LIFE & LEGACY OF HERMAN SCHLUNDT

Schlundt risked health for research

SCHLUNDT from page 1A

The making of a physical chemist

Schlundt was born in 1869 in Two Rivers, Wis., and completed his undergraduate work at the University of Wisconsin.

In 1899, he traveled to the University of Leipzig in Germany to work in the laboratory of Wilhelm Ostwald, a pioneering physical chemist. According to science historian John W. Servos, Ostwald is often listed with Swedish physicist-turned-chemist Svante Arrhenius and Dutch chemist Jacobus Henricus van 't Hoff, Jr. as a father of physical chemistry.

In his lab, Ostwald taught his students to apply the principles of physics, such as energy, to basic units of matter. In addition to Schlundt, more than 40 Americans were drawn to his lab from the 1890s to the early 1900s.

As a German-American from a Midwestern town, Schlundt differed from most of these chemists, who came from English families in the Northeast and Middle Atlantic.

After studying in Leipzig, most of this elite group went on to become chemistry professors at top private universities in the U.S. Others became leading government and industrial chemists.

Schlundt was one of the few who decided to teach at a public, land-grant university.

After earning his Ph.D. from the University of Leipzig in 1901, Schlundt came to MU. At that time, radioactivity was emerging as a subject for intense scientific study, as well as a popular science fad.

Schlundt kept a collection of pamphlets and newspaper articles throughout his career that advertised pseudo-scientific gimmicks to those seeking miracle cures. The collection provides a glimpse into the radiation hype of the early 20th Century.

'Miracle cure'

Radium, for example, was touted as a marvel of modern science, able to heal everything from cancer to eczema. "Radium - The Magic Element!" trumpeted one pamphlet that advertised a device called the Revigerator that was hyped as a way to irradiate drinking water.

An ad for a similar product, the Georadium Drinking Apparatus, proclaimed: "To-day it is universally conceded that the field of radium therapy at once is the most intriguing, the most mysterious and potentially the most valuable scientific development in the history of human achievement."

A news item declared that radium was capable, if properly employed, of preventing people from growing old.

Schlundt became fascinated with radioactive metals, which appear ordinary on the surface but do emit powerful and mysterious energy. In 1904, he began meeting with another chemistry professor twice a week to discuss the emerging study of radioactive elements. They read all the papers on the subject they could get their hands on.

"Scarcely two months passed by before we found ourselves building electroscopes," Schlundt wrote in a 1931 letter to university president Walter Williams.

One of Schlundt's early experiments was testing water from one of the university's deep wells for radioactivity. It tested positive (and still does, though at a level below the Missouri Department of Natural Resource's maximum contaminant level).

Schlundt then expanded his search for radiation to hot springs and aquifers all across the country. From 1906 to 1908, he tested the springs in Yellowstone National Park for the U.S. Geological Survey.

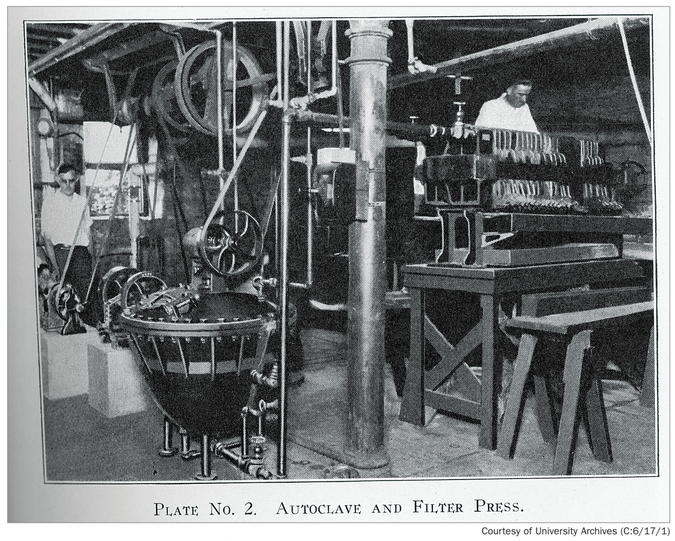

PLATE No. 2. AUTOCLAVE AND FILTER PRESS.

