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Short Communication

Witt and the Theory of Dyeing

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Abstract

Otto N. Witt (1853-1915) was the first to put a theory of dyeing in 1876 based on chromophore and auxochrome. He also conceived vacuum filtration as a method for rapid filtration.

Working in England

Otto Nicolaus Witt (1853-1915) was born in Saint Petersburg, Russia, the son of a German pharmacy professor. He was in school when the family moved again to Switzerland. He studied chemical technology at the Federal Polytechnic School in Zurich finishing his degree in 1873. He found a job in a steel works in Duisburg, Germany but within months was back in Zurich making colors for cotton printers. He then joined Williams, Thomas & Dower in west London.

Figure 1.

Back to Germany

Developments in the dyeing industry were so interesting that Witt went back to university in Germany to work in Victor Meyer's lab. His thesis in 1875 reported on the reactions of aromatic nitrosamines and their reactions with dichlorobenzene.

Figure 2.

Vacuum Filtration

Witt suggested placing a disc riddled with holes into a funnel, with filter paper laid on top, moistened to create a seal. He wrote a paper in 1886 describing an improved method for vacuum filtration. Witt's system worked, but it required care to use because the plates leaked round the sides and could slip sideways. Almost immediately the method was improved by Ernst Büchner (1850-1924) who developed his now funnel in which the plate is integrated into the funnel itself.

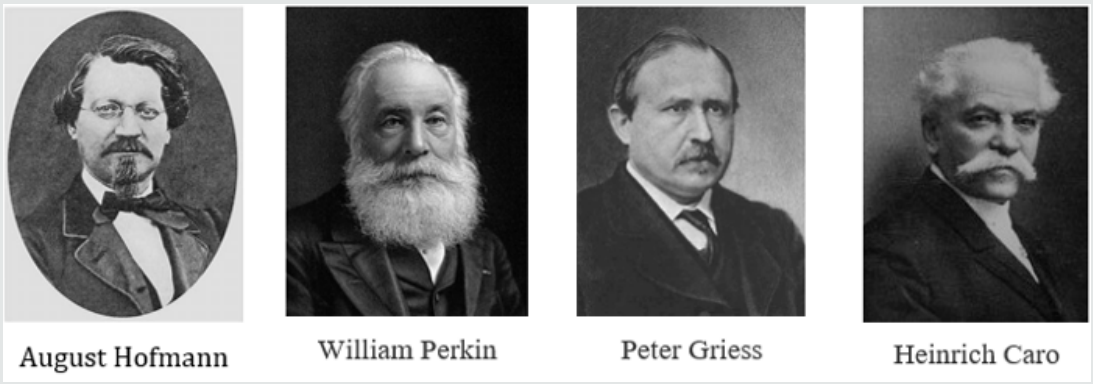

Figure 3.

Dyeing at the Time of Witt

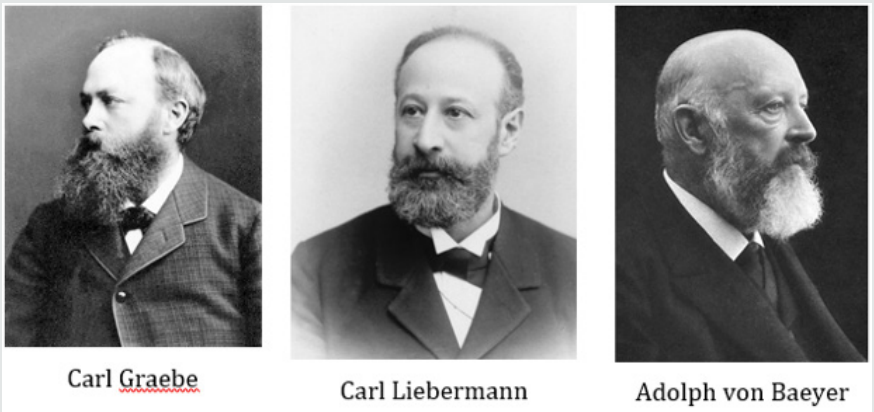

Figure 4.

In 1840 when Queen Victoria married her cousin Prince Albert who was prince of Saxe-Coburg-Gotha, a region near Justus von Liebig's laboratory, the prince who was active in promoting scientific education in England, was able to found a College of Chemistry in London with August Hofmann (1818-1892) as its director. Hofmann had worked with Liebig on separating the components of

coal tar before being invited to England. The discovery of mauveine in 1853 by William Perkin (1838-1907) in Hofmann Laboratory in London was soon followed by the discovery of other brightly colored compounds obtained by the oxidation of mixtures of anilines. The new colors began to revolutionize the textile industry. In 1858, the graduate student Peter Griess (1829-1888), working in Hermann Kolbe's lab at the University of Marburg, discovered the diazotization reaction when he treated anilines with nitrous acid. Griess's discovery opened up the possibility of coupling together a range of aromatic molecules that were being discovered across Europe.

