FRITZ ARNDT AND HIS CHEMISTRY BOOKS IN THE TURKISH LANGUAGE

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Fritz Georg Arndt (1885-1969) possibly is best recognized for his contributions to synthetic methodology. The Arndt-Eistert synthesis, a well-known reaction in organic chemistry included in many textbooks has been used over the years by numerous chemists to prepare carboxylic acids from their lower homologues (1). Perhaps less well recognized is Arndt's pioneering work in the development of resonance theory (2). Arndt also contributed greatly to chemistry in Turkey, where he played a leadership role in the modernization of the science (3). A detailed commemorative article by W. Walter and B. Eistert on Arndt's life and works was published in German in 1975 (4). Other sources in English on Fritz Arndt and his contributions to chemistry, specifically discussions of his work in Turkey, are limited. Arndt spent over two decades of his professional life at Istanbul University in two distinct periods: between 1915 and 1918 during the reign of the Ottoman Empire, and between 1934 and 1955 during the Turkish Republic. Among Arndt's major contributions while there are his books. These valuable historic sources provide insights into changes that occurred during Arndt's lifetime in the science of chemistry and in politics worldwide. They perhaps are most usefully considered within the time frame of Arndt's life and the development of Turkey as a modern nation (Table I).

Fritz Arndt was born in Hamburg on July 6, 1885. Education, music and science played an important role in his prosperous enlightened family. His paternal Uncle Adolf was a chemist, and perhaps an inspiration for young Fritz's interest in the subject. Music remained his "other great love, and Brahms unquestionably his favorite composer (5)."

After graduating from the Matthias-Claudius Gymnasium in Wansbek in greater Hamburg, Arndt began his university education in 1903 at the University of Geneva, where he studied chemistry and French. Following the practice at the time of attending several institutions, he went from Geneva to Freiburg, where he studied with Ludwig Gattermann and completed his doctoral examinations. He spent a semester in Berlin attending lectures by Emil Fischer and Walther Nernst, then returned to Freiburg and worked with Johann Howitz and received his doctorate, *summa cum laude*, in 1908. Arndt remained for a time in Freiburg as a research assistant with Gattermann and from there went to Griefswald, where he worked for a year with Karl von Auwers. He then became an assistant in Kiel to Heinrich Biltz, whom he accompanied in the autumn of 1911 to Breslau, now Wroclaw in Poland (4, 5a).

In 1915 Arndt, who had become a docent in Breslau, was offered a five-year teaching position in Turkey. The university in Istanbul (called the *Darülfünun* during the Ottoman Empire) was undergoing reforms; and, at the request of Şükrü Bey, the Ottoman Minister of Education, Germany agreed to provide an educational assistance mission consisting of twenty academics to help upgrade the institution. A specific request for chemistry faculty was forwarded to Emil Fischer in Berlin. Fischer sent the request along to Alfred Stock, who had gone to Berlin from Breslau. Stock had known Arndt in

Breslau and contacted him in the summer of 1915. As a result of these negotiations Arndt, having received an official offer from the German Ministry of Culture in Berlin in October 1915, accepted a five-year position with the title *Müderris* (Professor), as did two other chemists, Gustav Fester and Kurt Hoesch, assistants at the time at Frankfurt am Main and Berlin, respectively (4, 6, 7).

Arndt arrived in Istanbul in November, 1915. Within the year a new Chemistry Institute (*Yerebatan Kimya Enstitüsü*) housing the first academic department of chemistry in Turkey was founded under his leadership. For the first time, chemistry was taught as an independent discipline separate from medicine and biology (8). Arndt was convinced chemistry could not be taught without laboratory instruction and, finding the existing facilities at the university inadequate, he spent much of his first year planning a building in the Yerebatan district of Istanbul to house the new institute (9). Supplies and chemicals arrived from Germany in spring 1917 and classes started in fall 1918 (10). The facilities were modern for the times, and the curriculum was based on the German model. During lectures, according to Islamic Ottoman tradition, a partition separated the female students from the males. The female students also had their own laboratory. Arndt directed the institute and taught inorganic chemistry (11).

Professors at the Darülfünun wearing the required head gear (fez), Istanbul 1916. Arndt is seated in the front row, fourth from the left. (Courtesy of H. W. Arndt)

Linguistically gifted, Arndt was sensitive to the use of language and throughout his career stressed clarity of expression. In addition to German he spoke English, French, and Italian and had translated into German one of Bohr's books from Danish (5a). He worked closely with the students, learning to speak Turkish in one year and teaching in that language throughout his career at Istanbul University (12). His students recalled, with affection, his thorough command of the Turkish language including local colloquialisms and puns and the German accent which he never lost.

One of the major challenges Arndt and the Turkish students faced was the lack of chemistry textbooks containing current information and a consistent use of language. At the time of Arndt's arrival in Istanbul in 1915, texts were written in Arabic, then the official alphabet of the Ottoman State. For chemical notation, an ongoing debate over using Arabic script as opposed to the Latin alphabet resulted in numerous inconsistencies. Some authors used Latin letters for the names of the elements or their symbols and a combination of Latin letters and Arabic numbers for chemical formulae and for equations. Others preferred to maintain Ottoman tradition and used Arabic script (which reads from right to left) for all these purposes. Moreover, some authors followed the notational style of using superscripts for the number of atoms contained in a formula, while other authors used subscripts. Hence even the simplest substances might be written differently in different texts. For example, "water" might appear in Arabic script written out as a word or as a formula. Alternatively, it could be written with the Latin symbols as H^2O or H_2O. Reading from right to left, it might also be written as O^2H or O_2H depending on the author. The notations of more complex structures, such as organic ring systems, included even further inconsistencies.

