Celebrating 200 years of Julius Adolph Stoeckhardt, the author of *Schule der Chemie*. Using history to learn chemistry

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ABSTRACT

Julius Adolph Stoeckhardt —born in Saxonia in 1809— was not only a great chemist, he was also an excellent teacher and propagator of chemistry. The 200th anniversary of his birth gives us occasion to remember his life and his scientific work. His book *Schule der Chem*ie was one of the most successful textbooks in the field of chemistry. It was first published in 1846 in Germany, translated to several foreign languages, and mentioned by Nobel-Prize-winners like Emil Fischer and Wilhelm Ostwald as an important access to chemistry for them.
This paper explores historical pathways in learning chemistry, as well as the possibility for an historical approach to chemical problems as one interesting and effective method for learning and teaching chemistry.

KEY WORDS: History, Didactics and Popularization of Chemistry, Agricultural Chemistry

Figure 1. Julius Adolph Stoeckhardt (1809-1886) (Archive of the University Chemnitz UAC-502-611).

Introduction

"Soon I learned to care and foster it as the biggest treasure which was fallen in my hands so far. Because this book of chemistry proved as a masterpiece of instruction… *Stoeckhardt* fulfilled my desire to make all these fine experiments about which I read, by myself, …concerning the devices and the skillfulness of the pupil (in the book) it was expected only a little for the beginning, whereas later the pupil was well considered guided stepwise to more complicated objects…" (Ostwald, 1933, pp. 43-44).

With these words Wilhelm Ostwald (1853-1932), the Nobel Prize winner of Chemistry in 1909, described his impressions from the book *Schule der Chemie* (The School of Chemistry) written by Julius Adolph Stoeckhardt. Why was Ostwald – and not only he – deeply influenced by the *Schule der Chemie*? Who was the author of this ingenious textbook with the full title: *Schule der Chemie oder erster Unterricht in der Chemie versinnlicht durch einfache Experimente: zum Schulgebrauch und zur Selbstbelehrung insbesondere für angehende Apotheker, Landwirte, Gewerbetreibende usw.* (School of Chemistry or First Instruction in Chemistry sensualized by elementary experiments: for use at school and for self-instruction especially for prospective pharmacists, farmers, tradesmen, etc.).

The 4th of January, 2009 will mark the 200th anniversary of the birth of Julius Adolph Stoeckhardt (Fig. 1). It is time to remember this multitalented person, a scientist, a chemist and a teacher and to discuss the question of what the today's youth can learn by his book.

Biography

Julius Adolph Stöckhardt was born into the family of Christian Gottlieb Stoeckhardt (1773-1831) and Caroline (born as Rudolphi). Christian Stoeckhardt was the pastor in the little village of Roehrsdorf, between Meissen and Dresden, in the German country of Saxony. In that time, Saxony was a country with a highly developed manufacturing industry.

Julius was instructed by his father at first, and later he learned in a boarding school.

After an apprenticeship and employment in several pharmacies, Stoeckhardt studied natural sciences, especially pharmacy, in Berlin (Prussia) from 1832 to 1833. Heinrich Rose (1795-1864), Eilhard Mitscherlich (1794-1863), Sigismund Friedrich Hermbstaedt (1760-1833), Heinrich Friedrich Link (1767-1851), Karl Sigismund Kunth (1788-1850) und Henrich Steffens (1773-1845) were his scientific teachers. In 1833 he passed the pharmaceutical state examination to become a first class pharmacist in Prussia. After a journey through Europe with visits to famous chemists such as Michael Faraday (1791-1867), Joseph Louis Gay-Lussac (1778-1850), Antoine Laurent de Jussieu (1748-1836) and Jean

