NATIONAL ACADEMY OF SCIENCES

HOMER BURTON ADKINS

1892—1949

A Biographical Memoir by

FARRINGTON DANIELS

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Organic chemistry in the United States underwent an extraordinary expansion in the three decades which included the two world wars. This period of development was characterized by a rapid increase of laboratory knowledge which was quickly applied to industry; and also by a large expansion in the number of organic chemists who had graduate training in research. Among the pioneering and influential leaders of this period was Homer Adkins, whose death on August 10, 1949, at the age of fifty-seven came as a shock to his many friends. He was the world's authority on hydrogenation of organic compounds; he made important laboratory contributions to the mechanisms of catalyzed reactions of organic chemistry and he led the teaching of organic chemistry at the University of Wisconsin for thirty years, during which time he trained over one hundred Ph.D. students who are now in positions of responsibility and leadership in industry and education. He belonged to the close-knit group of leaders including Adams, Conant, Gilman, Marvel, Whitmore and others who did much to influence the course of organic chemistry throughout the second quarter of the twentieth century.

Born January 16, 1892, in Newport, Washington County, Ohio, the son of Alvin and Emily Middeswart Adkins, Homer Adkins was brought up with a brother and a sister on a peaceful farm located in a bend of the Ohio River. He attended high school at Newport and entered Denison University as a tall, shy, earnest country boy. He graduated in 1915 in three and a half years. He then spent three years in the graduate school at Ohio State University, taking his Master's degree in 1916 and his Ph.D. under the direction of Professor William Lloyd Evans in 1918. Soon after receiving his degree in early 1918, he began work as a research chemist for the War Department. The following academic year he spent as instructor in organic chemistry at Ohio State University and in the summer of 1919 he was a research chemist with E. I. Du Pont De Nemours and Company.

In 1919 he came to the University of Wisconsin, where he remained continuously until his death thirty years later, except for two summers of work in industry at the Bakelite Corporation in 1924 and 1926 and for responsibilities from 1942 to 1945 as administrator and research director in the war program of the National Defense Research Committee and the Office of Scientific Research and Development. He never took a leave of absence from the University of Wisconsin and was, in fact, on the teaching or research staff continuously, including nearly every summer. He was an indefatigable worker who devoted his life unstintingly to the teaching of organic chemistry, to the affairs of the University, to the advancement of organic chemistry through research, and to the application of organic chemistry to American industry and the war effort.

As a teacher, Adkins was precise, lucid and interesting. His books and published papers are models of clear, scientific expression. Throughout his whole career at the University of Wisconsin, he lectured to graduate students in a course called "Survey of Organic Chemistry" but he also kept contact with elementary students and continued for most of the time to give lectures in the first course in organic chemistry. His lectures were lively and interesting. They were witty and critical, sometimes to the point of being caustic. His point of view, recalled by one of his graduate students, is indicated by a statement made in a lecture in which he said that when he was a young man starting his career and casting about for a field of research, he decided that the field of catalytic reactions was a good one because there was a large body of facts waiting to be correlated. If someone were to examine all of these facts, he would surely arrive at a general theory of catalysis which would then cover all catalytic reactions and lead to successful predictions in the choice of catalysts. But, he commented, after studying catalytic hydrogenation and other catalytic reactions for a quarter of a century his present conclusion was, "What we need is more facts."

Professor Adkins used simple and effective illustrations and analogies in his teaching. He was among the first to emphasize the importance of distinguishing between the rates of organic

reactions and the extent of such reactions at equilibrium. He presented this concept to his class with a simple and obvious illustration: One could not predict the destination of two automobiles going west at equal speeds past the Chemistry Building; the destination of one might be Shorewood (a western suburb) while the other might be headed for Minneapolis.