In 1916, on Arndt's suggestion, Heinrich Biltz's manual *Qualitative Analyse* was translated from German into Ottoman Turkish by the Turkish chemist Suzi Osman Bey, who had been assigned to Gustav Fester as an assistant teacher. In the same year, *Praktikum der Quantitativen Anorganischen Analyse* by Alfred Stock and Arthur Stähler was translated from German into

Ottoman "with the assistance of Professor Arndt" by Fazlı Faik, Arndt's German-educated assistant teacher (13). Arndt's own *Kurzes Chemisches Praktikum für Mediziner und Landwirte*, published originally in German in 1912, and a new as yet unpublished laboratory manual by Arndt on inorganic chemistry were both translated from German by Fazlı Faik and published as *Muhtasar Tatbikat-ı Kimyeviye* (brief chemistry experiments) in 1916 and *Kimyayı Gayrı Uzvîden İlk Tatbikat* (first experiments in inorganic chemistry) in 1917 (14, 15). These books provide important documentation for the modernization of Turkish chemistry (16).

The German influence in Turkish textbooks was reflected in the use of the Latin alphabet for the names and symbols of the elements and for writing equations; Arabic letters were no longer used for these purposes. Subscripts for the number of atoms in chemical formulae were used consistently. The numbering system and representation of organic substances including ring structures became more consistent. German (and sometimes Latin) names were given for compounds in addition to the traditional French and Ottoman names. The French symbols for iodine (I for iode) and nitrogen (Az for azot) were replaced by the German symbols, J for Jod and N for nitrogen, or Stickstoff (17).

The periodic table included in Arndt's *Muhtasar Tatbikat-ı Kimyeviye* and *Kimyayı Gayrı Uzvîden İlk Tatbikat* is the second published in Turkey and the first in which chemical symbols are given with the Latin alphabet (18, 19). The table reads from right to left, consistent with Arabic tradition. The elements are organized according to their atomic weights, which are given in Arabic script. Explanatory text fragments, including the title ("the periodic classification of the elements"), properties of the periods and groups ("maximum positive value," "maximum negative value," "small period," "medium period," "large period," "radioactive materials," "rare earth metals") are also written with Arabic script. Elements are represented with Latin alphabet symbols and Roman numerals are used for the groups.

Arndt was to describe later the challenges involved in the printing of these books as follows (20, 21):

> These books were printed with Arabic letters but with Latin formulae. The difficulties are hard to imagine in Europe, and even in Turkey of today. The printing took place at the Imperial Press where chemistry books had been printed previously, but without additional attention at the time, to careful editing or the correction of errors. Numerous corrections were necessary on my part, and even when these were com-

The periodic table from Arndt's *Muhtasar Tatbikat-ı Kimyeviye* (1916) From E. Dölen, *Osmanlılarda Kimyasal Semboller ve Formuller (1834-1928)* (Ref. 6, p109)

pleted, with each corrected page, new errors in Arabic appeared which needed further correcting. This lasted until roughly 1918, when I was nearly finished. Then Turkey fell. The first Turkish student who used these books with me was not in Istanbul, but in Breslau. Naci Bekir, my student there, later completed his doctorate with me. In the Turkish Republic, these books were used until the Arabic script was banned.

by Christopher Ingold and his co-workers. In 1934 Ingold used the term "mesomerism" for resonance and his terminology was adopted widely and eventually by Arndt (24). Why Arndt's pioneering work in this area did not gain wider international recognition is discussed in Ernest Campaigne's revealing article, which focuses on this question, and in a more generalized article published recently by Ute Deichmann (25, 26).

TABLE I. Chronology of Fritz Georg Arndt's Life

YEAR	F. G. ARNDT	TURKISH HISTORY
1885	Hamburg, Born July 6	Ottoman Empire Reign of Abdülhamid II (1876-1909)
1908	PhD, Freiburg	Young Turk Revolution
1911-1915	Breslau	Reign of Mehmed V (1909-1918)
1915-1918	Istanbul	World War I (1914-1918)
1918-1933	Breslau	Reign of Mehmed VI (1918-1922) War of Independence (1919-1922) Abolution of the Sultanate (1922) Turkish Republic Founded (1923)
1933	Oxford, England	Atatürk's University Reforms (1933)
1934-1955	Istanbul	Death of Atatürk (1938) World War II (1939-1945) Turkey joins NATO (1952)
1955-1969	Hamburg (Died Dec 8, 1969)	Turkey a multiparty republic

At the end of World War I, the Ottoman Empire, then aligned with Germany, was defeated. The activities of the German professors in Istanbul were terminated, and German nationals were forced to leave. Returning to Breslau in January 1919, Arndt joined his family who had left Istanbul earlier. In Breslau, Arndt resumed a successful teaching and research career until 1933, making contributions to synthetic methodology and also to the development of resonance theory and to the emerging field of physical organic chemistry (22). The idea of the resonance hybrid or *Zwischenstufe* (intermediate state) was introduced by Arndt and his co-workers in 1924 (23). This notion was confirmed following the developments in quantum chemistry, and independently

