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Chemistry and History

My Reminiscences on Professor Otto Wichterle[1]

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For an American to understand my narration, he or she should imagine living under much harsher conditions than those under the McCarthyism of the 1950s, but for 47 years.

Otto Wichterle (Figures 1–3), the inventor of soft contact lenses, died on August 18, 1998, not long before his 85th birthday. He was born on October 27, 1913, in Prostejov, Czechoslovakia. He studied chemistry at the Institute of Chemical and Technological Engineering (Technical University) in Prague (1931–1935) where he obtained his doctoral degree in 1936 under Professor Emil Votocek, a world-famous sugar chemist. After the forcible closing of the Czech universities during the German occupation (1939–1945), he was employed in the Research Institute of

In this section we present articles by leading scientific historians that chronicle the important events, persons, and publications that make up the rich history of chemical science. The history of chemistry, of course, has taken place against the background of world history, and the articles in this section often make that very clear. Chemists and their research are always influenced by current events. These articles are intended to describe the setting in which important discoveries occurred and to humanize their discoverers.

—Clifford LeMaster, Editor in Chief

[1] Futher on only Wichterle. See Čapek, K. *Valka s mloky* (*War with the Newts*) [1]. “It is well-known that the greater the man is, the less he has on the nameplate on his door.”

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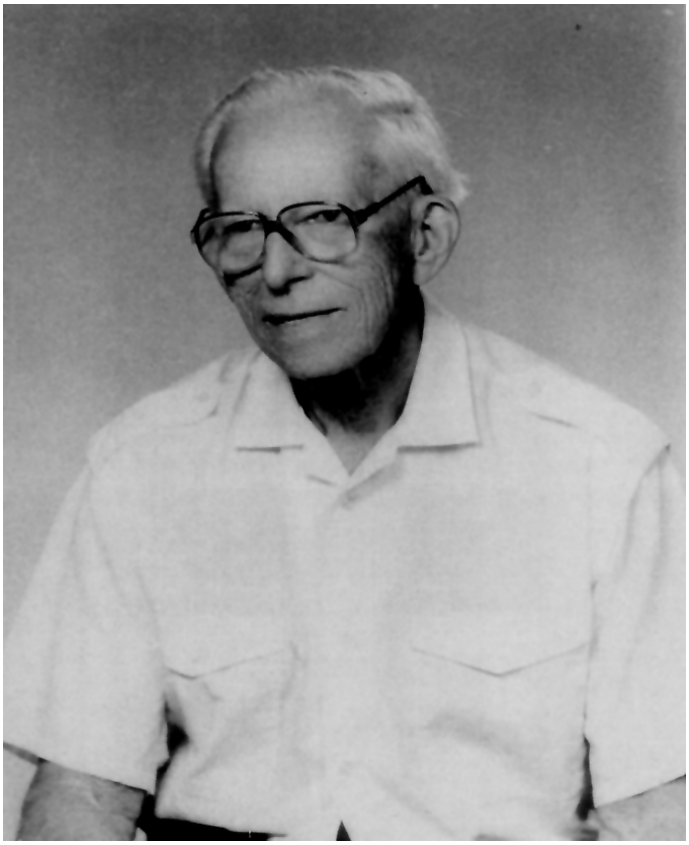

FIGURE 1. A PORTRAIT OF OTTO WICHTERLE.

Rubber Technology of the Bata Company, at that time the largest manufacturer of shoes in the world. There he worked on 1,3-dichloro-2-butene, a by-product of chloroprene rubber, and discovered the conversion of 3-chlorobutenyl derivatives to 3-oxobutyl derivatives (the Wichterle reaction).

$$CH_3CCl{=}CHCH_2Cl + CH_2(CO_2Et)_2 \xrightarrow{NaOEt} CH_3CCl{=}CHCH_2CH(CO_2Et)_2$$

$$CH_3CCl{=}CHCH_2CH(CO_2Et)_2 \xrightarrow[cooling]{H_2SO_4} CH_3COCH_2CH_2CH(CO_2Et)_2 \qquad (1)$$

He also developed, over a period of five years, the synthesis and polymerization of ε-caprolactam that was found nonpolymerizable by W. H. Carothers.