Not only as a lecturer and teacher was Professor Adkins successful, but also as a writer of books. His chief research contributions in the field of hydrogenation are summarized in the book "Reactions of Hydrogen" published by the University of Wisconsin Press in 1937. He was also co-author of "Practice of Organic Chemistry" and "Elementary Organic Chemistry" both published by the McGraw-Hill Book Company. He wrote the chapter on "Comparison of Chemical Reactivity" in Gilman's treatise on "Organic Chemistry" and with R. L. Shriner another chapter in the second edition on "Catalytic Hydrogenation and Hydrogenolysis." In addition to these books and chapters which have been read by thousands of organic chemists in training, Homer Adkins was also a member of the Board of Editors of Gilman's "Organic Chemistry" and a member of the Board of Editors of "Organic Syntheses" published by John Wiley and Sons. He became an editor of Adams' "Organic Reactions" less than a year before he died. To this publication he contributed a chapter on "The Catalytic Reductions of Esters" which will appear in Vol. VII.

Homer Adkins never lost personal contact with the laboratory. Even through his last years, he spent an appreciable amount of his time with his coat off working with his own hands in the laboratory adjacent to his office. He designed precision equipment for carrying out hydrogenation reactions under high pressures. In this development of high pressure equipment, Professor Adkins was aided by Mr. Lee Henke of the Chemistry Department Machine Shop, and the equipment was later developed and made available to all laboratories through the American Precision Instrument Company.

Adkins' approach to his research laid great emphasis on experiments with a minimum of theory and of mathematics. He expressed himself once as considering it unethical to speculate

very far beyond his laboratory data. He was a master of expression and could describe with great clarity the findings of his laboratory investigations.

He maintained a close contact with industry and was thereby able to bring to his graduate students, to his classes and to his research a fresh, practical and vigorous enthusiasm. He was a consultant to the Rohm and Haas Company from 1932 until his death and to Merck and Company from 1940 until his death. In 1944 he was a consultant to Charles Pfizer and Company and in 1946 to the General Aniline and Film Corporation. He never allowed these contacts to interfere with his research or his teaching, but he acted as an effective and important liaison professor, strengthening and accelerating the fundamental developments in industry, while at the same time adding to his ability to stimulate his students.

As an administrator, Adkins carried heavy responsibilities throughout the last war. From September 1940 to April 1946 he was Official Investigator in charge of a number of research contracts between the University of Wisconsin and the Office of Scientific Research and Development. From May to December 1942 he was in charge of Section B-3C of the National Defense Research Committee which was charged with research on "Protective Ointments and Fabrics." From December 1941 to February 1943 he was in charge of the Organic Chemical Group at the NDRC Explosive Laboratory at Bruceton, Pennsylvania. From January 1943 to December 1945, he was a member of Division 9 of the Office of Scientific Research and Development, in charge of Section one. From October 1940 to February 28, 1946, the National Defense Research Committee and the Committee on Medical Research assigned numerous investigations to be carried out at the University of Wisconsin by Professor Adkins and his assistants under a series of contracts (NDCrc-6, OEMsr-78, OEMsr-304 and OEMcmr 567). The problems involved in these investigations for chemical warfare involved synthesis of various chemical reagents, protective measures for clothing, problems of detoxification and decontamination and evaluation of effectiveness of agents against mustard gas and a

determination of the storage stability of various protective agents.

Professor Adkins was active in the affairs of the Chemistry Department of the University of Wisconsin and served on many committees. He was one of the vigorous leaders in departmental policy making. Professor J. H. Mathews, who brought Professor Adkins to Wisconsin and remained chairman of the department throughout the whole period of Adkins' life at Wisconsin, aided vigorously in obtaining equipment and support for Professor Adkins' work. Many of his publications acknowledge the help given to his research program by the Research Committee of the Graduate School and the Wisconsin Alumni Research Foundation.

Vigorous, intense, outspoken, not always consistent, a trial at times to his departmental chairman and his associates, Homer Adkins fought hard nevertheless for democracy and democratic procedures as he saw them. Intolerant of inefficiency and evasiveness, "He loved to present a good argument and to be opposed by one." He espoused vigorously the cause of anyone whom he thought to be the victim of injustice. In social groups and faculty gatherings, he was interesting, witty and often brilliant. He loved to make startling statements, but on the whole he could be classed as a moderate democrat.

