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REVISION BIBLIOGRAFICA

Richard Anschütz (1852-1937) – the Famous German Organic Chemist of the Second Half of the XIX Century and the First Quarter of the XX Century (To the 170th Anniversary of His Birth)

Richard Anschütz (1852-1937) - el famoso químico orgánico alemán de la segunda mitad del siglo XIX y el primer cuarto del siglo XX (Al 170 aniversario de su nacimiento)

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ABSTRACT

Richard Anschütz (1852-1937) was an important German chemist in the second half of the XIX century and the first quarter of the XX century. He carried out experimental studies in the field of organic chemistry. He proposed a new method for the synthesis of anthracene. He developed vacuum distillation. He prepared pure chloroform. He rescued the names of Archibald Scott Couper (1831-1892) and Joseph Loschmidt (1821-1895) from oblivion. The purpose of this paper is to familiarize readers with the important events in the life of Anschütz. In addition, literature on his selected articles and books is presented.

Keywords: R. Anschütz, Organic chemistry, Vacuum distillation, Chloroform, Germany – XIX-XX centuries.

RESUMEN

Richard Anschütz (1852-1937) fue un importante químico alemán de la segunda mitad del siglo XIX y el primer cuarto del siglo XX. Realizó estudios experimentales en el campo de la química orgánica. Propuso un nuevo método para la síntesis de antraceno. Desarrolló la destilación al vacío. Preparó cloroformo puro. Rescató del olvido los nombres de Archibald Scott Couper (1831-1892) y Joseph Loschmidt (1821-1895). El propósito de este artículo es familiarizar a los lectores con los eventos importantes en la vida de Anschütz. Además, se presenta literatura sobre sus artículos y libros seleccionados.

Palabras claves: R. Anschütz, Química orgánica, Destilación al vacío, Cloroformo, Alemania - Siglos XIX-XX.

INTRODUCTION

The important events in the Anschütz's life

Richard Anschütz (1852-1937) (Figure 1) was "universally recognized as one of the most distinguished of the later 19th and earlier 20th centuries" (Huntress, 1952, p. 37). He was called "a valuable organic chemist" (Poeti, 2020), the man "who elaborated and utilized the benzene theory" (Wilcox, 1966, p. 27), and "a talented experimenter in the field of organic chemistry" ("The World Biographical", 2021). Eighty-five years have passed since his death, but during this time few articles about this interesting German scientist were published.

Richard Anschütz was born in Darmstadt (Germany) on March 10, 1852, and he was the son of Carl Ludwig Anschütz (1820-1902), a German officer, and his wife Henriette Friederike, née Delp (1830-1887) (Kauffman, 1982a, p. 628; Klemm, 1953, p. 308; Meerwein, 1941, p. 29).

Fig. 1. *R. Anschütz (1852-1937) at the age of forty-six ("Richard Anschütz", 1898).*

In 1870, he graduated from the *Grossherzogliches Gymnasium* at Darmstadt and began his studies at the *Technische Hohschule* in his native city. Two years later, in 1872, he entered at the University of Heidelberg, where he studied under Robert Bunsen (1811-1899) and Gustav Kirchhoff (1824-1887). On February 24, 1874, he defended his doctoral dissertation and received his Ph.D.

Then he went to Tübingen, where he completed his education in organic chemistry (1874-1875) under Rudolfh Fittig (1835-1910) at the local university. In the spring 1875, on Fittig's recommendation, he became the *Vorlesungsassistent* (Lecture assistant) to August Kekulé (1829-1896) at the University of Bonn, where "he spent the

remainder of his career-more than a half-century of uninterrupted research and teaching activity" (Kauffman, 1982a, p. 628).

On August 1878, he presented to the Philosophical Faculty of the University of Bonn his *Habilitationsschrift* entitled *Über Phenanthren und ein Gesetz der Pyrokondensation* (About Phenanthrene and a Law of Pyrocondensation) (Meerwein, 1941, p. 30). On November 7, 1878, he delivered the public inaugural address entitled *Über die Wechselbeziehungen zwischen reiner Chemie und chemischer Technik* (On the Reciprocal Relationships between Pure Chemistry and Chemical Technology) and became *Privatdozent* (unsalaried lecturer) (Kauffman, 1982a, p. 628; Meerwein, 1941, p. 30).