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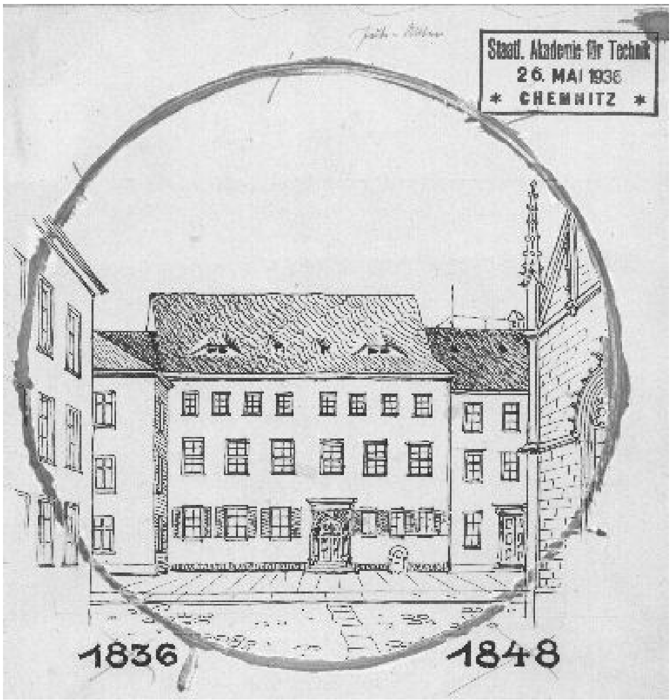

Figure 2. Building of the Royal Vocational School in Chemnitz (Archive of the University Chemnitz UAC-502-674).

Baptiste Dumas (1800-1884) he passed in 1835 the pharmaceutical state examination in Saxony and he started to work in the mineral-water-production laboratory of Friedrich Adolf Struve (1781-1840) in Dresden. Around 1830, public lectures were established in Dresden to give the members of the middle class a chance for improving their knowledge in the fast developing field of natural sciences. Georg Paul Alexander Petzholdt (1810-1889) was a very active propagator of the natural sciences (later he got the Chair of Agriculture and Technology in Dorpat (nowadays Tartu, Estonia)). He opened his private laboratory for his public lecture students. Stoeckhardt worked in this laboratory, too (Poenicke, 1960, p. 48). In 1837 Stoeckhardt became a teacher of natural sciences in the "Vitzthumsche Geschlechtergymnasium" [High school of the Vitzthum dynasty, donated by Rudolph Vitzthum von Apolda (1572-1639)] in Dresden, which was combined with the "Blochmannsche Erziehungsanstalt" [Boarding school of Karl Justus Blochmann (1786-1855), who had been a follower of the Swiss pedagogue Johann Heinrich Pestalozzi (1746-1827)] since 1828. In contrast to most of the Higher Schools in Germany at the time, the natural sciences played an important role in this educational establishment. In the same year the doctorate was conferred on Stoeckhardt by the faculty of Philosophy in Leipzig university for his paper *Res naturales, qua de causa perscrutandae, qua methodo docendae et tractandae, quomodo naturae convenienter disponendae* (the natural objects, why should they be investigated, which method is used for teaching, in which way nature is adequate described). From 1838 to 1847 Stoeckhardt was a teacher of natural sciences at *Koenigliche Gewerbschule* (Royal Vocational School) in Chemnitz (Fig. 2). This town was the most important industrial centre in Saxony in the middle of the 19th century, for instance, the manufacturing of drapery and mechanical engineering were highly developed there.

Figure 3. House of the Stoeckhardt family in Tharandt (Saxony).

Stoeckhardt established a chemical laboratory in the school and started to teach experimental physics, experimental chemistry, technical chemistry and organized practical courses for the pupils. In 1840 Stoeckhardt was appointed as a professor.

In that year he married Rosalie Liebster (1814-1872). The couple had four children: Carl Georg (1842-1913), Johanna (*1844), Martha Maria (*1848) and Marianne (*1852). The son studied theology and emigrated to the U.S.

In 1843 Stoeckhardt was appointed by the Royal Department of Justice in Chemnitz as a pharmacy-reviser. In consequence of this office he had to travel a good deal through parts of Saxony (Fig. 3). There, he became acquainted with the industry of this region.