Courtesy of University Archives (C:6/17/1)

Equipment used for extracting and refining radium from carnotite ores once stood in Pickard Hall. This photo was originally published in a 1923 MU research bulletin, written by Howard Barker and Herman Schlundt.

In fact, throughout his long tenure at MU, he received water samples from people still looking to score a scientist's endorsement of the healing power of their springs and wells.

Eventually, Schlundt turned his attention to radioactive metals.

Radium from ore

He had gotten an introduction to radium refining in the summer of 1913 at the U.S. Bureau of Mines station in Denver.

The bureau was working on refining carnotite ore, a sandstone streaked with neon yellow crust mined in western Colorado and eastern Utah. This ore was a vital source of radium for researchers all across the world.

> **"I spent last summer in Colorado in the U.S. Bureau of Mines and came in touch with the experiments in progress there on the separation of radium from the low grade ores of western Colorado."**
>
> HERMAN SCHLUNDT IN A 1914 LETTER
> Radiation researcher

"I spent last summer in Colorado in the U.S. Bureau of Mines and came in touch with the experiments in progress there on the separation of radium from the low grade ores of western Colorado," Schlundt wrote in a letter dated 1914.

The method he learned used a series of messy, labor-intensive steps to convert a lot of ore into tiny crystals of radium bromide salts.

"Although a large quantity of ore must be worked upon to get a very small quantity of radium at present, still this ore to-day is the principal source of radium," he wrote.

During Schlundt's summer in Denver, he spent time with Samuel Colville Lind, who became a lifelong friend and colleague. Lind was a decade younger than Schlundt, Tennessee-born and also an alumnus of Ostwald's laboratory in Leipzig.

According to a biography of Lind by the National Academies Press, the work they did was laborious and dangerous. Lind ended up burning away half of his right thumb and index finger after years of holding radium in his bare hands.

The summer they spent together provided the social connection that enabled Schlundt to get into the refining business later.

Golden partnership

In 1914, Schlundt took the work back with him to the university, partnering with a researcher named Howard H. Barker, who had once processed ore commercially.

Schlundt persuaded several corporations and individuals to send him donations of radium ore. Altogether, he received more than four tons of raw ore.

Radium was spread so thin throughout the ore that a ton might only yield a couple hundred milligrams, the weight of a small pill. That meant radium and other radioactive metals were more valuable than gold or diamonds in the late 1910s and early 1920s.

According to "New International Yearbook: A Compendium of the World's Progress," published in 1921, radium sold for $115 to $120 per milligram that year. Gold cost about $21 per troy ounce — roughly 1.09 ounces — that year, according to the National Mining Association. A milligram of gold would have been worth just 0.0007 cents.

Schlundt and Barker developed techniques to improve the efficiency and reduce the cost of extracting radium. They finished their work in 1922, the year American carnotite mining stopped. A new source of cheap radium — $70 per milligram, according to Schlundt — had been discovered in the Belgian Congo, and American mines couldn't compete.

This development generated interest in alternative sources of radiation.

Mantles for lanterns

While Schlundt and Barker were working on their radium refining method, Schlundt made contact with a man whose influence would shape the rest of his own career — Harlan S. Miner with the Welsbach Co. in New Jersey.

The company made mantles for gas lanterns, a crucial item before the rise of electricity. Miner was one of the chemists who perfected the use of another radioactive metal, thorium, which glows in a gas flame.

The process of extracting thorium from its source material, monazite sand, left tons of radioactive sludge. Miner wanted to find a way to turn this waste product into cash, and he needed a radium-refining expert to help the company profit from its waste materials. In 1917, the U.S. Bureau of Mines helped Miner locate Schlundt, most likely through Schlundt's friend Lind.

Schlundt soon realized that the process he used to extract radium from ores could easily be modified to extract an isotope of radium, radium-228, from Welsbach's industrial waste. He called this isotope "mesothorium." In one of his many letters to Miner, Schlundt described them both as "mesothorium rooters."

