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CHEMICAL RESEARCH, ITS VALUE AND INFLUENCE UPON RECOVERY[1]

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Man is a born explorer. The spirit of adventure has existed within him since time began. In studying the history of man we have found him ever trying to extend the frontier line of his abode to find out what is across the river, within the forest or beyond the mountain range. Sometimes this restlessness was through fear; the savage, for instance, in seeking a denser forest or a safer cave. Sometimes this change of abode was to find a soil more fertile or pastures more green; sometimes it was to seek gold and other precious metals; and sometimes it was simply to find out that which he did not know and understand.

[1] Presidential address delivered before the thirteenth annual meeting of the Alabama Academy of Science at Auburn Polytechnic Institute, March 20, 1936.

Now since the entire land surface has been explored and mapped, he has turned to other realms of interest. He is exploring the depths of the sea, giving most interesting descriptions of strange creatures that we never knew existed before. Though dangerous as it may be, the adventurous spirit of man and that burning desire to know things will continue to push him forward until the life within the sea will be as familiar to him as the life upon the land. He is continually building stronger equipment, safer balloons to further explore the infinite space beyond the earth's atmosphere. The desire to know is so great that a feeling of fear does not exist. Instruments have been and are still being constructed that increase a million times the power of the natural eye. With such instruments he is constantly discovering new stars and classifying them in their relationship to the solar system. He can measure distances through space as accurately as he can locate points on the surface of the earth. Of all expeditions ever made the one to the Antarctic region led by Rear Admiral Byrd was one among the greatest. Such could not have been accomplished a half century ago. Every science contributed something toward his success. In transportation he utilized the ship, the tractor, the dogtrain, the airplane to penetrate the ice-covered land and sea and to traverse the floes of ice to reach the pole. In the use of various recording instruments, the radio to communicate with his base, the camera and other inventions of American genius, Rear Admiral Byrd and his group of trained scientists have made a contribution to geography and the other sciences beyond the conception of the imagination. He states in "Skyward," "Exploration has always been a battle between man and the elements." Such is true, and the spirit in which Byrd's contribution was accepted signifies the universal interest in the different sciences.

All these different types of explorers have their place in the scheme of things, but there is another class of explorers that touch our lives in numerous ways. They are the "wonder workers" of the research laboratory. At the present time there are 1,500 or more of these laboratories scattered through the country, not including those of the large universities elaborately equipped. Nor does this number include the many departments of government that are assigned to research and investigation for the advancement of science and government. Such workers, numbering many thousands of men, are not only guiding industries but are establishing new policies and new relationships resulting from new discoveries and new inventions.

Further remarks will be restricted largely to efforts and influences of the research chemists.

Scanning the sky of depression, business sees a ray of light in the achievements of chemistry which may bring a new era of prosperity. The late Dr. A. D. Little, consulting chemist of Cambridge, Mass., puts it this way: "We may look with confidence to chemical industries for contributions which should go far toward supplying the stimulus essential to revival of our prosperity."

It is a well-known fact that advances in chemistry react on every industry, while, conversely, every progressive trend in other industries makes new demands on chemistry.

The approach to the Hall of Science at the Century of Progress was so arranged as to present to the visitor some of the concepts of the phenomenal development of chemistry as a symbol of the contribution of science to the human race. By means of the strikingly beautiful murals there were depicted the growth and the development of chemistry and its applications to industry, commerce and medicine. It is the natural tendency for the individual scientist to believe that the particular branch of science in which his interest lies is of basic importance in its contribution to human knowledge and thereby to human progress. The chemist, however, can claim with some justice that in his field—chemistry—all the sciences find there common meeting ground.

There is probably no other of the sciences which touches our lives as we live them to-day in as many ways as does chemistry. The chemist has done his part to make our lives longer and more pleasant.

Since the industrial revolution science has been the handmaid of industry, making possible the large-scale production of modern times. Scientific research has been stimulated by large industries, and vast expenditures have been made on laboratory equipment for the purpose of increasing production. Every scientific advancement means more efficient production of commodities and greater profit for business. Since the world war, scientific research has been accelerated, and the amazing results of our modern industrial technicians have created a technological revolution. The highest efficiency in machine production has been achieved, and the aims of industrial science are to conserve energy, eliminate waste and utilize all the by-products of industry for the purpose of achieving the maximum production at the minimum of cost. Big business has encouraged inventions, and through large-scale production has brought to the masses comforts and luxuries beyond their dreams.

