Whewell invents the words Faraday needs.

cathode cation anion anode

⊖ ⇦ H^+ O^- ⇨ ⊕