Post World War I years had been especially challenging for Turkey. At the end of the war, the internal structure of the Ottoman Empire collapsed, and British, French, Italian, and Greek forces occupied much of its territory. From the following War of Liberation led by Mustafa Kemal Atatürk, Turkish forces emerged victorious. The sultanate was abolished in 1922, and a new state, the Republic of Turkey, was founded in 1923 with Atatürk as its president. Major reforms were undertaken in the young republic to rejuvenate and modernize the nation. A new civil code granting women social rights was adopted in 1926, and Turkey was officially declared a secular state in 1928. Other reforms included the adop-

tion of the Latin alphabet in 1928 and the metric system in 1931. Reform initiatives in language were formalized with the founding in 1932 of the Turkish Language Foundation (*Türk Dil Kurumu*), the major function of which was to oversee changes in the language from Ottoman to Turkish (27). Reforms in higher education were also initiated to upgrade the university in Istanbul, which had suffered severely during and after World War I, and to raise its level to that of major European institutions. Plans for these reforms, drawn up in 1932, included the hiring of foreign faculty in a variety of fields. The persecution and displacement of academics in Germany provided a unique opportunity for the Turkish government to implement the university reforms and to hire a large number of outstanding faculty members (28). These reform initiatives together with the events taking place in Germany at that time were responsible for Arndt's return to Turkey.

As a result of the Aryan policies of the National Socialists soon after the Nazi takeover in January 1933, German academics started losing their positions (26, 29). Arndt was dismissed from his chair at Breslau in April of 1933, apparently because his father was Jewish. He received an invitation from Nevil Sidgwick and Robert Robinson to go to England through the intermediacy of the Academic Assistance Council, the English rescue organization later renamed the Society for the Protection of Science and Learning, in which Ernest Rutherford played an active role. Arndt accepted a research appointment in the Department of Organic Chemistry at Oxford University and soon joined his British colleagues. Meanwhile in Turkey, the Swiss rescue operation, *Notgemeinschaft Deuscher Wissenschaftler im Ausland* (Emergency Society of German Scholars Abroad) was helping many dismissed German scholars find positions at Istanbul University.

In 1934 the Turkish Ministry of Education invited Arndt, who was in England at the time, to come to Istanbul University. He did so, and returned to the institute he had founded two decades earlier. The name of the university had been changed from *Darülfünun* to Istanbul University in August 1933. Students were now using the Latin alphabet. The traditional headgear for males, the fez, had disappeared, as had the partition in the classroom separating the female students. In the new Chemistry Institute, Arndt held a chair in general chemistry (*Genel Kimya Kürsüsü*) and headed this division, which included the fields of inorganic and organic chemistry (30). He served in this capacity until his retirement in 1955 (31).

Among Arndt's most pressing activities in 1934 was the revision for publication of new editions of *Muhtasar Tatbikat-ı Kimyeviye* and *Kimyayı Gayrı Uzvîden İlk Tatbikat.* These texts were reprinted in the Latin alphabet. They were written in what was essentially a modern language, new Turkish or *yeni Türkçe*, which in 1934 was in an early state of development. The new Turkish translation from German of *Kurzes Chemiches Prakticum fur Mediziner und Landwirte* (*Muhtasar Tatbikat-ı Kimyeviye*) was printed with the Latin alphabet in 1934; updated versions followed in 1937, 1942, and 1946 (32). The new version of *Kimyayı Gayrı Uzvîden İlk Tatbikat* under the name *Gayrı Uzvî Kimyadan İlk Tatbikat* was printed with the Latin alphabet in 1935; updated editions of the latter followed in 1946 and 1950 (33).

In addition to these, Arndt published two major works during his second period in Turkey. These were comprehensive texts, both experimental in approach, in the areas of inorganic and organic chemistry. His inorganic textbook was first published in 1938 under the title *Genel Kimya Dersleri I – Gayrıuzvî Kimya* (General Chemistry Lessons I – Inorganic Chemistry). Updated editions were printed in 1944, 1949, and 1953 (34). Arndt's organic textbook, also published in 1938 as lecture notes under the title *Profesör F. Arndt'ın Genel Kimya Dersleri II – Uzvî Kısım* (Professor F. Arndt's General Chemistry Lessons II – Organic Section), appeared with updated editions in 1947 and 1950 (35). The different editions of Arndt's four books are summarized in Tables IIa and IIb. Arndt wrote in his forewords about the profound changes in chemistry that were occurring during his lifetime, mentioning specifically developments in the areas of quantum chemistry, nuclear chemistry, fluoride chemistry, the chemistry of silicon compounds, and theoretical organic chemistry. Incorporating these and other changes into books presented a challenge worldwide for chemists in his generation. In Turkish there was the additional challenge of using a language that was constantly changing (36).

Arndt contributed significantly to Turkish language reforms and worked closely with the Turkish government in the adoption of new scientific terminology (37). He was one of the few non-native speakers who served on the government's official commission on terminology (*Terim Komisyonu*) and in this context, dealt personally with Atatürk, whom he admired deeply. Arndt was, nevertheless, concerned about several aspects of these reforms, such as the constant changing of word usage, which he believed generated difficulties in com-

TABLE IIa. Arndt's Laboratory Manuals Published in Turkey between 1916 and 1950 [I.1 and II.1 are printed in Arabic script and in the Ottoman language, the rest are printed with the Latin alphabet and in the new Turkish language]

I. Laboratory Manual for Physics, Chemistry and Biology students [Kurzes Chemisches Praktikum, or Brief Chemistry Experiments]