To fulfil the requirements of the various industries for chemical aid in the development of their special interests the necessity for chemical control has so increased that these various fields have virtually become specialized departments of applied chemistry, with the chemist and his process in full control. This has meant that the fields of chemistry have become more extensive, that they have been developed to a greater depth in order to solve the numerous new problems which call for hosts of new materials with specifically designated properties increasing more and more in rigid specifications. This has resulted in chemistry building up the materials for the various industries resulting in the development of the new chemical industry, which is becoming larger and larger and assuming more and more importance in the development and advance of our civilization.

In the industries to-day the development of chemical operations has reached the point where none of our factories can operate without chemicals; as in the case of agriculture, which is dependent upon fertilizers and insecticides; and the textile industry, which requires bleaching materials and dyes. These examples could be greatly extended, to say nothing of transportation, communication—the telephone, telegraph and radio—medicine, the electrochemical industry, and even the arts—all must have their essential chemical supplies.

The biochemist, with the discovery of the several vitamins, has brought strongly to our attention the need of certain varieties of food. He also has shown the need of a variety of proteins. The industrial chemist working with the engineer has made it possible to preserve all kinds of food in all seasons. The common refrigerants—ice, ammonia and sulfur dioxide—are being replaced by solid carbon dioxide commonly known as dry ice. This refrigerant is being used extensively in keeping vegetables and fruits cool and fresh while in transit from California to the East. Space in cars is conserved and time is greatly reduced. No one knows better than the ice dealer himself what the possibilities are in the extensive use of this almost new refrigerant. We have comfortable homes in winter. We are to have comfortable homes in summer. Air conditioning is in its infancy, but expanding rapidly. Air conditioning and refrigeration in general require the use of a chemical under pressure in the apparatus to produce low temperature. The danger of accident from the escape of ammonia makes its use unsatisfactory for the refrigeration of buildings. Therefore, the product—di-chlor-di-fluoro-methane—developed some time ago by Thomas Midgley, seems to meet all the requirements of safety and service in this new field. There are other refrigerants that give promise as well. The specifications of all future office buildings and no doubt many homes will include air conditioning as well as heating and plumbing. In your car there is room for your baggage and radio; space will be found for a refrigeration unit. The railroads are competing with one another in adopting this new condition, using dry ice. There is a big concern in Illinois that has more than doubled the force in air-conditioning trucks for the handling of fruits, vegetables and milk for the market.

The improvements and economics in flour milling and blending, in bread and cracker manufacture, in the making of butter substitutes, in the keeping up of quality of our food generally, can be attributed largely to the work of the chemist.

In order to grow plants for food, food for plants must be present in the soil. As the soil is cropped from year to year it becomes exhausted of its plant food and we may say it must be fertilized. This fertilizing was done originally by the use of barn-yard manure and other animal waste, but since the supply of these materials was very limited, not over 25 years ago prominent students were predicting that within a generation or so the people of the world would begin to starve because of soil exhaustion. This worry was over the supply of nitrogen, the principal source of which was from the beds of sodium nitrate in the desert of Chili. But to-day the agriculturalist knows his soil and fertilizers as well as the baker knows his flour and his baking powder. The chemist, realizing the situation, turned to experimental work for the recovery of nitrogen from the atmosphere. There are several processes in the fixation of nitrogen, differing only in degree. All methods use high pressures, high temperatures and a catalyst. Success has been beyond expectations of the industry, and the synthetic product has now largely replaced the natural product. The chemist has not only given to industry and the world an inexhaustible supply of this essential plant food—nitrogen—but in so doing has almost bankrupted the country that held a monopoly of the product that contained this element. Nitrogen recovered as ammonia is being used largely to-day as a raw material for other products. Nitric acid so produced is used in the manufacture of dyes, nitro-cellulose products, explosives, plastics, lacquers, celluloids, urea ammonia solutions and other fertilizing materials.

The research department of du Pont has not by any means been idle during the depression. Backed by du Pont's millions these "wonder-workers" have introduced many new products. In the synthetic resin group alone some products are predicted to become as serviceable and profitable as Cellophane. "Dulux," a paint, has already attained a very prominent position in the finishing field. This product is destined to rival "duco," a lacquer in the auto industry. "Gordinola" is expected to revolutionize the soap industry.

Rayon was at one time referred to as artificial silk, but chemically it is the same as cotton. Cotton or cleaned wood-pulp is treated with the proper reagents to produce a jelly-like mass. This jelly is pressed through tiny holes into solutions which cause it to set. Each little stream of jelly produces a fiber of rayon; these fibers after being cured and washed can be dyed, spun and woven into cloth of great beauty. The demand and production are certainly increasing and the quality is being steadily improved. So we may look for more and better silky fabrics.