In 1882, he began work as Instructional Assistant for Organic Chemistry. Six years later, in 1888, he married Anna, née Pflüger. The spouses had two sons: Theophil, born in 1891, who died at a young age, and Ludwig (1889-1954), who in 1930 became Professor of Organic Chemistry at the *Deutsche Technische Hochschule* at Brünn (now Brno, Czech Republic) (Krollpfeiffer, 1957, p. XV).

In 1889, he received the title of *Extraordinarius Professor* (Extraordinary Professor) and in 1898 he became Director of the University's Chemical Institute. He held this position for 24 years until his retirement in in the spring of 1922 (Meerwein, 1941, p. 31).

In the spring of 1933, he fell seriously ill with the flu, from the consequences of which he never fully recovered. He died on January 8, 1937. With his death, science lost one of its "last representative classical organic structural chemistry" (Meerwein, 1941, p. 66).

Anschütz's works

The list of Anschütz's published works includes two hundred and eighteen papers, published in the years 1876-1936. There are the articles published in Germany in the journals *Berichte der deutschen chemischen Gesellschaft* and *Justus Liebigs Annalen der Chemie* (Meerwein, 1941, pp. A66-A74).

Anschütz's first works in the field of organic chemistry were published in 1876 in the *Berichte der deutschen chemischen Gesellschaft.* The first one concerned hydrazobenzene ($C_{12}H_{12}N_2$). In collaboration with Gustav Schultz (1851-1928), he obtained this compound by the action of sodium on bromoaniline. The following reaction take place: 2 $C_6H_4Br.NH_2$ + 2Na = $C_{12}H_{12}N_2$ + 2 NaBr (Anschuetz & Schultz, 1876, p. 1400). Two more of their jointly published articles concerned the decomposition products of phenanthrenequinone ($C_{14}H_8O_2$) with quick lime (Anschütz & Schultz, 1876a) and nitrophenanthrenequinone ($C_{14}H_7NO_4$) (Anschütz & Schultz, 1876b).

A year later, in 1877, he and Schultz published four articles. Two of them was works on phenantrenchinone (Anschuetz & Schultz, 1877; Anschütz & Schultz, 1877a). The third paper was about the use a simple apparatus for the convenient determination of high melting points (Anschütz & Schultz, 1877b). The fourth article concerned the action of sodium on halogen-substituted anilines, for instance, bromoaniline ($C_6H_4BrNH_2$). Oxidation of the intermediate reaction product ($C_6H_5NH.Na$) yielded azobenzene ($C_{12}H_{10}N_2$). In today's notation the reactions are expressed by the following equations: 1) 2 $C_6H_4BrNH_2$ + 2 Na = 2 $C_6H_4BrNH.Na$ + H_2, 2) $C_6H_4BrNH.Na$ + H_2 = $C_6H_5NH.Na$ + HBr, 3) 2 $C_6H_5NH.Na$ + O_2 = $C_{12}H_{10}N_2$ + 2 NaOH (Anschütz & Schultz, 1877c, p. 1803).