In Dresden Stoeckhardt made contact with Saxon industrial and agricultural associations. These relations intensified in Chemnitz. He started with public lectures. These lectures were addressed in particular to farmers because Stoeckhardt was influenced deeply by the book of Justus Liebig (1803-1873) *Die organische Chemie in ihrer Anwendung auf Agricultur und Physiologie* (Organic Chemistry in its applications to Agriculture and Physiology). In order to improve agricultural chemistry, it was necessary to create opportunities for academic training and for testing the new theories by experiments. Therefore, a special chair of Agricultural Chemistry was established in Saxony in the little town of Tharandt, southwest of Dresden. There had been a private school of Forestry since 1811, an Academy of Forestry since 1816 and an agricultural school since 1830 (Schober, 1866, pp.3-9). Chemistry had a long tradition in this academy (Schling, 1989, p. 134); it had been taught by Carl Leberecht Krutzsch (1773-1839) since 1816 for the forest workers and later for the farmers. The new chair of Agricultural Chemistry belonged to this academy (Fig. 4) and to this chair Stoeckhardt was appointed. Two years later a well equipped laboratory was opened. So he had the possibility to give practical instruction to his students and to do experimental research work in agricultural chemistry, as well as on questions of the fume damage of forest.

Figure 4. The historical building of the Academy of Forestry in Tharandt (today a department of the University Dresden) (photo Gisela Boeck).

Moreover he held about 500 popular lectures on agricultural chemistry, wrote many papers and fought for the establishment of experimental stations in bigger communities to give the farmers the chance to test the soil, the fertilizer etc. In 1870 the agricultural education program was moved from Tharandt to the University of Leipzig. Stoeckhardt´s chair was renamed – instead of Agricultural chemistry it was Chemistry. Stoeckhardt worked in Tharandt until his retirement in 1883. On the 1st of June in 1886 Stoeckhardt died in Tharandt (Fig. 5). (Marx et al., 2008; Nobbe, 1887; Wienhaus et al., 1986; Wilsdorf, 1887).

Stoeckhardt and agricultural chemistry

Two facts influenced the development of agricultural chemistry in Germany in the first half of the 19th century:

1. There was not enough food as a result of the growing population on the one hand and floods, storms and strong rains on the other hand. The soil was impoverished of mineral nutrients, and it was not effectively enriched with fertilizer.
2. For chemistry to be accepted in academia, the success of agricultural chemistry was vital.

Agricultural chemistry became a big movement in the German speaking countries of Middle Europe, but Saxony was the precursor. (Schling, 1989, p 8). It was highly industrialized, only 32% of the inhabitants worked in agriculture whereas in Prussia 64% of the inhabitants still worked in agriculture (Schling, 1989, p. 112).

In many cases Justus Liebig is called the father of agricultural chemistry, even though many agricultural facts were already known, for instance:

— The ancient Greek, Aristotele (384-322 B.C.) discussed the role of humus (humus is the result of decay of organic compounds in the soil).

— Johann Baptist van Helmont (1577-1644) investigated a growing willow shoot to demonstrate the transmutation of air and water to soil for the plants (even though his conclusions were wrong, it establishes that already in that time an experiment was carried out with quantitative results).

— Joseph Priestley (1733-1804) found out that green plants improve the air.

— First inorganic fertilizers were tested (saltpeter, marl and common salt).

— Jan Ingen-Housz (1730-1799), Jean Senebier (1742-1809) and Nicolas Théodore Saussure (1767-1845) developed the concept of photosynthesis and they explained that the plants use the minerals from the soil.

These facts were reported by Humphry Davy (1778-1829) in his "Elements of Agricultural Chemistry" in 1813. Albrecht Thaer (1752-1828) disseminated the theory that humus and water are needed for the plant to survive. The humus could be converted to inorganic salts thanks to the vital forces. Karl Sprengel (1787-1859), a pupil of Thaer, showed that the importance of humus is its contents of mineral nutrients (N, Ca, K, Mg, P, S, Fe, Mn, Cl, Cu), if one of these nutrients is missing or there is not enough present, the development of the plant is endangered. This was the first verbalization of the Law of minimum, which is normally connected with the name of Liebig (Schling, 1989, p.41).