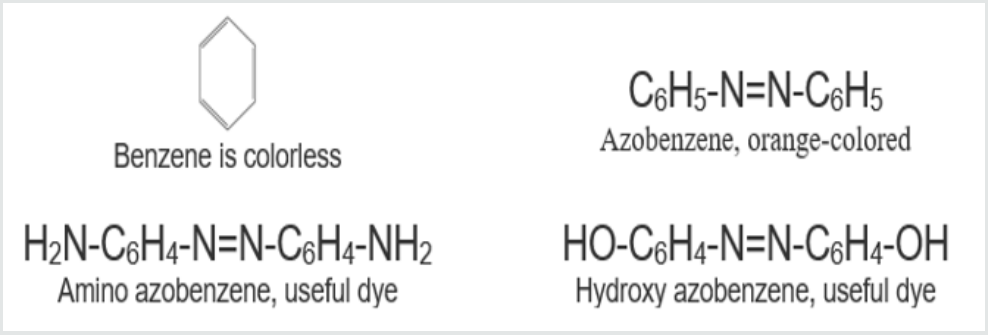

Figure 5.

Griess joined Hofmann's group in London, where he continued to study his coupling reaction. Around the same time, Heinrich Caro (1834-1910) working with his employer John Dale in Manchester, developed the first two azo dyes: Manchester Yellow and Bismarck Brown. Caro had already returned to Germany to join Badische Anilin- und Soda Fabrik in Ludwigshafen in Germany known as BASF. Carl Graebe (1841-1927) and Carl Liebermann (1842-1914) working for BASF synthesized the ancient dye alizarin in 1868. Adolph von Baeyer (1835-1917) Professor of chemistry in Munich researched the synthesis of the ancient dye indigo and determined its structure in 1870. The same year he prepared indigo. The result was that German firms like BASF, Hoechst, and Baeyer or the German-Belgian firm Aktiengesellschaft für Anilinfabrikation known as AGFA, steadily undercut the British in both price and quality. The British dye industry faded.

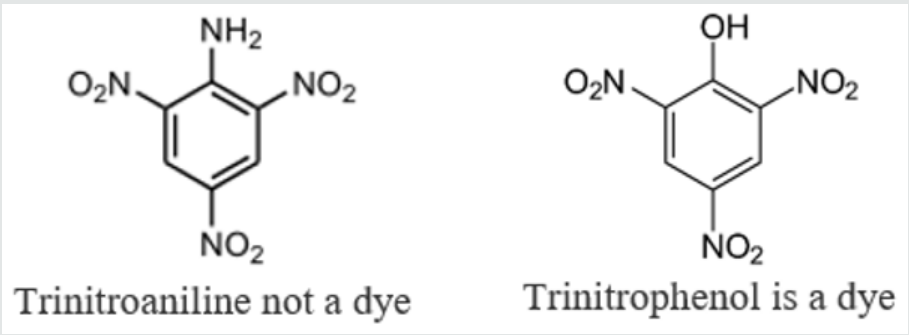

Figure 6.

Theory of Dyeing

In a paper published in 1876, he speculated that colored compounds were the result of a grouping of atoms – he called a chromophore. By adding the auxochrome, the dye could be made to stick to a fabric. According to Witt, benzene is colorless but azobenzene is orange colored. Although it is strongly colored it is devoid of dyeing power. Groups such as azo group, -N=N-, are called chromogenes. In order to convert them into useful dyes the introduction of an auxochromes, i.e., a salt-forming groups is necessary. Thus, while azobenzene is not a dye both amino-azobenzene and hydroxy- azobenzene are useful dyes. The presence of both chromophore and auxochrome does not necessarily indicate that the substance is a useful dye. For example, trinitroaniline contains both the chromophre group, NO2, and the salt forming auxochrome group, NH2, but it is not a useful dye because the basic character of the auxochrome is neutralized by the strongly acidic character of the chromophore. On the other hand, trinitrophenol (picric acid) is a useful yellow dye.

Conclusion

Witt's theory was later modified when it was discovered that the chromophore is usually electron-withdrawing, and auxochromes are normally electron-donating. The two groups are connected by a conjugated system.

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