Adkins served on several University committees, important among which was the Committee on the Evaluation of the Experimental College. He also served on a committee which developed and inaugurated the Program of Integrated Liberal Studies of the College of Letters and Science at the University of Wisconsin. He never shrank from his responsibilities to his department, to his University, to his chemical organizations, or to his nation.

He was an excellent judge of men and was responsible for selecting his outstanding associates, S. M. McElvain, W. S. Johnson and A. L. Wilds, who carry on the responsibilities for organic chemistry which he built up so effectively at the University of Wisconsin.

Professor Adkins was active in the affairs of the American Chemical Society and particularly the Division of Organic

Chemistry. He was Chairman of this Division in 1932 and served many times as a member of its Executive Committee. At the time of his death he had been invited to be a nominee for the presidency of the American Chemical Society. He served also as Chairman of the Wisconsin Section of the American Chemical Society and was elected many different times to serve as Councilor from the Wisconsin Section.

Homer Adkins was married on February 21, 1917, while he was a graduate student at the Ohio State University, to Louise Spivey, who had been a classmate at Denison and who was teaching high school mathematics. There are three children: Susanne Dorothea (Mrs. Gordon Chadek) who has three children; Nance, who served with the Marine Corps during the war; and Roger, who has enlisted in the U. S. Army after a short time at the University of Virginia.

Professor Adkins devoted most of his time to his professional life. He did find time, however, to read many books and his particular outside field of study and interest was the history of the Civil War. His reading was enlivened by several visits to the battlegrounds of that war. He took up golf enthusiastically for in it he found relaxation and healthful exercise. He was a charter member of the Blackhawk Country Club. He was a member of the First Congregational Church and served as deacon from 1926 to 1928.

Homer Adkins' death was undoubtedly hastened by the heavy responsibilities and extended travel which were occasioned by the war. Carrying a program of teaching, maintaining a large research program in his laboratories and the directing and administering of many researches in the east, combined with the war time pressure, took a heavy toll of his strength. In the late spring of 1949, he apparently had a slight attack while playing golf and concluded that as soon as he could get time he would have a complete medical checkup. The organic Symposium was held in Madison in June, 1949 and was attended by nearly one thousand organic chemists. Homer Adkins put much energy and time into the plans and organization for this Symposium. In the late afternoon of June 20, he presented a paper describing some of his recent research to

the Symposium. After this meeting he took a group of interested chemists to his laboratory to inspect some of his special high pressure equipment. On his way back to the meeting headquarters, he was stricken with a heart attack and was taken to the hospital where he stayed for a month or so. Later on he returned home and seemed to be improving, but quite suddenly began to fail rapidly and died on August 10, 1949.

Characteristic of his strong spirit and humor was a mimeographed letter which he sent to all of his associates and friends on July 5, 1949, which read as follows:

On Monday evening, June twentieth, I went out of circulation on account of a coronary occlusion, which resulted in some damage to my heart. Since then I have been very comfortably located at the Madison General Hospital and am recovering. Probably I will be here until about the middle of July, after which I expect to be at home.

I am sorry to have missed and inconvenienced so many of my friends. Practically speaking, I have no activities and it appears that I will be very limited in what I will be allowed to do for the next month or so. I feel better than I have for a long time, in fact I recommend my current mode of vacation very highly. I expect to be carrying on my normal activities after the prescribed rest at home.

Homer Adkins received many honors. He received the honorary degree, Doctor of Science, from Denison University, his alma mater, in 1938. He was awarded the "Medal for Merit" by President Truman for conduct and administration of investigations under the Office of Scientific Research and Development 1941-1945. He was elected member of the National Academy of Sciences in 1942. He was a member of Phi Beta Kappa, Sigma Xi, Phi Delta Theta, Alpha Chi Sigma and Phi Lambda Upsilon. He was a Fellow of the Chemical Society of London, a member of the Swiss Chemical Society, a member of the American Association of University Professors, a member of the Chemists Club of New York.

