DOWNLOAD PDF AMERICAN SYNTHETIC RUBBER RESEARCH PROGRAM

Chapter 1 : The American Synthetic Rubber Research Program | Peter J. T. Morris, Arnold Thackray

"A very readable account of the wartime project This well-researched and referenced book covers the technology of the development, which has its own fascination.

Kolthoff - Inductee - Professor Emeritus Izaak Maurits Kolthoff was a world renowned analytical chemist, widely regarded as the father of modern analytical chemistry. He was the chief force in developing analytical chemistry as a modern science, as reflected by nearly 1, scientific papers he has published, scores of textbooks he has authored, and a 30 - volume treatise on analytical chemistry. It was the originality, insight, and timeliness rather than the mere bulk of these publications that created an international reputation for Kolthoff. The significance his prodigious output of research papers, textbooks and reference books can be summarized by quoting J.. During his first chemistry course in high school he developed a keen interest in the subject. Later, his mother, making chicken soup for a special dinner, had mistakenly added sodium carbonate baking soda instead of sodium chloride table salt. She was ready to give up when Kolthoff, then 15, volunteered to help. He added hydrochloric acid to the soup, bringing up its pH factor until a strip of blue litmus paper turned pink. The soup was fine, he recalls. At age 21, Kolthoff published his first paper on the then-novel concept of pH expressing acidity or alkalinity - 7 is neutral, lower values are more acid and higher values more alkaline. In he was offered a one-year appointment as a professor and chief of the Analytical Division of the School of Chemistry of the University of Minnesota. His one year appointment became permanent and he remained at Minnesota until his nominal retirement in despite attempts by other institutions including his alma mater, the University of Utrecht to attract him. His work that most directly affected the general public was in the American Synthetic Rubber Research Program. It was the foremost chemical engineering project during World War II, and created a huge synthetic rubber industry in an unbelievably short period of time. Kolthoff, whose family was devastated during Nazi occupation of the Netherlands, quickly assembled a large research group and made major contributions to the program. He and his coworkers hold several key patents related to synthetic rubber. Nearly , tons of synthetic rubber were produced in and by the production rate was at , tons. Over the years the quality of synthetic rubber and the method of constructing tires were both improved, so today we have tires that will run for 60, to 80, miles compared to tires made exclusively of natural rubber that lasted only 10, miles. These biographies have been compiled from information accompanying the nomination form submitted to the Minnesota Inventors Hall of Fame, information available on the Internet and from a variety of other sources. Site designed and maintained by Matt Tonak.

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Chapter 2 : Sharing With Standard

This history of the government-funded synthetic rubber research program (6) offers a rare analysis of a cooperative research program geared to the improvement of existing products and the creation of new ones.