His radium-228 research probably contributed most to the lasting radioactivity in Pickard Hall because of the huge amount of radioactive waste he needed to synthesize it.

While the radium-228 refinery was in operation, he was receiving shipments of thousands of pounds of radioactive sludge from Welsbach and the Lindsay Light Co. in Chicago. This radioactive waste ultimately contaminated the grounds of both companies, leading to their eventual listing as EPA Superfund sites.

An excerpt from Schlundt's report on refining radium-228 from the waste materials shows how much was required to produce a tiny amount of the radioactive substance.

"Up to the present time, about sixteen hundred (1,600) pounds of the original material have been processed," Schlundt wrote. This yielded only 86 milligrams of radium-228 — or about .003 ounces, less than the weight of a sewing needle.

Schlundt ended up writing a pamphlet on radium-228 that the U.S. Bureau of Mines published in 1921. It explained in detail how the material could be extracted and used. He continued the produce the isotope for at least nine years after that, honing the technique and sending the finished product back to Miner.

"The laboratory for refining of mesothorium has now been in operation for twelve years," Schlundt wrote in 1931. "More than 3,600 milligrams of high grade mesothorium...have been produced mainly by graduate students working under the direction of Dr. G.F. Breckenridge and the writer."

These 3,600 milligrams had a market price of between $216,000 and $360,000 at the time, according to prices Schlundt quoted in his letters. In today's dollars, this would be about $3 billion to $4 billion, depending on the years for which inflation is calculated.

Most of the radium-228 returned to Welsbach, sent in increments spread out over years. When Schlundt left MU in 1921 to study for a year at the Cavendish Laboratory in England, his students kept up his work under Breckenridge's supervision. Breckenridge, another MU chemistry professor, left the university shortly before Schlundt returned in 1922.

Schlundt the businessman

Throughout the 1920s, the refinery in Pickard Hall churned out radium-228. Schlundt's letters indicate that Welsbach paid him as a consultant during that time.

In a letter he wrote in 1922 to a company that wanted to enlist his services, he said, "At the present time I am serving in a consulting capacity for the Welsbach Company on Mesothorium. Since the process for treating mesothorium and radium are nearly identical, it seems to me that I should not accept any other consulting work with a competing firm unless I obtained consent of the Welsbach Company."

But in a few months, he wrote, he might be able to work something out with the second company.

"My contract with Welsbach expires early in July," Schlundt wrote. "I shall then be free I hope and will stand ready to cooperate with you and your firm to the best of my ability."

This kind of arrangement seems to have been against the chemistry department's rules at the time. A set of university policies the department recommended to the university's executive boards in 1916 forbade faculty from using university laboratories, equipment or materials for commercial activities without the consent of the dean or department chair.

It could have helped that Schlundt was chair of the chemistry department from 1910 until his death in 1937, according to a history of the chemistry department by former MU chemistry professor Dorothy Nightingale.

Plus, he doled out favors with the the same enthusiasm as he doled out radium. He was constantly finding someone a job, answering those who wrote to him with chemistry questions and offering advice on how to improve chemistry education at rural high schools and colleges. He was, in many ways, a model citizen.

Schlundt's business arrangements also earned the chemistry department free equipment and supplies. When he wrote in the early 1930s to then-president Walter Williams asking for equipment, Schlundt mentioned he had sought financial support from private industry for most of his work.

"For nearly twenty five years the Chemistry department has conducted research work in the new field of science, which has revolutionized the theories of the structure of matter," Schlundt wrote. "By far the major parts of the expensive material needed for these investigations has been loaned or donated by private individuals or firms."

> **One of Schlundt's early experiments was testing water from one of the university's deep wells for radioactivity. It tested positive. Schlundt then expanded his search for radiation to hot springs and aquifers all across the country. From 1906 to 1908, he tested the springs in Yellowstone National Park for the U.S. Geological Survey.**

Friendship pays off

His friendship with Harlan Miner of Welsbach also allowed Schlundt to make high-profile donations of thorium-228 to prestigious laboratories in the U.S. and Europe. He had discovered that he could draw this bonus material, then called radiothorium, from the same lantern mantle sludge he used to refine radium-228.