In 1883, together with F. Eltzbacher, he proposed a new method for the synthesis of anthracene ($C_{14}H_{10}$) by reacting aluminum chloride with a mixture of benzene and acetylene tertrabromide (Anschütz & Eltzbacher, 1883, p. 623).
From 1887 to 1889, some of his papers were published in the *American Chemical Journal* (Anschütz, 1887a; Anschütz & Wirtz, 1887a; Anschütz & Emery, 1889a; Anschütz & Emery, 1889b; Anschütz & Moore, 1889). Anschütz and his co-workers also published some of these articles in the *Justus Liebig Annales der Chemie* (Anschütz & Emery, 1887; Anschütz & Wirtz, 1887b).
In 1893, he prepared pure chloroform. He described the method of preparing of this compound in the article entitled *Darstellung von reinem Chloroform mittelst Salicylid-Chloroform oder o-Homosalicylid-Chloroform* (Preparation of Pure Chloroform by means of Salicylid-Chloroform or o-Homosalicylid-Chloroform) (Anschütz, 1893).
In 1928, he published an article on the history of the isomerism of fumaric acid (*trans*-Butenedioic acid, $C_4H_4O_4$; HOOCCH=CHCOOH) and maleic acid (*cis*-Butenedioic acid, $C_4H_4O_4$; HOOCCH=CHCOOH) (Anschütz, 1928). His papers on this subject entitled *Zur Geschichte der Isomerie der Fumarsäure und der Maleïnsäure* also appeared in 1887 (Anschütz, 1887b) and 1889 (Anschütz, 1889).
In 1928, together with Harry Quitmann, he published a paper on the synthesis of γ, γ-dimetylo-δ-metylo-cyclo-homotetronic acid ($C_8H_{12}O_{3)}$ (Anschütz & Quitmann, 1928, p. 101).
Among the articles he wrote, there are also those in which he does not present the results of his experimental studies. For, instance, in 1914, he wrote an article about the German chemist Heinrich Debus (1824-1915) on the occasion of his 90th birthday (Anschütz, 1914).
He was the author of several obituaries on the chemists of his time. In 1911, he wrote the obituary of the American chemist Leonard Parker Kinnicutt (1854–1911) (Anschütz, 1911). In 1926, he published the obituary of the German-Italian chemist Wilhelm (Guglielmo) Körner (1839-1925) (Anschütz, 1926). Eight years later, the obituary of the German chemist Eberhard Rimbach (1852-1933), written by him, appeared in the *Berichte der deutschen chemischen Gesellschaft* (Anschütz, 1934). In 1936, he wrote the last obituary of the German chemist Ludwig Claisen (1851-1930), "one of the most successful researchers from August Kekule's school in the field of synthetic organic chemistry and tautomerism" (Anschütz, 1936, p. A97).

Books written by Richard Anschütz

In 1880, Kekulé resumed work on his Lehrbuch der organischen Chemie, oder, der Chemie der Kohlenstoffverbindungen in collaboration with Richard Anschütz and Gustav Schultz. Two years later, this textbook was published (Kekulé, 1882).
In 1887, the first edition of his Die Destillation unter vermindertem Druck im Laboratorium (The distillation under Reduced Pressure in the Laboratory) was published in Bonn (Anschütz, 1887c). Eight years later, a second edition of this book appeared in the same city. Its authors were Richard Anschütz and Hans Reitter (1865-1912). Figure 2 shows the title page of this edition (Anschütz & Reitter, 1895).

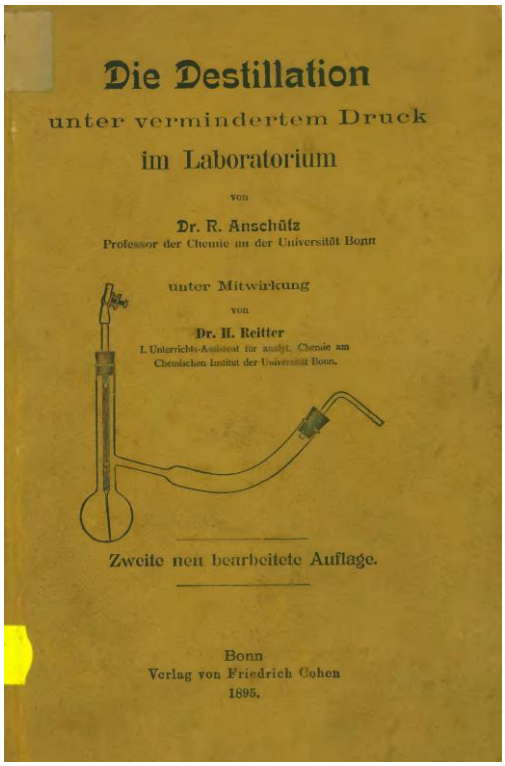

Fig 2. *Title page of Richard Anschütz's and Hans Reitter's Die Destillation unter vermindertem Druck im Laboratorium. Zweite neu bearbeite Auflage (Bonn: Verlag von Friedrich Cohen, 1895).*

A book edited by Richard Anschütz and Robert Schulze entitled *Das Chemische Institut der Universität Bonn* (The Chemical Institute of the University of Bonn) was published in 1904 in Bonn Anschütz & Schulze, 1904).