Many of the things we use everyday would not be possible without synthetic rubber. So how did that technology come to the United States? No, it was not industrial espionage, it was through long talks and agreements between a few key people in two big companies, Standard Oil of New Jersey, and I. Just before the first World War, Dr. Friedrich Bergius invented a process to convert the brown coal directly into oil, which he humbly named the Bergius Process. It was a great idea, but there were many practical difficulties which made it impossible to operate on an industrial scale. One of the stops on the trip is to the New Jersey oil refineries of the Standard Oil company,the largest in the country. Howard Once there, Howard finds an enormous industrial research department working on some new catalysts. These catalysts are used in the Bergius Process to convert coal into oil, but these catalysts are so good, that the oil can then be converted entirely into any number of useful products: Even the lowest quality oils and tars can be converted completely into high quality gasoline. This is the beginning of "cracking," the basis for all future oil refining. This is a great accomplishment. In the past, gasoline was distilled from crude oil, and it took four barrels of crude oil to make one barrel of gasoline. Also, most countries in the world did not have oil and have to buy it from other countries, but most countries have coal. Being impressed by these accomplishments, Standard wants a piece of the action. Since BASF has all this great technology and is not able to make it work on an industrial scale, Standard offers financial help in developing and perfecting the process. Although they are interested, BASF cannot agree because they, and six other companies, have recently become part of the German industrial conglomerate, I. Farben , and the entire group has to decide on any and all such business. In the summer of , Dr. Carl Bosch, chairman of I. Bosch has a good impression of the size of the American oil industry, as well as the vast potential strength of America. He agrees that a partnership between Standard and I. Farben would be beneficial to both groups. In a agreement, Standard agrees to cooperate technically in the development of the Bergius Process in the United States and to build and operate a plant with the capacity to produce 40, tons of hydrogenated oil products per year. If Standard makes any new developments, they will keep the patents and licensing and I. Farben will receive half of the royalties. Standard still wants more and "buys" the rights to the Bergius Process for the entire world outside of Germany for the low, low price of , shares of Standard stock. This works well until the start of World War II when both the American and German governments frown on the two companies working together. After all their work, Standard does not want to loose all the time and money they put into getting Buna rubber ready for market, and I. Farben does not want to just give it away. Farben gets the rest of the world. So, through a long series of patent trades and friendly agreements, which are greatly simplified here, the rights to German synthetic rubber technology comes to rest in the hands of the Standard Oil NJ Company. Not nearly as exciting as industrial espionage, but important to history. Soon, however, the Japanese will invade the Southeast Asian rubber plantations and the American government will say that the technology belonged to the people. Germany - The Birth of Buna Meanwhile In , the famous American comedy duo, Laurel and Hardy, makes their first film, Putting Pants on Philip, which is released in Also in , Robert H. Goddard and coworkers build and fly the first liquid-propellant rocket. Herbert, Vernon and Attilio Bisio. A Project That Had to Succeed. The Birth of an Industry, D. The First Fifty Years.

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Chapter 3 : Government Rubber

The American Synthetic Rubber Research Program Book Description: This history of the government-funded synthetic rubber research program (6) offers a rare analysis of a cooperative research program geared to the improvement of existing products and the creation of new ones.

Speed Marvel sounds like the hero of a summer big-screen blockbusterâ€”a melding of Speed Racer and the Marvel comic book universe. And instead of spandex, the primary stretchable material that he worked with was rubber. He also happened to be one of the most influential and colorful researchers in the more than year history of the University of Illinois Department of Chemistry. Recognized as a father of synthetic polymer chemistry, Marvel was a key figure in one of the most ambitious, but least-remembered, government projects of the 20th centuryâ€”the Synthetic Rubber Research Program. This heroic project, which involved the government, industry, and 11 universities, aimed to create enough synthetic rubber during World War II to compensate for the natural rubber supply that had been choked off by the Japanese. But the synthetic rubber, in most cases, was not as good. So something drastic had to be done, because the fate of the war effort could literally turn on something as basic as rubber tires. Enter Speed Marvel, a home-grown Illinois boy, born in on a farm three miles south of Waynesville. Polymers include all kinds of materials, such as plastics, neoprene, and rubber. This made it natural for Marvel to step in as one of the key leaders in the Synthetic Rubber Research Program, which began in and lasted until Chambers was not officially involved with the rubber program, but Marvel sometimes asked him to work on the project. He recalls the long hours, working 8 a. This was seven times as much synthetic rubber as the Germans produced during their peak year of For instance, the U of I team solved a major snag with the original process of polymerizing GR-S rubber; they discovered that polyunsaturated fatty acids interfered with the polymerization process. After World War II, Marvel went on a technical intelligence mission to Germany, where the team uncovered secrets that eventually led to a cold rubber process, which produced a superior rubber. The result was polybenzimadazoles PBI , a vital material in the aerospace industry. Marvel retired from the U of I in , but he essentially had a second career at the University of Arizona, where Marvel Hall now stands in his honor. Speed Marvel, who passed away in , was larger than life in both his personality and physical stature. At one point, he carried over pounds on a frame slightly over six feet tall. He was also something of an artist. So Marvel was an artist. At the bell concluding the class, he stopped talking and writing in mid-sentence, and walked out of the classroom. The tales of his birding expertise are absolutely true. I was also very interested in the photo of Professor Marvel:

Chapter 4 : Minnesota Inventors Hall of Fame - Izaak M. Kolthoff - Inductee

The peroxide effect[edit] In , a Russian chemist named Vladimir Markovnikov demonstrated that the addition of HBr to alkenes usually but not always resulted in a specific orientation. Kharasch, in his seminal paper entitled "The Addition of Hydrogen Bromide to Allyl Bromide", proposed that the anti-Markovnikov addition of HBr to allyl bromide to yield 1,3-dibromopropane was due to the presence of peroxides. He termed this the "peroxide effect", which he proposed proceeds through a free radical chain reaction addition. They instead argued that the direction in which the reaction proceeds is determined not by the presence or absence of peroxides, but by the nature of the solvent in which the reaction is taking place. In this paper, Kharasch analyzed one at a time the effects of temperature, solvent, and light on the direction in which the reaction proceeded. He concluded that the presence of peroxides was the driving force for anti-Markovnikov addition and that any changes in temperature , solvent, or light affected the orientation of addition only through the chemistry of the peroxides. Once Kharasch began determining the dibromopropane compositions of the products under various conditions, he made a startling discovery. In contrast, when the reaction was run in the presence of air or oxygen, it lasted a markedly shorter time with great variation , in one case only taking one hour to reach completion. Since the only apparent variable that had changed was the presence of oxygen other gases found in air were tested individually and did not show the same effect , Kharasch hypothesized that the rapid anti-Markovnikov addition of HBr to allyl bromide was the result of trace amounts of peroxide in the reaction mixture that could have resulted from the interaction of molecular oxygen in its diradical triplet state and allyl bromide to form allyl bromide peroxide. Even trace amounts of this allyl bromide peroxide radical would then be sufficient to begin a chain reaction whereby a hydrogen atom would be abstracted from the HBr, leaving a Br radical. This Br radical would then combine with an electron from the double bond of allyl bromide at the less-highly substituted carbon, giving the more stable 2o radical. Reaction of this radical with another HBr molecule would cause the abstraction of another H atom and would complete the anti-Markovnikov addition. Because he had no means of isolating the proposed allyl bromide peroxide, he performed an adapted version of the thiocyanate test, an analytical test that is often employed to check shelf-stored reagents for their peroxide content. The job of an antioxidant is to act as a radical scavenger, either accepting or donating an electron to a radical species. The is that[clarification needed] the radical becomes effectively neutralized , while the antioxidant itself becomes a radical. Antioxidants, however, are much less reactive radicals as they are usually rather large and resonance stabilized aromatic compounds, and therefore prevent undesired oxidations from occurring. The addition of antioxidants in the reaction mixture in this experiment would effectively quench the peroxide radicals, and therefore the reaction would then proceed to form mainly the 1,2 â€”dibromopropane product, as was observed. Although an increase in temperature at first glance seemed to direct the orientation of the addition to the anti-Markovnikov product, Kharasch explained that this temperature effect must be viewed as secondary to the peroxide effect, exemplified by the fact that the addition of antioxidants at elevated temperatures can produce a high 1,2- dibromopropane yield. He chose solvents with a wide range of dielectric constants i. In the presence of air, the solvents with a high dielectric constant tended to form the 1,2- product while the solvents with low dielectric constant tended to form the 1,3- product. However, these results could also be viewed in accord with the peroxide effect theory; many of the solvents with high dielectric constants were able to act as antioxidants themselves, therefore quenching any radical formation and promoting the 1,2- addition whereas the solvents of low dielectric constant often had little or no antioxidant ability and so the 1,3- addition proceeded uninhibited. Kharasch concluded that the solvent may contribute to the orientation of addition if it 1. Kharasch went on further to show that when both the temperature and the solvent were varied together, they still acted independently of one another, in the manners described above. Kharasch also showed that strong illumination at a variety of wavelengths favored the 1,3- addition, but in the presence of strong antioxidants the electrophilic addition was favored, exhibiting that this variable too only exerts its effects through affecting the reactivity of the peroxide. From this continued research, industrial polymerization reactions of unsaturated hydrocarbons were discovered and mass production of synthetic rubber and plastics was possible. Through similar radical processes, standard alkanes are halogenated and made substantially more reactive. This allows them to be very useful intermediates in organic syntheses. While standard conditions generally support one orientation of addition, in some cases it may be advantageous to have the halide on the less highly substituted carbon, in the anti-Markovnikov position. In this case a free radical addition step may be the key to obtaining the desired ultimate product, and is possible because of the work of Morris Kharasch.