In 1838 the British Association for the Advancement of Science had asked Liebig for a report on the development status of Organic chemistry. At the end of 1830, Liebig was not interested in theoretical, but in practical questions of chemistry. Instead of the above mentioned report he authored the "Organic Chemistry in its applications to Agriculture and Physiology" (Brock, 1999, p.125). This book was both celebrated enthusiastically and excoriated dramatically. Systematic investigations on soil and fertilizer were missing. But this book served as a starting place for introducing agricultural chemistry to a great extent, naturally not only with success.

Stoeckhard brimmed over with enthusiasm for Liebig´s ideas, but he disagreed with him in the question of azote. While Liebig declined the necessity in using N-fertilizer because the plants can use the azote in the air, Stoeckhardt defended it and fought for the use of guano (about this fertilizer he wrote a book) and Chile saltpeter as important N-providers in industrialized Saxony, as well as in the relatively undeveloped Mecklenburg. Stoeckhardt visited this German

Figure 5. The grave of Julius Adolph Stoeckhardt at the cemetery in Tharandt (photo: G. B.).

country in the north. He wrote enthusiastically, that the trip was "a long, bright and idyllic Sunday" (Stoeckhardt, 1854, p. 391). He lectured to the farmers and tested much Mecklenburgian soil and showed there to be no reason to assert the ineffectiveness of these fertilizers. Stoeckhardt´s laboratory in Tharandt was like the first agricultural experimental station because he was asked to do numerous analyses: between 1849 and 1856 more than 2000 analyses are reported (Schling, 1989, p. 245). But it was impossible to establish a realistic experimental station there because it lacked adequate proving grounds. Stoeckhardt understood the importance of district stations and fought for them. In 1851/2 the first independent station was opened in Moeckern near Leipzig. 25 years later 59 stations had been established in Germany thanks to the efforts of Stoeckhardt.

Stoeckhardt was a very effective writer on agricultural chemistry, too. From 1850 to 1854 he edited the *Zeitschrift fuer deutsche Landwirthe* (*Journal for German Farmers*) together with Hugo Schober (1820-1882). In 1855 he founded his own journal *Der chemische Ackersmann* (The Chemical Field-peasant). This journal was edited until 1875. Most of the published papers were written by Stoeckhardt. Some of his popular lectures were published in the book C*hemische Feldpredigten* (C*hemical Sermons on the field*) (Mammen, 1903).

At first Liebig praised Stoeckhardt for his engagement in agriculture (despite their differences in opinion regarding the role of azote). Liebig wrote: "Men like you, who are equipped with talent and all skills, who use their energy with true ardor for a good cause, are rare gemstones …. Do not get tired and continue to pray the chemical gospel to the agricultural heathen" (Stoeckhardt, 1875, p.6).

Some years later Liebig affronted Stoeckhardt with hard, unreasonable words on his opinion on N-fertilizer. Stoeckhard was cut to the quick by this criticism. He answered Liebig that he would continue to believe in the opinion of Liebig concerning agricultural chemistry, but on the question of azote he disagrees. Stoeckhardt did not intend to continue this dispute because the subsequent investigations would show which opinion will be the right one (Stoeckhardt, 1857 and Stoeckhardt, 1858). Around 1860 it was shown by experiment that fertilization with N- and P-compounds are useful.

Stoeckhardt and the environmental protection

Stoeckhardt engaged in more than agricultural chemistry. During his travels through Saxony he became acquainted with several other problems. The highly developed drapery needed colors. But the mercantilists did not know how to use the new synthetic colors. That's why Stoeckhardt wrote two papers about colors (Stoeckhardt, 1843 and Stoeckhardt, 1844). He provided information on the new colors, about their composition, their dyeing properties, their application possibilities and their cost. He also described testing methods for the colors. In particular, he gave a warning for correlating the name of a color with its poisonousness. If one color was forbidden because of his toxicity, the same was introduced in the market with a new name. Many mercantilists discontinued the use of Green from Schweinfurt (*Schweinfurter Gruen*) [$Cu(CH_3COO)_2 \cdot 3Cu(AsO_2)_2$] but they used the Green from Leipzig (Leipziger Grün) as a harmless color, unaware that it was the same chemical compound. Stoeckhardt gave instructions for recognizing a poisonous color, and methods to avoid and to treat the poisoning. It is important to know that Schweinfurter Gruen was used for the wallpaper!

