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ENERGY AND COSMIC RAYS

A BILLION years from now water, air, earth and iron, in the form of hydrogen, oxygen, silicon and iron, will continue to be the chief constituents of the earth, just as they are to-day. The energy used by mankind will continue to come from the sun, or perhaps from another sun that may have been formed when our present one is used up. There is no danger that scientists, in their efforts to "split the atom," may start a world-wide atom-splitting that will result in the complete annihilation of the earth in a burst of energy.

This was the reassuring message brought to the Society of Chemical Industry by Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology, who was awarded the Messel medal of the society in recognition of his work.

But his address also contained a pessimistic note. Energy can be made from the gathering of atoms of hydrogen to form heavier elements, especially helium, oxygen, silicon and iron. Out in the space between the stars this is probably happening. Can not man take the enormous quantities of hydrogen that exist as water in the oceans, and turn them into these elements? Dr. Millikan thinks that this is forever beyond the reach of mankind, for, he said, "the indications of the cosmic rays are that these atom-building processes can take place only under conditions of temperature and pressure existing in interstellar space."

In suggesting this source of energy Dr. Millikan departed from previously held ideas. With the discovery of radium by Madame Curie about thirty years ago, it was found that it and allied elements are constantly disintegrating into simpler elements with the liberation of energy. Many have thought that a similar process was taking place in all the elements, though too slowly to be observed in the small quantities available for laboratory study. On the whole, however, it was thought, it might be great enough to be an important source.

Einstein's discovery that mass must disappear if energy is to appear, combined with the development by F. W. Aston, an English physicist, of the relation between the weight of the atom and the mass of the electron at its center, show that this is not true, said Dr. Millikan. An atom with a weight less than a hundred times that of hydrogen can not disintegrate like radium. As 99 per cent. of the earth consists of elements of lower atomic weight than 100, we do not get much energy from this source. In fact, he said, "the energy available through the disintegration of radioactive or any other atoms may perhaps be sufficient to keep the corner peanut and popcorn man going on a few corners in our larger towns for a long time to come, but that is all."

It is this fact, also, he stated, that shows how unjustified are the fears of the "advocates of a return to the 'glories' of a pre-scientific age who have pictured the diabolical scientist tinkering heedlessly, like the bad small boy, with these enormous stores of sub-atomic energy and some sad day touching off the fuse and blowing our comfortable little globe to smithereens." If man ever does learn to disintegrate atoms, and he probably will, he will have to do it by putting energy into the process.

It is the cosmic rays that he has studied in collaboration with Dr. George H. Cameron, his colleague, that indicate the formation of energy in the building up of atoms out in the space between the stars. In previous addresses Dr. Millikan has made this suggestion, and now he believes that he knows just which atoms it is that are being made. Utilizing the discoveries of Aston and Einstein, he says that he has found that only in the formation of helium, oxygen, silicon and iron out of hydrogen could rays of such penetrating power as he has observed in the cosmic rays be produced. He has worked out also the penetrating power that the rays from the formation of each of these elements should have. In very recent experiments he has found that these rays are not all of the same exceedingly short wave-length. Nor are they uniformly spread over a range of wave-lengths, like light from a white hot poker. Instead, there are four bands in their spectrum, corresponding to four approximate wave-lengths, or four degrees of penetrating power. The most penetrating rays, with the shortest wave-length, are capable of going through 200 feet of water or 18 feet of lead. Other groups of the rays are of less penetrating power, but these different degrees of penetration, observed in the experiments, correspond very closely to those calculated for the rays from the principal elements.

"The agreement," he announced, "is better than our observational uncertainty, and leaves no doubt whatever in our minds that the observed cosmic rays are in fact the birth cries of the infant atoms of helium, oxygen and silicon. We have some little indications that we can also hear the shriller birth-squeaks of infant iron, but we are not as yet ready definitely to assert it."