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Chapter 5 : The American Synthetic Rubber Research Program : Peter J.T. Morris :

The resulting synthetic rubber program was a remarkable scientific and engineering achievement. The partnership of the government, industry, and academe expanded the U.S. synthetic rubber industry from an annual output of tons of general purpose rubber in to an output of 70, tons a month in

President Roosevelt declares rubber to be a "strategic and critical material," something the Germans found out the hard way during the First World War. The president makes this declaration because the German U-boats are blocking Atlantic shipping lanes, and there is a fear that the Japanese will stop shipment from the Asian rubber plantations. In June of , the Rubber Reserve Company, or RRC, is founded to stockpile rubber for the likely chance of being unable to buy rubber. The RRC also has control of the production of the raw materials needed to make synthetic rubbers, the production of the rubber, and the fabrication of products from the rubber. The patents and rights to these processes are given to the RRC through an information sharing agreement between Standard Oil, Goodyear, B. Goodrich, Firestone, and U. This is an historic agreement. It is the first time that this many American companies agreed to share their trade secrets. Along with the major rubber producing companies, 11 university research groups, including Carl "Speed" Marvel at the University of Illinois, Izaak "Piet" Kolthoff at the University of Minnesota, and W. Harkins and Morris Kharasch of the University of Chicago, join the effort to make synthetic rubber work. Their goal, set by the RRC, is to set up four plants which will produce 30, tons each of Buna-S type rubber per year. By the end of , the four plants are up and running, but falling short of their intended goal. By the end of , 15 plants were in operation, and supply finally begins to meet demand. The research focus during the war is on incremental improvement of existing processes. For example, if the rubber is allowed to polymerize till no monomer was left, long, branched molecules are produced, which gel and make the rubber difficult to process. It is also discovered that the polymerizations have an induction period which varied from batch to batch. An induction period is where nothing seems to be happening, then, all of the sudden, the reaction takes off. The researchers at the University of Illinois find that this is due to different fatty acids present in the different soaps needed for the emulsion process. These soaps also cause the solution to foam during the recovery of the remaining monomer. This problem leads to the development of candellia wax and silicone defoamers. The properties of the Buna-S type rubber are highly dependent on the amount of styrene in the rubber. To determine properties, it is important to know how much styrene had been incorporated. Baker of the Bell Telephone Laboratories solved this problem by developing a procedure for determining the amount of styrene using the refractive index of a solution of the rubber. Under the American Synthetic Rubber Research Program, all of the different types of synthetic rubbers get fancy, new code names, all of which start with GR, which stands for government rubber. In , 3, tons of GR-S are produced, and that increases to , tons in In , the year of peak demand, production triples to , tons, and by , production had increased to , tons. Although this might not seem like much, but, at the time, it is a huge success. Some call the American Synthetic Rubber Research Program a failure because more developments could have been made if the companies involved were working in competition. However, others believe that getting these companies to cooperate on such a large project in the midst of a war to produce a vital material was a success in itself. Click here to see the process illustrated in full color! While the American Synthetic Rubber Research Project is getting underway in , some people are not intimately involved with the war effort. Physicist Enrico Fermi and coworkers achieve the first controlled nuclear chain reaction at the University of Chicago. Modern Synthetic Rubbers, 3rd ed. Herbert, Vernon and Attilio Bisio. A Project That Had to Succeed. The Birth of an Industry, D. The University of Pennsylvania Press,

Chapter 6 : Morris S. Kharasch - Wikipedia

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