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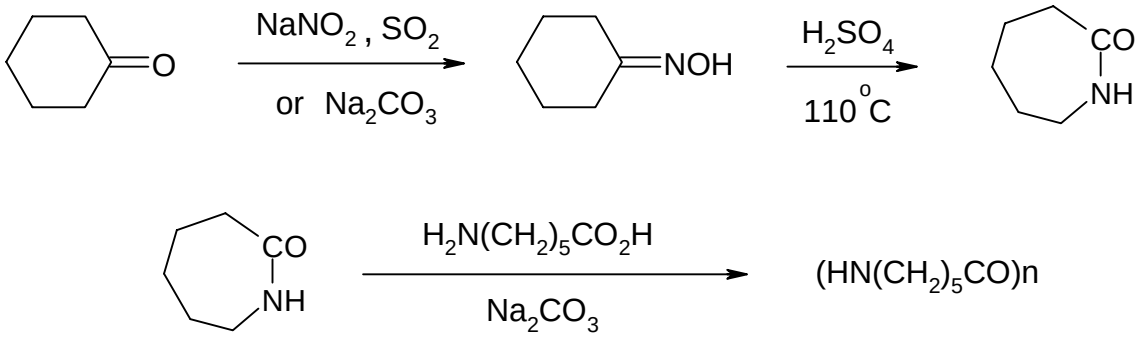
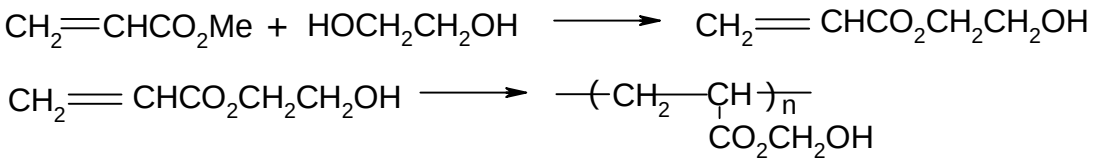


(2)

In 1952, Wichterle traveled by train to Prague and sat next to an ophthalmologist who was reading a journal advertising a tantalum prosthesis of a part of the eye. Wichterle mentioned to the ophthalmologist that it would be better to make such parts from hydrophilic organic polymers that would better blend with the rest of the eye, and he suggested, off the cuff, cross-linked polymers of hydroxyethyl methacrylate, unknown at that time. Soon after that, Wichterle prepared such polymers in the laboratory and found that they had the properties he expected. It took many more years before these polymers were developed into soft contact lenses, which are manufactured in the United States by Bausch & Lomb (based on Wichterle's patents), and are enjoyed by millions.



(3)

Wichterle's activities in the laboratory are paralleled by his excellent teaching abilities, which he practiced at the technical universities in Prague and Brno after WWII. Wichterle's lectures were made attractive to the students by the enthusiasm in his presentation and his tendency to include the most recent developments in organic chemistry, inorganic chemistry, and later on in macromolecular chemistry.

Wichterle wrote several books: *Czech Organic Chemistry* translated into German as *General Organic Chemistry*, *Czech General and Inorganic Chemistry*, and *Macromolecular Chemistry*. His autobiography was published in Czech as *Vzpominky* (1992, Impreso, Zdar nad Sazavou, Czech Republic) and in English as *Recollections*

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FIGURE 2. OTTO WICHTERLE AND HIS WIFE LINDA, CELEBRATING WICHTERLE'S 75TH BIRTHDAY (1988).

(1994, translated by B. Kukulisova and published by Ideu Repro, Prague, Czech Republic).