RESEARCH IN ORGANIC CHEMISTRY

How the chemist broke through the barrier between the mineral kingdom and the vegetable and animal kingdoms a hundred years ago, and how far he is likely to go in the production of artificial compounds in the future was the theme of the opening discourse of the distinguished British chemist, Dr. Jocelyn Field Thorpe, of the Imperial College of Science and Technology, London, at the first session of the American Chemical Society on September 11.

The society met on the centennial of an epoch-making event in the history of science, the synthesis of urea by the German chemist, Friedrich Woehler, of Göttingen University. This achievement dissipated the ancient superstition that some mysterious vital force was essential to the formation of the foods, flavors, perfumes, drugs and dyestuffs which had hitherto been found in plants and animals. But when Woehler, in 1828, succeeded in preparing urea, a waste product of animal life, from ammonium cyanate, a well-known salt, the discovery opened the way to the manufacture of an immense variety of useful compounds during the next century, ranging from such dyes as indigo to such medicines as camphor. The latest chemical dictionary describes the making of some 400,000 compounds of carbon. Some of these are to be found in nature, but most of them were not in existence until they were made in the laboratory by chemists following in the footsteps of Woehler. As to the future, Professor Thorpe says:

"It is pertinent to ask when additions to this already stupendous list are likely to cease. The answer is that it is never likely to cease and can not cease so long as fundamental research work in organic chemistry is being carried on. These compounds are not, as certain of our maligners suggest, prepared for the sake of preparing them but are merely steps incidental to the elucidation of some problem of fundamental importance to the progress of the science. It is absolutely necessary that these should be recorded in order that subsequent workers in the same field may utilize them as sign-posts indicating the direction along the paths already trodden. In no other way can we hope to explore and map the unknown country ahead of us. I have heard it said that organic chemistry is reaching finality, but to those of us who know, the realization that we have only scratched the surface of things is very evident. Many natural substances, such as strychnine, morphine and so forth, still evade the skill of the synthetic chemist. The wonderful researches of Willstaetter, who has enriched every branch of the science he has touched, have indicated the manner in which the coloring matter of flowers and plants may be investigated."

THE UTILIZATION OF AGRICULTURAL WASTES

GETTING money out of straw, cornstalks, grain hulls and other farm wastes is one of the major jobs that modern agriculture has to face, as industry faced and solved the by-products problem a generation or more ago. This is the opinion of Henry G. Knight, of the U. S. Department of Agriculture, set forth before the American Chemical Society at its annual meeting.

The problem is by no means an easy or a simple one, Dr. Knight believes. With a given waste product, like straw, many things are chemically possible, but they may not be economically feasible. Straw may be made into paper, building board, fuel briquets, cattle feed, several different kinds of fertilizers, or it may be simply burned to get it out of the way. Which course should be pursued in any particular part of the country will have to depend largely on economic considerations.

Some large industrial firms are undertaking the solution of their own farm-product problems. A large milk-chocolate concern owns its own dairy farms and sugar plantations. A paper mill in the South, finding a surplus of hydrogen on its hands, has gone heavily into peanut-planting in order to get a supply of oil for hydrogenation. Automobile and tire manufacturers have set out their own rubber plantations. The speaker expressed his doubts, however, of the long-run economic and social benefits of industry going into agriculture on a large scale and changing the status of the farmer from that of an independent landowner to that of a hired worker.

Dr. Knight predicted the possibility of severe upsets in agricultural economy by the development of new industries based on the utilization of waste products. If cornstalks are converted into rayon, which probably would not be of great material aid to the corn farmer in the aggregate, the market for cotton goods is diminished, which is of concern to the cotton farmer. The fungus, *Aspergillus niger*, which makes citric acid out of sugar, works to the advantage of the sugar-beet grower and the sugar planter and to the disadvantage of the grower of lemons. The ruin of the madder and indigo plantations by the development of the synthetic dyestuffs industry is a historical incident that may hold a lesson for to-day.