After his death, Adkins' associates and many former students and friends, under the leadership of Dr. Ralph Connor and Dr. S. M. McElvain, raised a fund in his honor and for the next few years the Homer Adkins Fellowship will support a

graduate student in chemistry at the University of Wisconsin. The first recipient of this fellowship has been chosen. The Chemistry Department gratefully remembers the contributions and the leadership of Homer Adkins and considers the fellowship named for him to be the highest honor that it can bestow on an outstanding graduate student.

President Edwin B. Fred of the University of Wisconsin said, "He was recognized as one of the leading chemists that America has produced. He was the kind of man who makes a University distinguished," and President James B. Conant of Harvard said, "the academic world has suffered an irreparable loss."

HOMER ADKINS' CONTRIBUTIONS TO ORGANIC CHEMISTRY

In American Men of Science, Adkins listed his research interests as "causation of organic chemical reactions; relations of catalysis, reactivity and structure of organic compounds; the reaction of hydrogen with organic compounds; oxidation potential." He was always hoping for generalizations which would correlate the many facts of organic chemistry but in practice he could not bring himself to go very far away from the laboratory and empirical approach. From his laboratory have come a large number of important contributions dealing with hydrogenation and with factual material on chemical equilibrium, rates of reaction, and molecular structure which have given us a better understanding of the principles of chemical reactivity in organic chemistry. The principles and techniques which Adkins and his students developed have been important in synthetic organic chemistry both in the laboratory and in industry.

A complete bibliography with descriptive titles is given at the end of this biography which shows clearly the range of Professor Adkins' interests and the influence of his researches on the development of organic chemistry. Comments can be made on only a few fields of activity selected from this record in chronological order.

Homer Adkins' first publication in 1919 was based on his Ph.D. thesis under the direction of Professor William Lloyd Evans at the Ohio State University. All the rest of his work was done at the University of Wisconsin and most all of it has been published in the Journal of the American Chemical Society.

His Doctor's thesis was concerned with the rates of oxidation by potassium permanganate of acetaldehyde, oxalic acid and other organic materials and the influence of the different variables such as temperature on these rates. The nature of the intermediates and the influence of molecular structure were the points of his chief interest.

His second paper was based on an attempt to synthesize a vat dye from phenanthrene, perhaps on outgrowth of interests acquired during an earlier summer's work in the Du Pont laboratories.

His third research involved the catalytic action of oxides on esters and profoundly affected the whole course of his research interests. Bancroft had pointed out the widely different nature of the products obtained from a given starting material depending on whether the catalyst was an oxide of aluminum, titanium or thorium. Adkins verified the marked specific action of the different catalysts and hoped that it would be "better to study the types of reactions as related to the simple surface conditions of the solid catalyst rather than to the complex phenomena which occur in liquid solutions."

Further studies of the catalysts led to new methods of preparing catalysts by heating aluminum alkoxides to give aluminum oxides with different spacings depending on the alkyl groups involved.

Acetal was used by Professor Adkins in several different researches in his studies of chemical reactivity and catalysis. This work led to studies of hemi-acetal.

The study of different catalysts soon led to the use of promoters in oxide catalysts and to mixed oxides. A copper-chromite catalyst was one of Dr. Adkins' chief contributions and with it he was able to hydrogenate esters to alcohols. He always retained a special interest in this catalyst and one of his last papers was concerned with its structure and catalytic

mechanism. Adkins next took up metallic catalysts and made a great deal of use of the Raney nickel catalyst.

In extending this hydrogenation to many compounds, Adkins saw the need for going to higher and higher pressures and much of his experimental ingenuity was devoted to designing practical equipment with thick walled bombs for carrying out this work. He devoted most all of his attention to reactions in which the catalyst was suspended in the liquid phase and the hydrogen under very high pressure was dissolved in the liquid.