Wichterle always spoke his mind: during his studies, during the German occupation, and especially during the communist regime after the coup d'etat in 1948 and the Russian occupation (1968–1989). His outspokenness against these oppressive regimes resulted in his removal from the Technical University in Prague in l958 during a communist purge, and it caused many conflicts with the communist regime, especially after the Russian occupation.

His opposition to these oppressive regimes earned him the nickname "Czech Sacharov," which was mentioned after 1990 by the outstanding Russian chemist M. I. Rochlin.

Wichterle earned considerable national, as well as international, recognition as stated in his obituaries in *Nature* [2] and in the *Journal of Polymer Science* (not yet published).

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Reminiscences

The main topic of "My Reminiscences" is the events that occurred during our collaboration (1941–1945) and our coexistence at the Technical University from 1945 to 1958.

I began my chemistry studies in the Fall of 1938 at the Technical University in Prague where Wichterle was an Assistant Professor. On November 17, 1939, all Czech universities were closed and occupied by German SS units. Neither the students nor the professors were admitted to the buildings. Only later were the professors allowed to take their personal belongings. Before the schools were closed, Wichterle was working with 1,3-dichloro-2-butene, a by-product in the production of chloroprene rubber by the Bata Company. Wichterle's chemical intuition, which did not abandon him for the rest of his life, allowed him to perceive that the compound possessed a potential for useful chemical applications because it contained a double bond, one reactive allylic chlorine, and one unreactive vinylic chlorine. He used the compound for alkylation of diethyl malonate. When he washed the distillation residue in the flask with concentrated sulfuric acid, he noticed a vigorous evolution of hydrogen chloride. He repeated the experiment, treated the product with concentrated sulfuric acid while cooling it, and decomposed the reaction mixture with ice. At this stage in his work, the schools were closed. When Wichterle was allowed to carry his belongings from the building, he smuggled the decomposition product through the Teutonic guards. In the Research Institute of Rubber Technology where he was employed since January 1940 he worked up the product, and discovered that the 3-chlorobutenyl residue was transformed to 3-oxobutyl residue.

When I came into Wichterle's laboratory as a technician in 1941, I was assigned to study the reactions of 1,3-dichloro-2-butene. I was handicapped by not knowing any organic chemistry or experimental techniques, as the university was closed when I had just started the sophomore year. "No problem," said Wichterle "here you have *Gattermann's Praktikum fuer Organische Chemie*. Carry out some of the experiments, and if you learn whatever is printed in smaller fonts you will not flunk the organic chemistry examination when the schools reopen after the war." Following Wichterle's

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FIGURE 3. OTTO WICHTERLE AT WORK IN HIS LABORATORY.

advice, I trained diligently in the experimental techniques. Once, when I was filtering bright yellow crystals of a salt of coumarin-2-carboxylic acid, the “big boss” docent Stanislav Landa, the director of the Institute, entered the laboratory to talk with Wichterle. Instead, he caught sight of the yellow crystals and marched directly to me. “What is this stuff here,” was his question. Even before I could think what to say, as I was not doing my research, Wichterle came to my rescue, explaining that he told me to carry out a model experiment.

Wichterle was an excellent experimentalist. His motto was: “The chemistry professor must be a universal technician,” and he lived up to this idea. He loved to assemble complex apparatus. I could not have wished to have a better example to follow. That I learned something from him is supported by his remark that “I was the most skillful good-for-nothing in his laboratory.” In the laboratory he carried out most of the experiments with his own hands, and he was very inventive. Occasionally, his experiments were somewhat risky.