And Stoeckhardt observed another consequence of industrialization. Already in 1844 he began to investigate the impacts of smelter fume and hard coal on vegetation. It is interesting that Stoeckhardt differentiated between harmless and harmfull components of the smelter fume: whereas carbon dioxide, soot, hydrocarbon, water vapor and nitrogen are harmless, he warned against the several kinds of intoxication by sulphur dioxide, sulphuric acid, hydrochloric acid, chlorine gas and heavy metal oxides. He described the direct contact with gases or vapor and the indirect way the plants take heavy metal ions from the soil.

Stoeckhardt analyzed leaves and polluted soil, but also the straw from roofs and the plasterwork of houses and corroded iron materials and gave a description of the criteria for assessing sulphur dioxide damage. Experiments were carried out on controlled dosage of fume gas components on test plants (Wienhaus, 1999), and these investigations have continued in Tharandt until now. So Stoeckhardt was not only the "father of the agricultural experimental stations", but also the first "forest chemist".

Stoeckhardt and the teaching of natural sciences

The Doctoral thesis of Stoeckhardt at the University of Leipzig was titled, *Res Naturales, qua de causa perscrutandae, qua methodo docendae et tractandae, quomodo maturae convenienter disponendae* (the natural objects, why should they be investigated, which method is used for teaching, in which way nature is adequate described, Stoeckhardt, 1837). The first question about the necessity of a treatment of nature was answered with words from Carl von Linné (1707-1778): "Anything that is useful for human beings comes from natural matter. So there is no need to explain why the cognition of nature is necessary" (Langen, 1740, pp. 2-3). However, for Stoeckhardt the highest aim of cognition regarding nature was the cognition of god in nature and the worship of god. Stoeckhardt had a teleological point of view because he accepted that in all objects there is usefulness. It can be assumed that Stoeckhardt was influenced by natural philosophy (in Berlin he visited lectures of Steffens who taught natural philosophy with speculative direction) and by the empirism of Francis Bacon (1561-1626). In the second part of his thesis, Stoeckhardt made proposals on the methods which should be used in teaching natural sciences. Here one can find many similarities to opinions of August Hermann Francke (1663-1727) and Ehrenfried Walter von Tschirnhaus (1651-1708) (Francke, 1701 and Tschirnhaus, 1729). Stoeckhardt insisted on using only a few examples for teaching, as too many examples would strain the memory of the pupil. It is more effective to discuss some examples very intensively. The examples chosen should have a connection to the surroundings of the pupils. Stoeckhardt recommended showing natural objects during instruction as much as possible to the pupils and to give them the opportunity for experimental work because this is very good for the memory. Stoeckhardt also developed the course to progress from the simple to the complex. He explained that this law of the ascent from the simple to the complex is found in the nature (Stoeckhardt, 1839). In the consequence the teacher should start with simple examples, and further on he can use more complex ones.

At the end of the 18th and the beginning of the 19th century knowledge about nature had developed extensively. It was difficult to teach such a mass of facts, hence the great endeavor to systematize knowledge, which can be established even in connection with textbook writing (Bensaude-Vincent, Bertomeu, Belmar, 2002 and Frercks, Markert, 2007). In the third part of his doctoral thesis Stoeckhardt developed his scheme (Fig. 5) for natural sciences after discussing the role of several other schemes and the criterions for them. He divided nature into matter and forces, but he stressed that forces cannot exist without matter (and vice versa). Matter exists in three forms, namely, *Organica*, *Atmosphaera* and *Inorganica*. This is unusual because normally matter was divided into the compartments of mineral, vegetable and animal matter. But in the opinion of Stoeckhardt, the atmosphere which includes air and water must have a special place in the scheme because life cannot exist without air and water. The inorganic part is formed by water and air, too. He divided *Organica* and *Inorganica* into further disciplines that he then connected again in the three fundamental disciplines: *Geologia*, *Biologi*a and *Atmosphaeriliologia*.