"To secure the radiothorium we must have the good will of Dr. Miner of the Welsbach Company, as it is through his firm that we get our supply of mesothorium," he wrote to the would-be sponsor in 1922.

One of his donations was sent to the Paris laboratory of Marie Curie, who won a Nobel Prize in physics and chemistry for her work on radioactivity. Curie wrote a thank you letter to Schlundt through Miner.

"I will soon receive the preparation of Radiothorium, which Mr. Pr. Schlundt offered to prepare in his laboratory," Curie wrote to Miner in French. "I would ask you to thank Mr. Pr. Schlundt on my behalf."

Curie's letter came in 1930 and marks the height of Schlundt's prominence in his field. But like many researchers who dealt too carelessly with radioactive materials, his work took a deadly toll on his health.

In the decades of research and industrial refining at MU, Schlundt, his colleagues and his students had all been exposed to to dangerous levels of radiation.

PLATE No. 1. LEACHING POTS, BOXED, AND SUCTION FILTERS.

Courtesy of UNIVERSITY ARCHIVES (C:6/17/1)

In Pickard Hall, a researcher maneuvers a drum used in the extraction of radium from carnotite ore. The first phase of the procedure involved mixing the ore with acid in this drum. Howard Barker and Herman Schlundt, a former MU chemistry professor, published this photo along with the results of their work in a 1923 research bulletin.

From cure to killer

Radiation poisoning became a national health scare in the early 1930s, when press coverage of a lawsuit against a chemical company by factory workers who had been exposed to radium developed into the "Radium Girls" scandal. One of radium's uses was in painting watch dials and gun sights — the radioactivity would make paint glow in the dark.

The women had worked at the United States Radium Corp.'s factory in East Orange, N.J., in the late 1910s and early 1920s, where they painted watch dials. Many of them would lick the tips of their tiny brushes into fine points, ingesting toxic levels of radium, according to a report Schlundt wrote for the U.S. Public Health Service.

Papers warning of the dangers of handling radium began appearing in scientific journals in the 1910s and early 1920s. Many of them were published in the French Journal of Radiology, Electrology and Nuclear Medicine. One paper by Dr. Thomas Ordway titled "Occupational Injuries Due to Radium" appeared in the Journal of the American Medical Association in 1916. Radium Corp. collected many of these papers and republished their abstracts in a book dated 1922.

About 12 years after some of the dial plant workers were exposed, they became deathly ill. The radium they had accidentally eaten had lodged in their bones. For some of them, it caused their jaws to rot away.

According to environmental historians Bill Kovarik and Mark Neuzil, five of the dial plant workers sued Radium Corp. for $250,000 each in 1927. Newspapers went from trumpeting the health benefits of radium to playing up the pain and suffering of the dying women.

"Most of the news media dove in with a mixture of sensationalism and muckraking that accelerated and expanded the controversy," Kovarik and Neuzil noted.

The publicity put pressure on Radium Corp. to settle. Later that year, the company agreed to pay each woman $10,000 and $600 every year for the rest of their short lives. The company would also pay their future medical expenses.

Radium Corp. had a marked connection to Schlundt. The company had loaned him ore during his early experiments with Barker. By the time of the scandal, Barker had become a vice president of the company.

Before the factory workers' case went to trial, Barker and Schlundt were writing back and forth, with Schlundt offering his opinion on dosage levels.

In 1928, the Surgeon General convened a meeting with officials from the Public Health Service and the National Consumers League. Those at the conference agreed that two committees should be set up to investigate workplace practices with radium.

Schlundt was placed on one of the committees to do research on some of the women. He traveled to New York about 1931 to test two women who had worked at the Radium Corp. factory in the late 1910s, and he published a report of his work there.

"The two girls, who after a lapse of nearly 12 years, are still radioactive, present cases of more than passing interest, inasmuch as they stand as striking examples of the tolerance of living persons for radium," he wrote.