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During the war, there was a lack of many chemicals and consequently any waste was to be avoided. Ether was dried in five-liter bottles with sodium, and when the sodium residues and sodium hydroxide accumulated to about one third of the bottle, they were decomposed by gradual addition of ethanol. Thus, plenty of alcohol and ether were wasted. Once, a revolutionary idea occurred to Wichterle: He added a large amount of water into the bottle with the sodium residues, but, because there was still much ether present, the contents of the bottle started to boil very vigorously. Within seconds, Wichterle grabbed a reflux condenser, inserted it into the neck of the bottle, tightened it with filter paper, connected it to a water tap, and saved most of the ether (and the laboratory from a fire).

In contrast to the majority of the heads of the departments in the research institute, Wichterle always displayed a humane attitude toward his technicians. He included their names in his publications, which was not the common practice at that time.

Once, when I was rushing with a vacuum distillation, as I did not want to miss my tennis game, he took over the distillation saying he did not want me to be late. Indeed, an unusual attitude for a boss! When we played tennis together, he always trounced me because, as he said, “my backhand was his gold mine.”

After his return to the university after the war, Wichterle brought a new spirit to his laboratories as well as to his lectures. Because there was a critical lack of chemicals, he worked out, in addition to the classical experiments in the sophomore organic laboratories, procedures for the preparation of the starting materials or intermediates needed for research. Thus, many students prepared in small batches sufficient amounts of useful chemicals (e pluribus unum). He even introduced the preparation of chloroacetic acid from trichloroethylene, which required a fairly sophisticated apparatus and some glass blowing.

Wichterle liked to browse through the sophomore laboratories, watch the students working, and sometimes observe their mistakes and help to correct them. In the summer he wore shorts and was sometimes hardly distinguishable from some of the students. Once he pointed out the flaws in an apparatus of one student. The student turned to him: “Hey, you, what are you doing here? Why aren’t you working at your own desk?” Wichterle continued his browsing, and when he returned to his office, the student came in and started apologizing: “Sir, I am very sorry, I did not know that you

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are an associate professor." "How come" interrupted Wichterle, "aren't we on a first name basis?"

Wichterle had a unique ability to react quickly to a change of circumstances, be it in the laboratory or in his lectures. He recalled of one such episode. He was lecturing, "off-the-cuff," of course, (using notes during lectures was not allowed in the Votocek Institute), and when he talked about thionyl chloride and sulfuryl chloride, he mentioned that thionyl chloride boils lower than sulfuryl chloride. To verify how much lower, he took a look in his book, and to his surprise found that it is the other way around. Within seconds it occurred to him why. "Such an estimate would be justified if the boiling points were based on the molecular weight; however, because the molecules of thionyl chloride are more polar and are associated, thionyl chloride boils higher than sulfuryl chloride (79 and 69 °C respectively)."

My contact with Wichterle was temporarily interrupted in 1948 when I spent one year as a post-doc at Ohio State University in Columbus, Ohio. We only exchanged occasional letters. One of them was written shortly after the communist coup d'état in February of 1948. This event drastically changed life in Czechoslovakia, and the people had to get adjusted to communist rule, which included learning communist jargon and slogans. Wichterle informed me, paraphrasing the communist way of writing, that "...the furrow that our people tilled in the famous February days did not reach too deep into the ground of our Institute…." And when I returned in 1949 not knowing whether I would be still employable at the University, Wichterle assured me that not a single member of the faculty signed the application to the communist party that was forced on all teachers.

After his invention of soft contact lenses, when their production was still in the cradle, Wichterle liked to demonstrate the ease of application of the lenses. Once, during a visit in my home, he all of a sudden peeled off a lens from his eye, dropped it into the tea, stirred the tea, fished the lens out, and inserted it into his eye. Still, it remains a mystery to me as to why the inventor of the soft contact lens always used glasses.

Conclusion

I am sure that the situations described in my reminisces are understandable to citizens of the Czech Republic, whose people have lived under oppressive regimes for decades.

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1. Čapek, K. *Valka s mloky* (*War with the Newts*), 10th ed.; Fr. Borový: Prague, 1947, p 37.

2. *Nature*, **1998** (Sept. 24), *395*, p 332.