After developing the techniques for hydrogenation of unsaturated compounds in which hydrogen is added to a double bond, the next step was to extend the work to more general reactions in which hydrogen reacted on a catalytic surface with a given molecule to split off two new molecules. Adkins gave the name hydrogenolysis to these reactions. He then extended the reactions of hydrogen to an ever widening group of organic compounds, such as nitrogen compounds and ring structures.

In 1937 Dr. Adkins brought all of his work on hydrogenation together in his most important single contribution, the book "Reactions of Hydrogen with Organic Compounds over Copper-Chromium Oxide and Nickel Catalysts." This proved to be a best seller for the newly created University of Wisconsin Press. As evidence of its popularity an order for thirty copies soon came from the Japanese Government. Of his book, Adkins writes in the preface "The present volume is an attempt to correlate and summarize, and indicate the significance of experimental results in the Wisconsin laboratory in the development of high pressure hydrogenation as a tool for use in synthetic organic chemistry.

"I believe that we have considerably extended knowledge with respect to the relationship of the structure of organic compounds to their behavior with hydrogen, and that we have made some progress in the development of methods for selective or preferential hydrogenation and hydrogenolysis. I hope we have described useful and practical apparatus for the reaction of

hydrogen at higher temperatures and pressures. All the observed facts are in harmony with the conception that the catalyst in hydrogenation combines with both the hydrogen acceptor and with hydrogen and each is activated and held in such a position with respect to the other that reaction may ensue."

A later summary of hydrogenation and hydrogenolysis was collected by Adkins and Shriner in Gilman's 2nd edition of "Organic Chemistry" in 1943. In this chapter, new techniques and equipment are described and special instructions given for making catalysts, building high pressure equipment and selecting suitable solvents. Many pages of hydrogen reactions are given with yields to be expected under a variety of conditions.

At the time of his death, Professor Adkins was working on an extensive revision of his book.

Homer Adkins has given to chemistry another classic contribution which brings together a wide range of phenomena. In 1932 he published a paper on the "Comparison of Chemical Reactivity" and in 1938 and 1943 he wrote a chapter in Gilman's "Organic Chemistry" on the same subject. In these writings he clearly distinguishes between equilibrium and reaction rate and points out that different workers have used widely different criteria for comparing chemical reactivity of different chemical compounds and that it is necessary to specify what experimental method is being used as a reference frame. The comparison can be made "by measuring (1) the extent of a reversible reaction, (2) the rates under identical conditions if the reaction is free of side reactions, (3) the severity of conditions (such as temperature) which are necessary to induce a given type of reaction to occur, (4) the relative rates of competitive reactions as measured by the ratio of the products."

From 1940 to 1946 Homer Adkins' research activities were largely taken up with many problems of chemical warfare, as listed later in this biography.

After the war, Professor Adkins returned to his former researches on catalyst behavior and hydrogenation and made a logical extension to carbon monoxide under pressure instead of hydrogen. With these techniques, he was able to convert

alcohols into acids with one additional carbon atom and thus accomplish carbonylation on a practical basis. In his last research, he was interested in working out the best conditions for carrying out the reactions in standard laboratory equipment and determining the identity of the product formed, the nature of the alcohols that can be carbonylated and the effect of structure.

As is the case with most leaders of active academic research, Homer Adkins was influenced by new developments and by the scientific work of his friends. Although his chief effort was directed along his major research, he undertook, nevertheless, several unrelated projects such as the nitration of organic compounds with nitrogen pentoxide, the synthesis of derivatives of ergosterol and cholesterol to be tested for vitamin D potency, and the synthesis of a material which might be related to penicillin. He was quick to appreciate and use new techniques such as oxidation potentials, and the dropping mercury electrode for determining the concentration of organic compounds and calculating equilibrium constants.

Summarizing, Homer Adkins made outstanding contributions to organic chemistry in at least six special fields.