Our attention should be drawn to the improvement made in dyes. At one time the United States was almost entirely dependent on Germany for its dye supply. During the world war this supply was cut off and we were stimulated to make our own. Now we are independent of the rest of the world and, besides the old standard colors, many new ones have been produced, as is evidenced by the dyed fabrics now being used. Not even the rainbow or the sunset can rival the artificial colors in richness and in variety.

While the dye chemist has been improving the number and quality of his products, the rubber chemist has been very busy. By research and experiment he has learned how to make tires and tubes and rubber goods which wear several times as long as similar articles did a few years ago. This has come through improved methods of curing the rubber latex, of vulcanizing and applying the rubber. Much progress has been made in preventing the deterioration with age by the addition of so-called anti-oxidants. Mr. J. D. Tew, president of one of the largest rubber companies in the country, told the National Research Council only recently that his company was producing several thousand distinct products. Similar work is being done by other companies. Many of these products were produced intentionally, yet many came into existence by accident, and an example of the latter—rubber under certain conditions—would adhere tenaciously to metal surfaces. Investigation of this phenomenon resulted in the Goodrich Vulcalock process, by which rubber is bound to a variety of materials such as steel, glass, concrete and other surfaces. Commercially speaking, we now have pipe lines, vats, evaporators and other equipment used in process work, lined with rubber. There are now several hundred railroad tank cars in service lined with rubber, handling materials of a corrosive action safely and satisfactorily. It was the rubber chemist who came to the rescue of the commercial airplane service, thereby permitting service in all kinds of low temperature weather. The rubber de-icer for airplanes makes it possible by means of compressed air to inflate and deflate rubber sheathing on certain parts of the wings, thus breaking the ice as it forms, permitting it to fall to the earth.

Big business utilizes science to create numerous by-products from raw and finished materials and from waste products, and in this way fortifies itself against the possible exhaustion of any basic raw material which would endanger modern industry. Although American crude oil is now so cheap as to be causing acute economic distress in several oil fields, the supply is not inexhaustible, and chemists are already prepared to make gasoline and lubricating oil out of coal. Much has been said about low temperature carbonization of coal and the greatly increased recovery of oil and tar during the past decade, but there is not much encouragement for the coal operator in this country for two reasons—he is reluctant to admit that coal is a raw material and not a finished product, but the most important reason is there exists to-day in this country an abundance of cheap natural gas, cheap artificial gas, cheap fuel oil and cheap electricity so that low temperature processing is not economical. Yet the research chemist has done his part and, when economic conditions justify, the process will become active.

The mention of motor fuel from coal should remind us of the improvements made in gasoline as well as economies in its production. Much of the crude petroleum as it comes from the wells contains perhaps 20 per cent. of light hydrocarbon which might be classed as gasoline. Yet by process of cracking it is not unusual to produce upward of 70 per cent. of gasoline from the crude oil. The less valuable oils are broken down into lighter ones which are commonly considered gasoline. This makes for a much more efficient utilization of this great natural resource.

In the field of electricity, the problem of using the vast energy of the sun for human purposes is nearing a solution. Dr. Bruno Lange, of the Wilhelm Institute, has recently perfected a device which converts sunlight into electric current more completely than ever before, at a price which may compete with the present hydroelectric installations. This remarkable achievement of modern science also partly solves the problem of the exhaustion of the earth's coal supply, and will give us access to more power than ever before. An expansion of human engineering activities to a new scale, similar to what happened after the invention of the steam engine, is foreshadowed by this latest development in photo-electricity. Talking pictures, television and automatic controlled devices in every branch of technology will be the first no doubt to benefit by the new light-sensitive cell.

The light-sensitive vacuum tubes, containing potassium or caesium, which have played a fundamental part in recent developments, will probably be replaced in most of their uses by the cheaper and simpler Lange device.

In addition to producing energy out of the sun's radiation, these photo-cells will be utilized in many ways. The sensitivity of these cells is nearly the same as that of the human eye and the cells are peculiarly sensitive to color differences and have a sufficiently large output of energy to be used for many purposes without amplification. Microscopes for metallurgical purposes have been built, the ocular of the microscope being replaced by these cells. In transmitting phonograph records infra-rays have been used instead of the usual disks. All sorts of signaling methods, through dense fog, are made possible to signal ships in fogs. It will enable aviators to determine the sun's position while flying through clouds.