In 1929, he wrote a detailed two-volume biography of Kekulé which appeared in Berlin (Anschütz, 1929a; Anschütz, 1929b). In the first volume of this book an account of the Sessions of the International Congress of Chemists in Karlsruhe, on 3, 4, and 5 September 1860 was published as Appendix 8 (Anschütz, 1929a, pp. 671-688). The English translation of this account can be found in a *Classic Chemistry* (Giunta, n.d.).

In 2011, the first volume of Anschütz's biography of Kekulé appeared in Hamburg. It was a reprint of the original 1929 edition (Anschütz, 2011). A year later, the second volume of this book was published. It was also a reprint of the original 1929 edition (Anschütz, 2012).

Editions of Victor von Richter's Textbook of Organic Chemistry, edited by Richard Anschütz

The Russian-German chemist Victor von Richter (1841-1891) (Sztejnberg, 2020) was the author of excellent academic Textbook on Organic Chemistry. The first (1876) German edition of his *Kurzes Lehrbuch der Organischen Chemie oder der Chemie der Kohlenstoffverbindungen* appeared in Bonn (Richter, 1876). The second edition of this textbook was published in 1880. The next four editions, up to the sixth one (1882, 1885, 1888, 1891), were published while the author was still alive.

After Richter's death, Richard Anschütz continued to expand and refine this textbook. The seventh edition appeared in 1894 and the eighth in the years 1897-1898 (Richter, 1897; Richter, 1898). The last 12th German edition was published in 1928. In the years 1931-1959 the publication of this edition was resumed.

The first volume of the French edition of Richter's *Traité De Chimie Organique Par R. Anschütz Et G. Schroeter* was published in 1910 (Richter, 1910), and the second in 1918 (Richter, 1918). The translator was Henry Gault (1880-1967), lecturer at the Faculty of Science and deputy professor at the School of Medicine and Pharmacy of the University of Caen.

The American edition of this textbook under title *Chemistry of the Carbon Compounds or Organic Chemistry* was first published in Philadelphia in 1886. The translator was the American chemist Edgar Fahs Smith (1854-1928). (Richter, 1886). A second American edition of this textbook appeared in 1892 (Richter, 1892). The third American edition was published in 1899-1900 It was translated from the eighth German edition, edited by Richard Anschütz (Richter, 1899; Richter, 1900). In the years 1902-1913, the third American edition of this textbook was resumed in Philadelphia and London. In 1934, the first volume of the book entitled *Organic Chemistry or Chemistry of the Carbon Compounds* appeared in New York. It was translated from the 12th German edition, edited by Richard Anschütz and Fritz Reindel. The translator was Eric Newmarch Allott (1899-1980) (Richter, 1934). In the late 1930s and the second half of the 1940s, Richter's textbook was published several times under the title *The Chemistry of the Carbon Compounds* by Elsevier Publishing House in New York (Richter, 1946) and by Nordemann Publishing Company in New York. At this point it should be emphasized that the editor of the second part of the fourth volume (Organic Free Radicals), published in 1947, was Ludwig, son of Anschütz (Richter, 1947).

Richard Anschütz's determination of the fate of the Scottish chemist Archibald Scott Couper (1831-1892)

In the history of chemistry the Scottish chemist Archibald Scott Couper (1831-1892) was completely forgotten until the end of the first decade of the 20th century. Anschütz "discovered that Couper, almost simultaneously with Kekulé, had proposed the self-linking of carbon atoms" (Benfley, 1961, p. 707). Couper's theoretical paper entitled *Sur une nouvelle théorie chimique* appeared in 1858 in the *Comptes rendus hebdomadaires des séances de l'Académie des Sciences* (Couper, 1858a) and under the title *On a New Chemical Theory* in *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science* (Couper, 1858b). Therefore, Anschütz wanted to get to know Couper's life and fate more closely and familiarize the scientific community with his chemical work.