Declining health

Schlundt proved he was willing to subject himself to the same risks he had exposed others to. He drank water spiked with a known dose of radium to find out how quickly it would stop showing up in his urine. "As high as 91 percent of the radium taken was eliminated during the first four days after drinking the radioactive water," he wrote in his report to the Public Health Service.

When he returned to Columbia, he turned his attention to health hazards. In his letter to Walter Williams, he described some of his health studies in the early 1930s. He published a paper in the Journal of Industrial Hygiene in 1931 titled, "Dangers in Refining Radioactive Substances."

"Our first study of this problem indicates that the refining operations may be conducted without hazard when proper safety measures which we have introduced are followed by the workers in the refining laboratory," he wrote.

By then, Schlundt had begun to suffer health problems probably related to his research. In a 1933 letter, he complained of recurring bouts of sleeping sickness. He developed severe encephalitis that year and spent much of the 1933-1934 school year in the hospital, according to Nightingale's history. When he returned in 1934, he had to cut his hours.

He died of uremic poisoning, a result of kidney failure, in 1937. He was 68.

Schlundt's radioactive legacy

No mention of Schlundt's industrial refinery appeared in a two-part obituary published in the Missourian in 1937. It referred to him as an authority on radioactivity who also found time to be involved in scientific fraternities, professional chemistry societies, the Columbia Kiwanis Club and the Columbia Red Cross. It noted his connection to Curie.

It would be years before the university understood the radioactive mess he left behind. Peter Ashbrook, former director of the university's Environmental Health and Safety department, explained the situation to the Nuclear Regulatory Commission in a hearing in June 2011.

> **"We are not aware of anyone having been harmed by radiation in Pickard Hall."**
>
> PETER ASHBROOK
> Former director of the Environmental Health and Safety department at MU

Ashbrook told the commission the university has known about Pickard's radiation since the late 1970s, when staff surveyed the building and removed contaminants "where it was easy to do so."

Some of the radioactive leftovers were behind walls and under floors, making them hard to reach. They placed metal shields over some spots and restricted access to the attic and basement. They placed dosimeters, which calculate the dose of radiation a person receives when exposed.

"We are not aware of anyone having been harmed by radiation in Pickard Hall," Ashbrook said.

Questions still remain about what if any harm might have come to Schlundt's students, the ones who faced direct exposure to more concentrated radioactive materials. These men would have been in their 20s in the 1920s. Their lives were not nearly as well-documented as Schlundt's.

Despite the danger he unwittingly posed to his students, he won the admiration of MU's student body. "The University freshman in need of a firmer grasp on the life about him found homesickness or discouragement considerable lessened through the words of Dr. Schlundt," the obituary stated.

The final paragraphs of Schlundt's obituary reveal his greatest talent, the reason he was able to accomplish everything he was in his life.

"He possessed an unusually retentive memory for names and faces. His greatest hobby was people."

Supervising editor is Jeanne Abbott: abbottjm@missouri.edu, 882-5741.

Chronology: Radiation research in Pickard Hall

Courtesy of UNIVERSITY ARCHIVES (C:6/17/1)

Former MU chemistry department chair Herman Schlundt poses in this undated photograph, taken sometime between 1902 and 1937.

1869
Herman Schlundt is born in Two Rivers, Wis.

1899-1901
Schlundt studies in the laboratory of Wilhelm Ostwald at the University of Leipzig. Ostwald is often listed with Swedish physicist-turned-chemist Svante Arrhenius and Dutch chemist Jacobus Henricus van 't Hoff Jr. as a father of physical chemistry.

1902
Schlundt is hired to teach chemistry at MU.

1903
Marie Curie, Pierre Curie and Henri Becquerel are awarded a Nobel Prize in physics for the discovery of radioactivity.

1905
Albert Einstein publishes his paper on special relativity and his famous equation, E = mc2.

1906-1908
Schlundt tests Yellowstone National Park's hot springs for radiation at the request of the U.S. Geological Survey.