1. Muhtasar Tatbikat-ı Kimyeviye (1916) Author: F. Arndt, Professor (Müderris) of Inorganic Chemistry at the Istanbul Darülfünun (translated from German into Ottoman by Fazlı Faik)
2. Kısa Kimya Tatbikatı (1934) Author:Ord. Prof. Dr. F. Arndt (translated from German into new Turkish by Dr. Abdurrahmanlı and Selâhattin Mustafa)
3. Kısa Kimya Tatbikatı (1937) Author: Ord. Prof. Dr. F. Arndt (translated from Ottoman into new Turkish by Dr. Abdurrahmanlı and Selâhattin Mustafa)
4. Kısa Kimya Lâboratuarı (1942) Author: Ord. Prof. Dr. F. Arndt
5. Kısa Kimya Lâboratuarı (1946) Author: Ord. Prof. Dr. F. Arndt

II. Laboratory Manual for Chemistry, Chemistry-Physics and Chemistry License Students [First Experiments in Inorganic Chemistry]

1. Kimyayı Gayrı Uzvîden **İ**lk Tatbikat (1917) Author: F. Arndt, Professor (Müderris) of Inorganic Chemistry at the Istanbul Darülfünun (translated from German into Ottoman by Fazlı Faik)
2. Gayrı Uzvî Kimyadan **İ**lk Tatbikat (1935) Author: Ord. Prof. Dr. F. Arndt
3. Anorganik Kimyaya Ba**ş**langıç Laboratuarı – **İ**lk Tatbikat (1946) Authors: Ord. Prof. Dr. F. Arndt, "with the assistance of " Dr. Lütfi Ergener and Melika Ergener
4. Anorganik Kimyaya Ba**ş**langıç Laboratuarı – **İ**lk Tatbikat (1950) Authors: Ord. Prof. Dr. F. Arndt and Doç. Dr. Lütfi Ergener

TABLE IIb. Arndt's Textbooks Published in Turkey between 1938 and 1953 [All are printed with the Latin alphabet and in the new Turkish language]

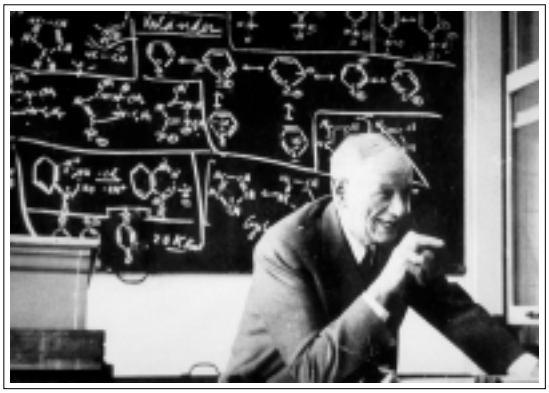
I. Textbook in Inorganic Chemistry

1. Genel Kimya Dersleri I - Gayrıuzvî Kimya (1938) [General Chemistry Lessons I – Inorganic Chemistry] Author: Ord. Prof. Dr. F. Arndt
2. Denel Kimya Dersleri I - Umumî ve Anorganik Kısım (1944) [Experimental Chemistry Lessons I – General and Inorganic Section] Author: Ord. Prof. Dr. F. Arndt
3. Denel Anorganik Kimya (1949) [Experimental Inorganic Chemistry] Authors: Ord. Prof. Dr. F. Arndt and Dr. Lütfi Ergener
4. Denel Anorganik Kimya (1953) [Experimental Inorganic Chemistry] Authors: Ord. Prof. Dr. F. Arndt and Doç. Dr. Lütfi Ergener

II. Textbook in Organic Chemistry

1. Profesör F. Arndt'ın Genel Kimya Dersleri II – Uzvî Kısım (1938) [Professor F. Arndt's General Chemistry Lessons II – Organic Section] Author: None indicated; lecture notes
2. Denel Organik Kimya (1947) [Experimental Organic Chemistry] Authors: Ord. Prof. Dr. F. Arndt and Doç. Dr. Lütfi Ergener
3. Yeni Denel Organik Kimya (1950) [New Experimental Organic Chemistry] Authors:Ord. Prof. Dr. F. Arndt and Doç. Dr. Lütfi Ergener

municating with the students. He felt that these changes were especially challenging for chemistry students who needed to acquire, in addition to a new language, a scientific vocabulary unique to the field. Arndt discussed problems related to the changing language in detail in the forewords of several of his textbooks (38).



Arndt lecturing. Note double-headed arrows on the board and his characteristic warm,witty style. (Courtesy of H. W. Arndt)

Arndt's students must have found the dictionary (*lügatçe*) included in the 1949 and 1953 editions of *Denel Anorganik Kimya* particularly helpful (39). In this dictionary, the equivalents in four languages (Turkish, Ottoman, German, and English) of 137 chemical terms are given in tabular form (selected examples are shown in Table III). Also of interest in the 1953 edition is a biographical footnote on Ernest Rutherford, which includes the following statement, quite atypical for a chemistry text (40):

Lord Rutherford founded, during the reign of the darkest dictatorship in Europe, a worldwide committee, the Society for the Protection of Science and Learning, to protect the freedom of science and of ideas.