Getting a scarce product from a different source is one thing, improving the product or making an entirely new one is another, and these doers of the impossible are versatile.

Take glass, for instance. The very first characteristic of glass that occurs to you is its fragility. It has to be handled with care, but in a research laboratory recently a man tossed a glass lens into the air and let it fall on a concrete floor. Repeatedly the lens fell from a height of ten feet without even chipping. This lens was not fabricated of thin laminated sections like an automobile windshield; nor was it reinforced by wires or any other mechanical aids; it was a solid piece of clear optical glass—tough glass that can be broken if you insist on it, but your blow must be many times as great as that required to break a similar lens of ordinary glass.

The chemists make this tough glass by violating a long-established rule of factory practice. The prevailing idea is that after a piece of glass is poured or cast, it must be cooled slowly, but tough glass gets no such consideration. It is plunged from a heat of 1,500 degrees or more into a bath of oil at 400 degrees, and by that sudden change of temperature the toughness is imparted. The exterior layer solidifies before the interior does, and in the slow contraction of the interior tensions are set up which oppose and counterbalance exterior blows.

Glass suggests building materials—for glass brick and glass paneling and glass columns are now on the market, and houses with a wall or a roof of glass have recently been constructed. The chemists have added to glass the ability to filter the solar heat rays and transmit only the rays of light, so a glass house may be cool, and it may be proof against the stone-thrower too, for toughness is not confined to optical glass.

Also just out of the laboratory are artificial stones and artificial woods made of waste; stainless metals made of new alloys, synthetic resins made of new chemical combinations. A typical example of the last named, and also of modern synthetic chemistry, is vinylite, developed at the Mellon Institute in Pittsburgh.

Visitors to the Century of Progress Exposition will remember the three-room apartment fashioned entirely of this new stuff out of a test-tube—the floors of vinylite tiles, the walls of vinylite panels, the baseboards, mouldings, sills, ceilings, all of the same; each door a single piece of vinylite, cast and pressed into shape; even the windows a translucent vinylite. Whole tables, desks, chairs, chests and other articles may be had in one piece.

About fifty years ago young Hall, in a woodshed and with a hand-made makeshift for a furnace, after many experiments and seeming failures finally obtained metallic aluminum from clay. Compare his workshop with the acres of buildings at Alcoa, Tenn., filled with all kinds of furnaces, heavy machinery and rolling mills turning out all kinds of aluminum products from cooking utensils to massive equipments; yes, out of this white, light metal—a competitor of steel in its variety of applications exists.

It is a long story from the trunk of a tree rolling down an incline to the modern ball-bearing, accurately balanced wheel of the automobile, or the steam turbine speeding at the rate of 3,600 or more r.p.m., yet the radical changes in the application of aluminum and different stages in the development of the automobile were made during the last few decades. In every instance you will find the research man just one step ahead of every change of any importance.

And those swift streamlined passenger trains—they can be credited to the chemist's crucible quite as much as to the mechanical engineer's slide rule, for there is hardly a material in the new trains that did not come out of recent research. Even locomotive parts are being made of light-weight alloys. One train of three cars weighs no more than a single pullman car of all-steel construction.

Before finishing, we ought to be reminded of the progress made by the biochemist in the field of medicine. We know of the vitamins and their importance to health. We have heard of insulin, discovered at the University of Toronto, which brings hope and comfort to the patient suffering from diabetes. We know that typhoid fever and many other contagious diseases are completely under control from the constructive work on the part of the individual and group of individuals in medical science. It will be only a short while before cancer and heart failure will be similarly controlled.

In the field of antiseptics much has been accomplished. Dakin's solution, a new tried solution of sodium hypochlorite, did wonderful service during the war in preventing gangrene and is still used in hospitals. Even more useful is choramine T, a close relative but more stable and less irritating. Very important and interesting is hexyl-resorcinol, which is 50 times as powerful as carbolic acid and yet can be taken by mouth. It disinfects the blood stream and especially the kidneys and renders the urine sterile.

Besides antiseptics have come new anesthetics, and in addition to cocaine for local anesthesis, we now have procaine, apolthesine, butyn and others for special purposes which are less toxic, cheaper and are not habit-forming. The chemist has learned to associate certain structures in the molecule with specific effect, so can make a drug with almost any given desired effect.