Stoeckhardt believed that these are the constituent parts of natural history. The application of the term “biology” is somewhat astonishing for the period. Even though biology was “invented” by Jean-Baptiste de Lamarck (1744-1829) and Gottfried Reinhold Treviranus (1776-1837), it is hard to define the exact meaning of “biology” in that time (Kanz, 2007).

Stoeckhardt divided the forces into three parts, too: into inorganic and organic forces and in *vis vitalis* (vital forces which should be existent in plants and animals). Then he gave various examples of the transformations of these forces (the word *force* is often used for energy in the modern sense). It can be established that Stoeckhard knew of the current developments in science. Stoeckhardt expressed his opinion that schemes are helpful tools but the pupils must learn to connect the different parts again to obtain the whole view of nature. In this way Stoeckhardt propagated one natural science. One can reason that Stoeckhardt followed the fundamental views in the didactics of natural sciences which were already established in the 17th and 18th centuries. In his general view of natural science there are many aspects of natural history.

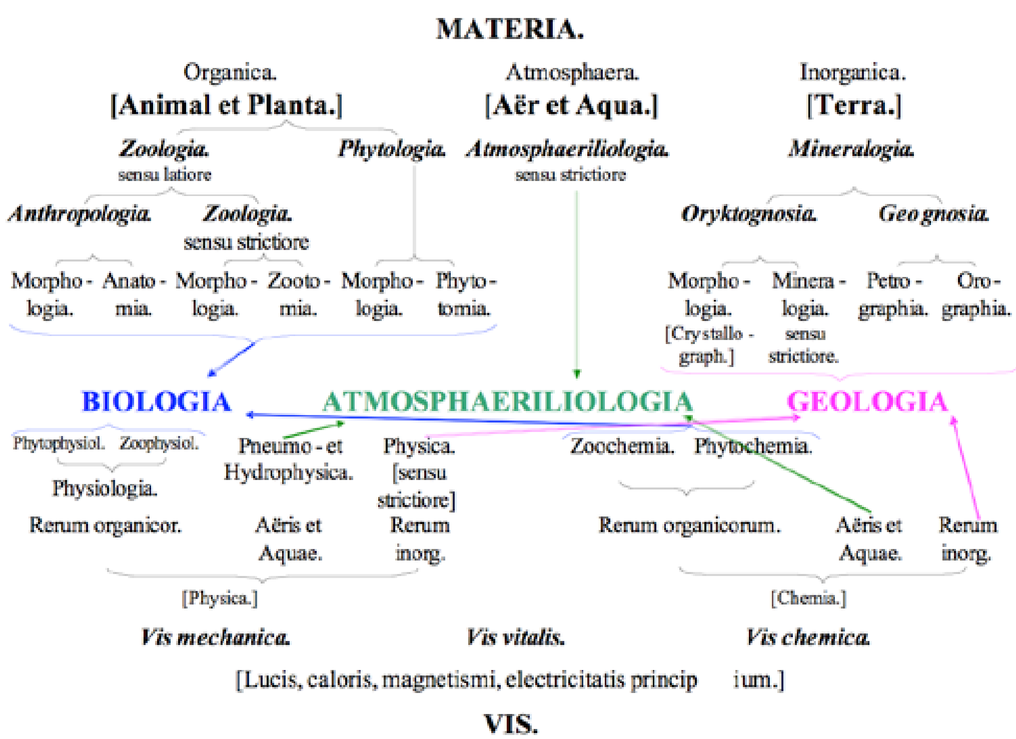

Figure 5. The scheme of Nature used by Stoeckhardt in his doctorate (slightly modified in the format).