After fifty-three years, in 1911, the book with the Couper's work entitled *Uber eine neue chemische Theorie* was published in Leipzig. Anschütz was its editor (Anschütz, 1911). Two years earlier, in 1909, his article in German about Couper's life and work was published in the *Archiv für die Geschichte der Naturwissenschaften und der Technik* (Anschütz, 1909a). In the same year, his paper entitled *Life and Chemical Work of Archibald Scott Couper* appeared in the *Proceedings of the Royal Society of Edinburgh.* The translator was the Scottish organic chemist Alexander Crum Brown (1838-1922) (Anschütz, 1909b). A reprint of this article was published in Edinburgh that same year (Anschütz, 1909c).

From 1930 to 2000, several authors wrote about Couper's life and work, for instance James C. Irvine (1930, pp. 2818-2820), Leonard Dobbin (1934), James Kendall (1939, pp. 105-115), Howard S. Mason (1943, p. 349), Hugh W. Salzberg (1991, p. 244), Alfred Bader (1997, pp. 101-104) and Roberto Poeti (2000).

The discovery of Joseph Loschmidt's book by Richard Anschütz

The Austrian chemist Joseph Loschmidt (1821-1895) was the autor of the book entitled *Chemische Studien, I: A. Constitutions-Formeln der organischen Chemie in graphisher Darstellung; B. Das Mariotte'sche Gesetz* which was published in 1861 in Vienna (Loschmidt, 1861). This book for chemists was discovered by Anschütz when he re-published it in 1913. He added an 11-page biographical sketch of Loschmidt (pp. 99-109) and 208 annotations to Loschmidt original text (Anschütz, 1913, pp. 109-154).

The American chemist and historian of chemistry George Bernard Kauffman (1930-2020) wrote about this great historical discovery by Anschütz (Kauffman, 1989) as follows:

Like [the Italian physicist Amedeo] Avogadro's [(1776-1856)] hypothesis, published in 1811 in a journal read primarily by physicists … and negleded by chemists until resurrected by [the Italian chemist] Stanislao Cannizzaro [(1826-1910)] at the Karlsruhe Conference in 1860, Loschmidt's privately printed opus languished in obscurity for more than half a century. In 1913 Richard Anschütz, Kekulé's successor at Bonn … republished it as a volume in "Ostwald's Klassiker der exakten Wissenschaften" series (p. A281).

Several authors wrote about Loschmidt's graphic formulas and his book. For example, Anschütz's article under the title *Über Loschmidts graphische Formeln, ein Beitrag zur Geschichte der Benzol-Theorie* (About Loschmidt's Graphic Formulas, a Contribution to the History of the Benzene Theory) was published in 1912 (Anschütz, 1912). Howard S. Mason wrote about Loschmidt's graphic formulas in his paper entitled *History of the Use of Graphic Formulas in Organic Chemistry* (Mason, 1943, p. 351). Moritz Kohn's article about Loschmidt and his forgotten book appeared in 1945 in the *Journal of Chemical Education* (Kohn, 1945). Walter Böhm wrote about Loschmidt's book in the *Dictionary of Scientific Biography* (Böhm, 1981, p. 508). Alfred Bader wrote about Loschmid's "Chemische Studien" in his chapter in a book edited by Wilhelm Fleischhacker and Thomas Schönfeld (Bader, 1997, p. 105) and in his chapter in a book edited by Balazs Hargittai and István Hargittai (Bader, 2015, p. 99-100). Günter Paulus Schiemenz's article entitled *Joseph Loschmidt und die Benzol-Formel* was published in 1994 in the *Sudhoffs Archiv* (Schiemenz, 1994).