Arndt's expertise in resonance theory is clearly apparent from the organic text published in 1938. In this book, the differentiation between tautomerism and resonance (which he called *tautomeri* and *mesomeri* in Turkish) is clearly made, both in the wording of the text and in his early use of the presently accepted conventions in notation. By 1938 Arndt was using the presently accepted convention of representing tautomers with reversible arrows, and resonance hybrids with double-headed arrows (41). Many authors who were writing at this time were using reversible arrows to indicate resonance, or were showing different resonance structures without the use of arrows. Arndt may be, in fact, one of the first authors to include the double-headed arrow in a textbook. In an interview in Istanbul with the author during summer 1993, Professor Enis Kadıoğlu, who was a former student of Arndt at Istanbul University, stated that Arndt was masterful in the classroom in making these concepts perfectly clear. His Turkish students who called him *Arndt Hoca* (pronounced hodja in English, the Turkish manner of addressing a teacher with respect) fully appreciated the significance of their teacher's pioneering work in this area and valued learning from the "*eksper*" or expert (42).

Group photo of Arndt at Istanbul University with his Turkish students, c. 1950. (Courtesy of H. W. Arndt)

Several factors contributed to Arndt's success as a teacher and an author. Arndt taught both inorganic and organic chemistry and was skillful in communicating and integrating information. He discouraged memorization and emphasized recognizing underlying principles. In his lectures and books, he bridged the areas of inorganic and organic chemistry. His texts in these fields complement each other, and contain many interconnections. For instance, the organic text of 1947 includes over fifteen references to the inorganic text in the first eighty pages (43).

Arndt was also masterful in integrating theory with experiment and constantly stressed the significance of the latter. Of his four books, two are manuals for the laboratory; and the updated editions of both his inorganic and organic texts contain the word "*Denel*" (experimental) in their titles. Included throughout the text in these latter works are short experiments (or lecture demonstrations), which help to illustrate the chemistry or concepts being discussed. In the classroom, an assistant would typically carry out the demonstrations as Arndt lectured. Arndt's texts are rich in visual and sensual information. Descriptions of color (or lack of), physical state, appearance of a solid (*e.g.*, as beautiful crystals), and smell (*e.g.*, as having a pleasing fragrance, or a fragrance that is familiar to ev-

eryone) reflect his intimate acquaintance with these materials and depict him as a practicing experimentalist. In one example, which is most likely based on personal experience, he cautions against exposure to hydrogen cyanide, or *siyanür asiti* (44). This very dangerous volatile material, he writes, has a subtle fragrance, experienced more typically as a strange feeling in the tonsils. Risk of exposure is high for those who cannot sense this. For detecting the elusive toxin, he suggests smoking a cigar or pipe in the area since the presence of trace amounts characteristically will ruin the taste of tobacco (45, 46).

In his inorganic and organic texts, Arndt frequently illustrates his points by using local examples relevant to the Turkish students. Examples from his organic textbook of 1947 include (49):

> under the subject of hydrocarbons, the properties of the oil (*petrol*) harvested from the Caucasus and Lake Baykal regions; under the subject of alcohols, the preparation of ethanol from corn in Turkey rather than from potatoes in Europe; under the subject of fats and oils, the similarity of the appearance of aqueous mixtures of these materials to the mixture obtained "when water is added to rakı" (the Turkish drink which turns cloudy when mixed with water); under the subject of polyenes, the cultivation near Istanbul of the native *kök sakızı otu*, a plant used as a source for rubber; under the subject of sugars, the economic significance in Turkey of the production of beet sugar and the properties the latter (47). In another example in this text relevant but not unique to Turkey, Arndt writes about coal mine explosions in a discussion of properties of hydrocarbons. Here he discusses Sir Humphry Davy's safety lantern (which, the text indicates, is shown to the class.) The safety principle is demonstrated in lecture by igniting ether in a crucible and pouring the burning mixture through a wire mesh: the vapor above the mesh continues to burn, but what goes through does not. The use of a similar mesh in Davy's lantern separating the flame and the outside atmosphere, Arndt points out, has prevented numerous mine disasters from the buildup of explosive methane-oxygen mixtures, or *grizu*. Arndt makes a connection here to inorganic chemistry and refers to pages in the inorganic text that describe the chemistry of hydrogen and its potential explosion hazards, which in the presence of air or oxygen, Arndt points out, are similar to those of methane (48). The addendum to the 1947 organic text is of historic interest: here are mentioned as current significant developments in chemistry the structure elucidation of penicillin through X-ray analysis by Dorothy Crowfoot Hodgkin and a paper by R. B. Woodward and C. H. Schramm on a novel preparation of a synthetic fibrous protein analogue, which Arndt deems a noteworthy accomplishment in polymer as well as in protein chemistry.

Arndt's comprehensive textbooks for inorganic and organic chemistry are written in a warm, conversational style, perhaps because they were initially based on lecture notes (50). They include many phrases such as "as we saw before," "as you see in the organic (inorganic) book," and "now that we know that." These phrases also add to the continuity and interconnection of the topics. Inclusion of the experimental component and examples relevant to the reader make the material engaging, interesting, and easy to read.

Many generations of chemistry students in Turkey used these books, which were highly valued, in constant demand, and commonly out of print. These works reflect, in addition to the author's chemical expertise, his teaching philosophy and unique talents as a sensitive pedagogue and a linguist.