Of very great interest and importance is the study of the secretions of the so-called ductless glands. For the relief of those who have asthma, or heart failure, we now have adrenalin. It not only is of use as mentioned, but stops bleeding locally where injected, by causing a contraction of the blood vessels. This substance has been synthesized and its structure is understood so that it can be prepared pure and of definite strength. Another product rather recently discovered is thyroxin, a substance present in the thyroid glands, connected in its effect with growth and metabolism control. Studies bringing much information about the pituitary and other glands and the so-called hormones connected with them have been very fruitful, and medicine is profiting greatly therefrom.

We might go on in other fields, and at every turn we should find the chemist doing his part in the preparation, purification, protection or improvement of practically everything with which we come in contact. There is no science which has more to do with our lives and habits of living than the science of chemistry.

In conclusion permit me to say that I have refrained from discussing more recent discoveries and the many new products of the research laboratory for the reason that the true commercial value of them has not yet been determined. "Luxuries of to-day become necessities of to-morrow." Many, many products are often developed and their value proven conclusively, yet months and sometimes years elapse before any very great activity occurs putting said products on the market. The research man, though seemingly slow, is ever seeking after truth—truth as expressed in the laws of nature.

Dr. Carver, the Negro scientist of Tuskegee, summarized well the work of the research chemist when he said of his own work, "I simply try to think the thoughts of the Almighty after Him. Humbly I try to utilize some of the many things He has placed here for our benefit."

Yes, 'tis true, these "wonder workers" are ever striving, pushing forward, to know and understand more fully the laws that govern and control the universe, thereby creating opportunities so that they and others may render greater service to humanity.

OBITUARY

JOSEPH N. HARPER

Dr. Joseph N. Harper, widely known in connection with soil fertility interests in the South, died at his home in Atlanta, Georgia, on July 1.

He was born on March 11, 1874. He began his advisory career with his appointment in 1898 as agronomist to the Kentucky Experiment Station, where he made notable contributions on the culture of tobacco, wheat and hemp.

In 1905 he was called to head the Department of Agriculture of Clemson College, South Carolina, and to direct the activities of the South Carolina Experiment Station. These positions he held for eleven years, and under his direction the Research Department of Clemson College became recognized as a leading experiment station dealing with problems of soil fertility and plant diseases.

Dr. Harper, in 1917, was chosen to direct the extensive work of the Soil Improvement Committee of the Southern Fertilizer Association. His sound scientific knowledge and practical judgment won for him, in his travels all over the South, the respect of all concerned with the maintenance and building up of soil fertility.

With the formation of N. V. Potash Export My., Inc., Dr. Harper became a director of this company's agricultural and scientific bureau, in charge of the southern territory, which position he held until the formation of the American Potash Institute in July, 1935. For the institute he was manager of the southern territory.

Dr. Harper held memberships in many scientific societies and had held every office in the Association of Agricultural Workers, which is composed of the leading agriculturists of the South. It has been said of him that his success was due not only to his scientific knowledge, but to his practical knowledge of farming, and that when he talked to farmers he had his own experience of a lifetime of farming from which to draw upon.

R. H. S.

RECENT DEATHS AND MEMORIALS

Dr. Franklin Davis Barker, professor of zoology and head of the department at Northwestern University, died on July 10 at the age of fifty-eight years.

Professor Jesse Earl Hyde, head of the department of geology of Western Reserve University and curator of geology and paleontology in the Cleveland Museum of Natural History, died on July 3 at the age of fifty-two years.

Dr. Percy G. Stiles, since 1916 assistant professor of physiology at the Harvard Medical School, died on July 5 at the age of sixty-one years.

William Tyler Olcott, lecturer and writer on astronomy, since 1911 secretary of the American Association of Variable Star Observers, died on July 6. He was sixty-three years old.

Otto Paul Amend, of New York City, who retired in 1934 as president of Eimer and Amend, manufacturing druggists, died on July 4 at the age of seventy-seven years.

William G. Marquette, Jr., a graduate student of Columbia University, who had been working this summer at the Marine Biological Laboratory at Woods Hole, has died by suicide at the age of twenty-two years.

William Ernest Dalby, emeritus professor of engineering in the University of London, died on June 25 at the age of seventy-two years. He was an authority on the steam engine and in particular on the balancing of engines.

Henri Leon Ungemach, the Alsatian mineralogist, died on June 11 at the age of fifty-seven years.

The death is announced of Dr. Guglielmo Romiti, professor emeritus of anatomy at the University of Pisa.

The Chicago Ophthalmological Society is establishing the William Hamlin Wilder Foundation Memorial in memory of the late Dr. W. H. Wilder, professor of ophthalmology at Rush Medical College. A fund of