(1) Throughout his whole research program, he sought to predict equilibrium conditions from molecular structure and he distinguished clearly between equilibria and rates of the competing reactions which are striving to reach equilibrium. This work was concerned chiefly with esters, alcohols and acetals, and, to a lesser extent, with unsaturated compounds and nitrogen containing compounds.

(2) Adkins is best known for his catalytic hydrogenation and hydrogenolysis. His studies have given us practical methods of preparation of many types of compounds hitherto obtainable only with great difficulty. These studies have led not only to successful laboratory methods but in addition have proved to be of considerable industrial significance. As examples may be cited the hydrogenation of pyridine and its derivatives and of furfural. Probably the most significant contribution in this field was the catalytic hydrogenation of esters to give primary alcohols over a copper-chromium oxide catalyst. This

procedure has found wide industrial application in the preparation of the higher alcohols from the naturally occurring esters of the fatty acids, as for example in the vegetable oils. The availability of these higher alcohols from this hydrogenation process has made possible the development of the important group of detergents known as the sodium alkyl sulfates.

(3) Adkins' experimental techniques have been made available for making catalysts and for using them for hydrogenation under high pressures in special bombs. They are used widely by chemists all over the world.

(4) The studies on hydrogenation over metal catalysts led naturally to the development of methods by which organic compounds can be dehydrogenated by the same catalysts in the presence of certain hydrogen acceptors such as benzene. This dehydrogenation process marked quite a step forward in the preparation of certain organic compounds by the removal of hydrogen from cheaper raw materials.

(5) In hundreds of reactions, Homer Adkins determined and recorded equilibrium constants or oxidation potentials, thus providing data which can be used in present and future attempts to predict chemical reactivity from molecular structure.

(6) An expansion after the war of the high pressure catalytic techniques led to the addition of carbon monoxide to alcohols in order to convert them into acids.

It is safe to predict that if his career had not been ended prematurely, he would have extended his techniques and his background of research to valuable new methods of synthesis and to a still wider understanding of organic chemical reactions.

A LIST OF THE INVESTIGATIONS AND REPORTS BY HOMER ADKINS UNDER CONTRACTS BETWEEN THE OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT AND THE UNIVERSITY OF WISCONSIN

The National Defense Research Committee and the Committee on Medical Research, during the period from 1 October

1940 to 28 February 1946, assigned numerous investigations to be carried out at the University of Wisconsin under a series of contracts, NDCrc-6, OEMsr-78, OEMsr-304 and OEMcmr-567. The problems studied in the laboratories in Madison were as follows:

1. Synthesis of compounds of possible value in chemical warfare as poisons, vesicants, lachrymators, or sternutators.

2. Synthesis and development of methods for the preparation on a large scale of compounds for use in ointments or clothing, for protection against vesicants and toxic agents.

3. Synthesis of compounds for the detection of chemical warfare agents.

4. Synthesis of compounds requested by representatives of the Army or Navy, for purposes not disclosed.

5. Studies on detoxification and decontamination of chemical warfare agents.

6. Evaluation of chloroamides for relative effectiveness against mustard and other vesicants.

7. Determination of thermal, hydrolytic, and storage stability of chloroamides in the pure state, on clothing, and in ointments.

8. Development and application of methods for evaluation of impregnated or coated fabrics protective against mustard and other vesicants.

9. Evaluation of a method for the preparation of hydrogen peroxide.

10. Formulation of protective ointments.

11. Evaluation of the irritancy of various chloroamides when applied to human skin in various ointment formulations.

12. Development of methods for the effective utilization of non-volatile poisons in warfare.

13. Synthesis of potential antimalarial agents and intermediates.

Thirty-eight formal OSRD reports on projects listed above (restricted).

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J.A.C.S. = Journal of the American Chemical Society
J. Chem. Educ. = Journal of Chemical Education
J. Phys. Chem. = Journal of Physical Chemistry

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