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8. (a) A. R. Berkem, *Türkiyede Son Yetmiş Yılda Kimya Alanındaki Gelişmeler*, Türkiye Kimya Derneği Yayınları: No. 8, Istanbul, 1988, 3-19; (b) A. R. Berkem, *Üniversitelerimizde Kimya Öğretimi*, Türkiye Kimya Derneği Yayınları: No. 10, Istanbul, 1990, 5-8; (c) A. R. Berkem, *Kimya Tarihine Toplu Bir Bakış*, Türkiye Kimya Derneği Yayınları: No. 12, Istanbul, 1996, 163-170.
9. The Turkish word *yerebatan* means sunken, or underground; the district is named for the Byzantine cisterns located in the historic Sultanahmet section of Istanbul, near the university and in the vicinity of the Aya Sofya museum, the Topkapı Palace, and the Imperial Printing House where Arndt's first books were printed.
10. In 1918, three transfer students (all male) from biology were admitted to the Chemistry Institute as second-year students. These were the first graduates who received in 1920 the first chemistry diplomas granted in Turkey. Of the eight students who made up the first year class in 1918, four were female. Seven members of this class (including the four females) graduated in 1921 making up the second group of Turkish chemists to receive diplomas in the profession. (Ref. 8a, p 6)
11. K. Hoesch taught organic chemistry and G. Fester industrial chemistry. Other courses in the new chemistry program were taught by Turkish faculty with the exception of geology, which was taught by Dr. Penck, formerly a docent at Leipzig. These courses included analytical chemistry, biochemistry, dyeing materials and techniques, nutrition chemistry, topics in industrial chemistry, mathematics, physics and geology. Physical chemistry was not incorporated into the chemistry curriculum in Turkey until the French chemist Michel Faillebin joined the faculty at the Chemistry Institute as the head of the physical chemistry division in 1926.
12. Arndt refused to use a translator in his Turkish classes. For this he gave the following reasons: the presence of a translator in the classroom interfered with the personal interactions between the teacher and the students. The required synchrony in the classroom between the lecture and the chemical demonstrations was disrupted during translations, and translations that lagged in time were not useful. In addition, the correctness of the information conveyed to the students by the translator could not be checked. (Ref. 7, p 235)
13. E. İhsanoğlu, *Açıklamalı Türk Kimya Eserleri Bibliografyası (Basmalar/1830-1923) ve Modern Kimya Biliminin Türkiye Cumhuriyetinin Kuruluşuna Kadar Olan Durumu ve Gelişmesi*, İlim Tarihi Kaynaklar ve Araştırmalar Serisi No.2, Istanbul, 1985, 96-97; see also Ref. 6, pp 106-107.
14. E. Dölen, "Ord. Prof. Dr. Fritz Arndt'in Türkçe Yayınlanmış Yapıtları," *Doğa ve Bilim*, Sayı 11 (Haziran 1982), 68-76; See also Ref. 13, pp 99-100.
15. In the foreword of the 1935 edition of *Kimyayı Gayrı Uzvîden İlk Tatbikat*, Arndt states that this book is based

for the most part, on *Experimentelle Einführung in die Unorganische Chemie* by "Professör H. Biltz" and on *Anorganisches Practikum* by "Professör E. Riesenfeld."