CONCLUSION

Richard Anschütz (1852-1937) was the important German chemist of the second half of the 19th century and first quarter of the 20th century. He received several scientific honours. Among them, there are membership of the Academy of Sciences and Scientific Societies. In 1887, he became a member of the *Imperial Leopoldino-Carolinische Deutsche Akademie der Naturforsche* in Halle (Knoblauch, 1891, p. 8). In 1908, he was elected an honorary member of the *Physikalischen Vereins* in Frankfurt am Main (Meerwein, 1941, p. 65). He "was one of the oldest members of the German Chemical Society and served (1918-20) as one of its vice presidents" (Huntress, 1952, p. 39). On Monday, February 4, 1935, he became a Foreign Honorary Fellow of *the Royal Society Of Edinburgh* (Thompson, 1936, p. 187).

On Wednesday, 26th September 1906, on the occasion of the Quatercentenary celebrations, the University of Aberdeen conferred him honorary L.L.D. Degree (Anderson, 1907).

Some authors wrote about his life and works. For instance, in 1926 his biographical note appeared in the *J. C. Poggendorffs, biographisch-literarisches Handwörterbuch zur mathematik, Astronomie, Physik, Chemie und verwandte Wissenschaftsgebiete* (Weinmeister, 1926, pp. 27-28). In 1932, F. Reindel wrote an article about him on his eighteenth birthday (Reindel, 1932). Nine years later, in 1941, a paper about his life and work by Hans Meerwein (1879-1965) appeared in the *Berichte der deutschen chemischen Gesellschaft* (Meerwein, 1941). In 1952, Ernest H. Huntress wrote about him in his article published in the *Proceedings of the American Academy of Arts and Sciences* (Huntress, 1952). A year later, his biographical note by Friedrich Klemm appeared in the *Neue Deutsche Biographie* (Klemm, 1953, p. 308). Two articles about his life (Kauffman, 1982a) and work (Kauffman, 1982b) appeared in 1982 in the *Journal of Chemical Education*.

His speeches delivered on various occasions were also published. For instance, his address given at the Beginning of the Rectorate of the *Rheinische Friedrich Wilhelms Universität* on October 18, 1915, entitled *Die Bedeutung der Chemie für den Weltkrieg* (The Importance of Chemistry for the World War) was published in 1915 (Anschütz, 1915). In 1961, his speech on the occasion of dedicating the Kekulé Monument in Bonn, June 9, 1903 (Anschütz, 1903), translated into English, was published in a book edited by the American chemist and historian of chemistry Eduard Farber (1892-1969) (Anschütz, 1961, pp. 697-702).

After Anschütz, not only his papers and books survived. In addition, several of his portraits were produced. One of them was included by him in his biographical book on Kekulé (Anschütz, 1929a, p. 492). Another of his portraits can be found in the article by George B. Kauffman (1982a, p. 627). His portrait from 1921 is available in the *Deutsche Museum Archiv* (German Museum Archive) in Munich ("Digiporta Digitales Porträtarchiv", n.d.).

The authors of *The World Biographical Encyclopedia* wrote about him and his achievements ("The World Biographical", 2021) as follows:

Anschütz was able to dedicate himself to research in the field of organic chemistry for almost fifty years. He was a talented experimenter, who successfully combined physical methods and chemical synthesis as a means of establishing chemical structure. He also pioneered in methods of vacuum distillation (1887). ... Another Anschütz`s achievement came in 1893 when he succeeded in clarifying the action of phosphorus oxychloride on salicylic acid. These experiments led to his research on salicylides, dithiosalicylides, and sulfonylides, which, in turn, led to the discovery of a crystalline salicylide chloroform that is one-third chloroform by weight. As a result, chloroform of high purity was extracted, which was later named "Anschütz," and was used for narcosis (p. 1).

Richard Anschütz, as a great German chemist, went down in the history of chemistry, and his name was written in it forewer. It was made possible thanks to his achievements as well as his numerous papers and books. He became famous not only as an excellent biographer of August Kekulé, but also as editor of many editions of Victor von Richter's Textbook of Organic Chemistry.

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