Figure 7. The 13th edition of *Schule der Chemie.*

Stoeckhardt´s *Schule der Chemie*

With regard to Stoeckhardt's role in didactics we must discuss his book *Schule der Chemie* (Fig. 7). When Stoeckhardt taught experimental chemistry in the Royal Vocational school he used the 5th edition of the textbook *Grundriß der Chemie* (*Compendium of Chemistry*) written by Friedrich Wöhler (1800-1882). But it was only suitable for inorganic chemistry. In organic chemistry he used his own materials (Stoeckhardt, 1839, p. 48). These notes were finally the basis for the book *Schule der Chemie*, which was first published in 1846 by the well-known publishing house Verlag Friedrich Vieweg in Braunschweig. Stoeckhardt used this textbook in his classes (Stoeckhardt, 1846, p. 34). But it was used for self-instruction, too. *The Schule der Chemie* was a very successful book. Soon after the appearance of the book there were positive reviews, but the best argument for the book was that the second edition came out in the same year! After a short time the *Schule der Chemie* was translated into several languages, such as English, Dutch and Swedish or Russian (our inquest did not find a translation into Spanish). The Dutch book was brought to Japan, translated and used as a textbook in some Japanese schools (Goldberg, 1926 and Sakanoue, 1995).

All in all 19 editions were made by Stoeckhardt; the last three were edited by Ernst Lassar-Cohn (1858-1922) who was a famous chemist and known as a popular writer. He modernized the chemistry of the book but did not change its fundamental construction.

In the foreword to his book, Stoeckhardt takes a critical look at the methods of teaching. He did not agree completely with Bacon, who said that it is dangerous to choose a strong systematic way of teaching science (Stoeckhardt, 1863, p. IV). Stoeckhardt defended the opinion that for beginners, every teacher should prefer a systematic course.

Experiments are indispensable for such a teaching course in chemistry. Indeed, in contrast to other popular books of that time, Stoeckhardt used many experiments for introducing new knowledge. He demanded, that the experiments must be simple and riskless, that they must be the fundament or the framework of the theory, and that they must be carried out with known bodies and explain known phenomena, and that the experiments must ascend in natural order from the known to the unknown.

The description of experiments is brought to perfection with the help of instructive illustrations of many experiments (Fig. 8). In the book, Stoeckhardt recommended stores where the readers could buy chemical compounds and apparatus.

The content is divided into inorganic and organic chemistry. At first he described chemical processes, and the use of the balances and the thermometer; he explained the specific weight and the changes of state of aggregation, the diffusion of heat and the composition of water. Later on, the metalloids, the acids (including the organic acids) and the metals were reviewed. Part of organic chemistry covers vegetable and animal matter. Starting with the 5th edition, a list of the most important reactions for analysis were included, and with the 10th edition, tables for spectral analysis were included.

In all of Stoeckhardt´s editions there was no change in the concept of organic chemistry, though organic chemistry as a chemistry of carbon compounds was already established in the middle of the 19th century. Stoeckhardt tried to systematize the elements using a parabolic arrangement, but he never mentioned the system of Dmitrij I. Mendeleev (1834-1907). In 1868 he discussed the new atomistic theories, but in organic chemistry he used the old theory. Obviously he was hesitant to introduce new theories.

Some of the experiments are useful even in our day; you can find some of them in current didactic papers (for instance the experiment of boiling water with the help of ice, de Vries, 2002). Stoeckhardt did not use ice but cold water for this fascinating experiment and explained the observation (Stoeckhardt, 1863, p. 92). Naturally the experimental instructions must be modernized. But Stoeckhardt gives examples for simple experiments, which improve the ability for watching and observing, for example, the observation of the boiling process of water (Stoeckhardt, 1863, p. 37), the extension of volume in consequence of changes in temperature (Stoeckhardt, 1863, pp. 25-26), or the warming of water with the help of sunlight in different vessels, one mantled with white, one with black, one with silver paper (Stoeckhardt, 1863, p. 48). This is inspiring and fascinating for "modern" children, too. Such observation experiments should be used in the early scientific education of children in kindergarten and in primary schools.