1910
Schlundt becomes chemistry department chair, a position he holds until his death in 1937.

1910s-early 1920s
Papers warning of the dangers of working with radium begin to appear in scientific journals, including the French Journal of Radiology, Nuclear Medicine and Electrology and the Journal of the American Medical Association.

1913
Schlundt gets an introduction to radium refining at the U.S. Bureau of Mines station in Denver. He befriends Samuel Colville Lind, a chemist for the bureau. Lind was another alumnus of Ostwald's lab who would become Schlundt's lifelong colleague.

1914-1922
Schlundt returns to MU and takes the radium refining work back with him. He publishes his results in a university research bulletin in 1923.

1917
The U.S. Bureau of Mines, probably through Lind, introduces Schlundt to Harlan S. Miner with the Welsbach Co.

1918
Schlundt begins refining industrial waste for the Welsbach Co., harvesting radium-228 and thorium-228. Schlundt, his fellow professors and their graduate students refine waste for the company for the next 12 years.

1921
Schlundt travels to England for a year of study at the Cavendish Laboratory. The refining continues under the direction of another chemistry professor.

1922
Schlundt returns to Columbia and continues refining Welsbach Co.'s waste in his laboratory until around 1930. Welsbach pays Schlundt as a consultant for at least part of that time.

The price of radium goes from $115 to $120 a milligram to $70 a milligram after a new source of ore is discovered in the Belgian Congo. American ore mining stops. Schlundt focuses his refining process on Welsbach's industrial waste.

1922-1930
Graduate students working under Schlundt's direction churn out 3,600 milligrams of radium-228. Most of it returns to Welsbach Co.

1927
Former workers at U.S. Radium Corp.'s watch dial plant in Orange, N.J., sue the company after experiencing radium poisoning. The workers were painting watch dials with radium-infused glow-in-the-dark paint. Many of them would lick the tips of their tiny brushes into fine points, ingesting toxic levels of radium.

1928
Muckraking newspaper coverage feeds the 'Radium Girls' scandal. Radium Corp. settles with the dial plant workers, paying them $10,000 and $600 a year for the rest of their short lives. The Surgeon General places Schlundt on a committee to investigate the hazards of working with radium.

ca. 1930
Schlundt makes high-profile donations of thorium-228 to several major laboratories in the U.S. and Europe. One of them is Marie Curie's in France. Curie writes to Schlundt through Miner thanking him.

ca. 1931
Schlundt travels to New York to test two women who had worked at the Radium Corp. factory in the late 1910s. He drinks water spiked with a known quantity of radium to see when it stops showing up in his urine.

1933
Schlundt's health begins to decline. He suffers bouts of sleeping sickness. Severe encephalitis keeps him in the hospital for a year.

1937
Schlundt dies of uremic poisoning, a result of kidney failure.

1976
The Museum of Art History and Archaeology opens in the renovated Pickard Hall.

Late 1970s
University officials become aware of lingering radiation in the building. At a hearing in 2011, former director of MU's Office of Environmental Health and Safety Peter Ashbrook told the Nuclear Regulatory Commission that after discovering the radiation, MU staff removed contamination in areas within reach and place shields over patches of radioactivity. Some contamination remains behind walls and beneath floors. They place exposure-measuring dosimeters in the building, which return low readings.

Late 1970s-early 2000s
The university continues to monitor radiation in the building and attempts to restrict access to certain areas in its basement and attics. Ashbrook told the commission in 2011 that over the years, his office "took additional steps to reduce exposures even more to be...as low as reasonably achievable."

2007
New regulations take effect that require the Nuclear Regulatory Commission to regulate sites with naturally occurring radioactive materials. They requires these sites to be taken off the commission's list of sites to monitor. The official term is "decommissioning."

2009
MU notifies the commission that the new regulations apply to Pickard Hall. The commission asks MU to submit a two-year cleanup plan.

2011
The university asks the commission for an indefinite extension on the clean-up timeline. The commission denies the request.

May 2013
MU announces Pickard's closure. Pickard must be empty by the end of December so a new round of testing can be conducted.