16. Ref. 13, pp 26-27 and Ref. 6, p 106.
17. By the early twentieth century, the number of Turkish students who were receiving their degrees and training at Germany had increased substantially. Turkish-German cultural relationships were gradually replacing Turkish-French relationships of the previous centuries, and German influences in education were replacing French traditions.
18. The first periodic table in Turkey was published in 1894, in **İ***lmi Kimyayı Gayrı Uzvî-i Tıbbî* (medicinal inorganic chemistry) by Vasil Naum. Naum's table is titled "the classification of elements according to the system of the chemist by the name of Mendeleyef" (translation from Ottoman Turkish by the author.) The names of the elements are given in full, and all of the text and numbers are written in Arabic script. The table reads, in Arabic tradition, from right to left. In contrast, the periodic table included in the 1907 memorial article for his teacher Mendeleyev, by Ali Bey Hüseyinzade Turan from Azerbeycan, is also written with Arabic letters and numbers. However, this latter table does not follow the Arabic tradition of reading from right to left, instead, it reads from left to right. This convergence of Arabic and Western tradition in the history of the development and adoption of the periodic table is quite interesting. See Ref. 6, pp 69, 108-111 and Ref. 14, pp 70-72.
19. The periodic table in the two books is the same, with one exception: The atomic mass of Cd (112) in *Muhtasar Tatkibat-ı Kimyeviye* (Ref. 6, p 109) is written as ``2 (only the first two digits are in Arabic script) and as ``` (all three digits are in Arabic script) in *Kimyayı Gayrı Uzvîden* **İ***lk Tatkibat* (Ref. 14, p 72). This is possibly due to an editorial correction by Arndt himself.
20. The printing house, Matbaa-ı Amire, is located in the first courtyard of the Topkapı Palace, near the building of the Yerebatan Chemistry Institute. It presently houses the conservation laboratories of the Istanbul Archaeological Museum.
21. Ref. 7, p 237-8, translated into English from the Turkish by the author.
22. For the development of this field in England and in the United States see M. Saltzman, "The Development of Physical Organic Chemistry in the US and in the UK," *J. Chem. Educ.*, **1986**, *63*, 588-593.
23. F. Arndt, E. Scholz, and P. Nachtwey, "Über Dipyrylene und über die Bindungsverhältniss in Pyron-Ringsystemen," *Ber. Dtsch. Chem. Ges.*, **1924**, *57*, 1903-11.
24. C. K. Ingold, "Mesomerism and Tautomerism," *Nature*, **1934**, *133*, 946-7; see also M. Saltzman, "C. K. Ingold's Development of the Concept of Mesomerism," *Bull. Hist. Chem.* **1996,** *19*, 25-32.
25. Ref. 2a, pp 337-338.
26. U. Deichmann, " Chemists and Biochemists during the National Socialist Era," *Angew. Chem. Int. Ed. Engl.*, **2002**, *41*, 1310-1328.
27. Over the centuries, the court language of the Ottomans had incorporated many Arabic and Persian terms, and this official language was not easily accessible to the majority of the Turks, especially to those who were not educated. In the new Turkish republic, the language reforms addressed these issues. In an effort for improved communication nationwide, and with the outside world, words with Turkish roots (*öz Türkçe*, or pure Turkish) were substituted for Arabic and Persian equivalents; internationally accepted terms were adopted for words which did not exist in pure Turkish. For the Hungarian parallel of "the language problem" see G. Palló, "Roles and Goals of Chemical Textbooks on the Periphery, The Hungarian Case," in *Communicating Chemistry - Textbooks and Their Audiences, 1789-1939*, A. Lundgren and B. Bensaude, Eds., Watson Publishing International, Canton, MA, 367-395.
28. In the summer of 1933, the Turkish government offered positions at Istanbul University in a variety of disciplines to over thirty displaced German professors who arrived with their families and assistants. These individuals were well established in their fields, and they, and others who arrived in the following years, helped design the modern Turkish higher education system. In addition, serving as consultants to the Turkish government in many areas, they helped build the new nation.
29. S. Friedlander, *Nazi Germany and the Jews. Vol 1: The Years of Persecution, 1933-1939*, Harper Collins, New York, 1997.
30. The other two divisions in the new Chemistry Institute at Istanbul University were Industrial Chemistry headed by Reginald Herzog, who was displaced from his position as second director of the Kaiser Wilhelm Institute in Berlin, and Physical Chemistry, headed by Gabriel Valensi. Prof. Ali Rıza Berkem who was a former assistant of Professor Valensi eventually became head of the division of Physical Chemistry and served in this position until his retirement. Professor Berkem continues his contributions to chemistry as the president of the Turkish Chemical Society, and as a prolific historian of chemistry.
31. After he retired from Istanbul University Arndt returned to Hamburg and remained professionally active. He received numerous awards and lectured and traveled widely until his death in 1969.
32. (a) F. Arndt, *Muhtasar Tatbikat-ı Kimyeviye*, çeviren Fazlı Faik, Matbaa-ı Amire, Istanbul 1332 [1916]; (b) Ord. Prof. Dr. F. Arndt, *Kısa Kimya Tatbikatı*, çevirenler Dr. Abdurrahmanlı ve Selâhattin Mustafa, Fen Fakültesi Neşriyatından, Arkadaş Matbaası, Istanbul, 1934; (c) Ord. Prof. Dr. F. Arndt, *Kısa Kimya Tatbikatı*, çevirenler Dr. Abdurrahmanlı ve Selâhattin Mustafa, Fen Fakültesi Yayınlarından, Arkadaş Matbaası, Istanbul, 1937; (d)

Ord. Prof. Dr. F. Arndt, *Kısa Kimya Lâboratuarı*, Üniversite Kitabevi, Istanbul, 1942; (e) Ord. Prof. Dr. F. Arndt, *Kısa Kimya Lâboratuarı*, Ankara Üniversitesi Fen Fakültesi Yayınları, Um.: No. 35, Kim.: No 5, Marifet Basımevi, Istanbul 1946.