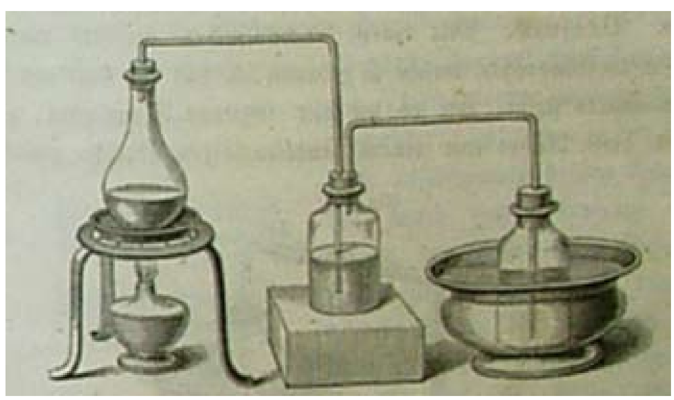

Figure 8. An illustration of the twice rectification from the first edition of *Schule der Chemie*, page 457.

Stoeckhardt "translated" the strong scientific language into a popular one. For us it is somewhat astonishing to read: "The soluble antimony compounds are open foemen against the animal life, the consequence is the effort of the stomach to get rid of such substances which are introduced in the body" (Stoeckhardt, 1863, p. 423) or "If we call the gold the king of the metals so iron is the most important and useful man in the state" (Stoeckhardt, 1863, p. 324).

And Stoeckhardt reminded his readers that they often use or meet chemistry in their everyday lives (Stoeckhardt, 1863, p. 3): "Everybody knows that a piece of iron … inverts to rust if it is situated in moist air or soil, that the pressed juice of grapes becomes wine bit by bit and then vinegar, that the wood which burns in an oven, or oil in a lamp vanishes." Stoeckhardt's is a clear language with a lot of metaphors!

Incidentally, in the middle of the 19th century you can find other books with similar experiments, written in a popular manner. For instance Emil Postel (1813-1875) wrote the book *Laienchemie* (*Chemistry for amateurs*) (Postel, 1857). He emphasized that his book was much cheaper than the *Schule der Chemie*! Postel's experiments do not differ much from those of Stoeckhardt. Postel preferred a style which connects the author with the reader (he often writes "we are doing" etc). I fact, Postel's book was cheaper. But Stoeckhardt's book had many more editions than Postel's. And know that Adolf von Baeyer (1835-1917), Emil Fischer (1852-1919) and Wilhelm Ostwald (1853-1932) all used the *Schule der Chemie* (Remane, 1991, p.18 and Remane, 1993, p.156, Goldberg, 1926, pp. 43-44). Last but not least – Wilhelm Ostwald continued to use the model of *Schule der Chemie*, for his book, in which he used the form of a dialog between teacher and pupil to explain chemistry on a new level, including the fundamentals of physical chemistry (Ostwald, 1903).

Conclusions

Why should we look at such old chemical textbooks? Is it at all interesting to hear something about academics who lived more than five generations ago? If we are looking at *Schule der Chemie* we can find experiments which are well-suited to invite children to observe real nature, and away from computers. Also today it is important that the pupils understand that chemistry is connected with their life. That is why it can be useful to carry out experiments with materials from the househould (Freienberg et al., 2001, 2002) —it is indeed instructive to build an extinguisher from citric acid and natron. It is thus that the Schule der Chemie animates its discussion of organization of the chemistry classes.

Despite the fact that, Stoeckhardt's doctoral thesis holds some antiquated views, it is important to show students the connection between chemistry and other sciences. Only on that fundament can students understand the importance of interdisciplinary cooperation. And it should not be forgotten that a beginner needs a systematic foundation which can culminate later in the complex network of knowledge.

The scientific work of Stoeckhardt was so successful because he proofed his theories by experiments. This method continues to be important for experimental sciences.

Stoeckhardt is the epitome of a hard working scientist who was engaged in the problems of society and committed to noble behavior in scientific conflicts.

Since 1982 a working group of students in Chemnitz, and since 1996 the Olympiad of Chemistry which is held in Chemnitz, are named after Stoeckhardt (Marx et al., 2008).

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