33. (a) F. Arndt**,** *Kimyayı Gayrı Uzvîden* **İ***lk Tatbikat***,** çeviren Fazlı Faik, Matbaa-ı Amire, Istanbul 1333-1917; (b) Ord. Prof. Dr. F. Arndt, *Gayrı Uzvî Kimyadan* **İ***lk Tatbikat*, Fen Fakültesi Neşriyatından, Arkadaş Basımevi, Istanbul, 1935; (c) Ord. Prof. Dr. F. Arndt, yardım edenler Dr. Lütfi Ergener ve Melika Ergener, *Anorganik Kimyaya Başlangıç Laboratuarı – İlk Tatbikat*, Istanbul Üniversitesi Yayınları: No. 269, Şirketi Mürettebiye Basımevi, Istanbul 1946; (d) Ord. Prof. Dr. F. Arndt ve Doç. Dr. Lütfi Ergener, *Anorganik Kimyaya Başlangıç Laboratuarı – İlk Tatbikat*, Istanbul Üniversitesi Yayınları: No. 269, Kutulmuş Basımevi, Istanbul, 1950.
34. (a) Ord. Prof. Dr. F. Arndt, *Genel Kimya Dersleri I - Gayrıuzvî Kimya*, Kimya Talebe Yurdu Neşriyatı, Istanbul 1938; (b) Ord. Prof. Dr. F. Arndt, Denel Kimya Dersleri I - Umumî ve Anorganik Kısım, Üniversite Kitabevi, Istanbul, 1944; (c) Ord. Prof. Dr. F. Arndt ve Dr. Lütfi Ergener, *Denel Anorganik Kimya*, Istanbul Üniversitesi Yayınları: No. 406, Şirketi Mürettebiye Basımevi, Istanbul, 1949; (d) Ord. Prof. Dr. F. Arndt ve Doç. Dr. Lütfi Ergener, *Denel Anorganik Kimya*, Istanbul Üniversitesi Yayınları: No. 406, Fen Fakültesi Yayınları: No. 6, Kutulmuş Basımevi, Istanbul, 1953.
35. (a) *Profesör F. Arndt'ın Genel Kimya Dersleri II – Uzvî Kısım*, Kimya Talebe Yurdu Yayınlarından, Arkadaş Basımevi, Istanbul, 1938; (b) Ord. Prof. Dr. F. Arndt ve Doç. Dr. Lütfi Ergener, *Denel Organik Kimya*, Istanbul Üniversitesi Yayınları: No. 329, Kutulmuş Basımevi, Istanbul, 1947; (c) Ord. Prof. Dr. F. Arndt ve Doç. Dr. Lütfi Ergener, *Yeni Denel Organik Kimya*, Istanbul Üniversitesi Yayınları: No. 329, Kutulmuş Basımevi, Istanbul, 1950.
36. The changes in the Turkish language, which started in the 1920s, continue to this day.
37. Other German professors who contributed to the Turkish language reforms and the adoption of terminology in their fields include Wolfgang Gleissberg in astronomy, Fritz Neumark in economics, and Ernst Hirsch in law.
38. See for instance the forewords of Ref. 33 (b) and (c).
39. Ref. 34 (c), pp 607-612 and 34 (d), pp 607-610.
40. In this book, Arndt's admiration for Ernest Rutherford's chemical achievements is obvious. The statement regarding Rutherford's leadership in the Society for the Protection of Science and Learning, which was instrumental in Arndt's going to England in 1933, may be a reflection of Arndt's debt to the great chemist. See Ref. 34 (d), p 356.
41. For examples of Arndt's early use of double headed arrows, see Ref. 35 (a), pp 75, 119, 174, 251, 260, and 356.
42. Conversation at Istanbul Technical University (Istanbul Teknik Üniversitesi) with the late Professor Enis Kadıoğlu, May 12, 1993.
43. Ref. 35 (b), pp 1-80.
44. Ref. 35 (b), p 153.
45. This method of detecting the presence of hydrogen cyanide is attributed to Gattermann. See J. R. Partington, *A History of Chemistry*, Macmillan, London, 1964, Vol.4, 834.
46. Arndt was fond of smoking cigars and pipes. The Arndt family lived in Ortaköy, on the Bosphorus during Arndt's second period in Turkey. In a conversation with the author in May 1993, Cemil Güyümcüoğlu, the proprietor of the tabacco store in Ortaköy, remembered "Arndt Bey" (Mr. Arndt) as the "Professor with the pipe" (author's translation from Turkish.)
47. Ref. 35 (b), pp 55, 81-82, 129, 211, 341.
48. Ref. 35 (b), p 61.
49. Ref. 35 (b), pp 501, 523. For the publications of these works, see D. Crowfoot, C. W. Bunn, B. W. Rodgers-Low and A. Turner-Jones, "X-ray Crystallographic Investigation of the Structure of Penicillin," in *Chemistry of Penicillin*, H. T. Clarke, J. R. Johnson and R. Robinson, Eds. Princeton University Press, Princeton, NJ 1949; R. B. Woodward and C. H. Schramm, "Synthesis of Protein Analogs," *J. Am. Chem Soc.*, **1947**, *69*, 1551-2.
50. For another example of a successful textbook which was developed from lecture notes, see M. J. Nye, "From Student to Teacher – Linus Pauling and the Reformulation of the Principles of Chemistry" in A. Lundgren and B. Bensaude, Ed., *Communicating Chemistry - Textbooks and Their Audiences, 1789-1939*, Watson Publishing International, Canton, MA, 2000, 397-414.

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TABLE III. Selected terminology in four languages (Turkish, Ottoman, German and English) from the dictionary (*lügatçe*) included in the 1947 and 1953 editions of *Denel Anorganik Kimya* (Experimental Inorganic Chemistry)

TÜRKÇE	OSMANLICA	ALMANCA	INGILIZCE
[Turkish]	[Ottoman]	[German]	[English]
ametal	sibihmaden	Nichtmetal	nonmetal
anorganik	gayrı uzvî	anorganisch	inorganic
bilesik	mürekkep	Verbindung	compound
çözünemez	gayrı kabili inhilâl	unloslich	nsoluble
denel	tecrübî	experimentell	experimental
esnek	elâstikî	elastisch	elastic
hat	hat	Linie	line
ısık	ziya	Licht	light
organik	uzvî	organisch	organic
saydam	seffaf	durchsichtig	transparent
teori	nazariye	Theorie	theory
ultra-mor, ultra-violet	__	Ultraviolett	ultra-violet

FUTURE ACS MEETINGS

March 23-27, **2003**—New Orleans, LA
September 7-11, **2003**—New York, NY
March 28-April 1, **2004**—Anaheim, CA
August 22-26, **2004**—Philadelphia, PA
March 13-17, **2005**—San Diego, CA
August 28-September 1, **2005**—Washington, DC
March 26-30, **2006**—Atlanta, GA
September 10-14, 2006—San Francisco, CA
March 25-29, **2007**—Chicago, IL
August 19-23, **2007**—Boston, MA
April 6-10, **2008**—San Antonio, TX
August 17-22, **2008**—Philadelphia, PA
March 22-26, **2009**—Salt Lake City, UT
August 16-21, **2009**—Washington, DC
March 21-26, **2010**—San Francisco, CA
August 22-27, **2010**—New York, NY
March 27-31, **2011**—Anaheim, CA
August 28-September 1, **2011**—Chicago, IL
March 25-29, **2012**—San Diego, CA
August 19-23, **2012**—Boston, MA