FLAX WASTE AND CORNSTALKS

CELLULOSE, that all-important raw material of the new industrial development, which means paper, rayon, automobile lacquer, explosives, toilet articles, is reaching into all corners of plant production and gathering up what once was waste. Members of the American Chemical Society, at their Swampscott meeting, considered neglected sources that might yield paying quantities of the valuable stuff.

Earl R. Schafer and Mark W. Bray, of the U. S. Forest Products Laboratory, Madison, Wisconsin, told their fellow-chemists of the cellulose possibilities offered by waste flax stalks, left over after they have been threshed for linseed. Such stalks are not used for making linen, and have hitherto been a dead loss. The long fibers of the stalks, known technically as "bast," are nearly pure cellulose and hence of potential value. But they are mixed up with shorter fibers known as "shives," which have sticky and woody constituents, and these shives must be separated out before the cellulosic bast fibers can be of full use. Flax pulp as now made still has too large a proportion of shives in it, but the speakers expressed the opinion that further purification would make this pulp a valuable product.

The perennially discussed cornstalk came in for a round with the paper of H. A. Webber, of Iowa State College at Ames. Mr. Webber is a colleague of Professor O. R. Sweeney, one of the foremost authorities on cornstalk utilization. The total production of cornstalks in the United States each year is estimated at approximately 175,000,000 tons. The average yield per acre of dry stalks in the corn-belt states is two tons, of which 1.5 tons are available for use as a source of cellulose. The cellulose content of the stalks is approximately 35 per cent. To get it out, much the same methods can be used as are now employed for producing cellulose from wood; but because of the softer nature of the stalks the mechanical treatment and cooking of the new material must be less violent than in the wood-pulping processes.

THE VELOCITY OF SOUND IN LIQUIDS

A NEW way of measuring the physical properties of liquids by measuring how fast sound travels in them was described at the meeting of the American Chemical Society by Egbert B. Freyer, of the Franklin Institute, Philadelphia. The method makes use of a vibrating crystal of quartz. The physicist calls it a piezo-electric crystal, and it is also used by broadcasting stations to keep their wave-length at the position assigned to them.

The particular form of the apparatus used by Dr. Freyer is called the sonic interferometer, and was developed by Professor J. C. Hubbard, of Johns Hopkins University, and Alfred L. Loomis, at the latter's private laboratory at Tuxedo Park, N. Y. Dr. Freyer's work was in collaboration with Professor Hubbard and Donald H. Andrews.

At the bottom of a cylinder containing the liquid to be studied is the quartz crystal. Above and beneath it are electrodes, connected with a rapidly oscillating electric circuit from radio vacuum tubes. Vibrations similar to sound waves, though much too frequent to hear, are produced. These travel up to the top of the liquid and are reflected back. At intervals in the liquid are produced points called nodes that can be detected with a vertically moving piston. The distance between these nodes permits the experimenter to determine how fast sound travels through the liquid, though with a much higher precision than with ordinary methods. Knowing the velocity of the sound, the scientist can calculate the liquid's compressibility, as well as other important properties.

DISCOLORATION OF GASOLINE

DISCOLORATION in commercial motor gasoline does not necessarily mean poor quality, according to R. E. Wilson, research chemist of the Standard Oil Company of Indiana, speaking at the American Chemical Society Institute. Brown tints in the fuel, often plainly apparent to the customer served from modern glass dispensing apparatus, have no relation to possible damage which a fuel might do to a motor. On the contrary some very corrosive, low-grade gasolines are sparkling, "water-white" liquids.

Emphatic protest was voiced by Dr. Wilson against various obsolete tests and specifications which uninformed purchasers often demand of the oil companies, both on gasoline and lubricating oil. These demands, based on old-fashioned petroleum practice of a generation ago, are unreasonable, applied to the new modified motor products.

Specific gravity, once a critical measure of gasoline quality, now has almost nothing to do with merits in automotive use. In spite of this fact one state still demands a certain specific gravity test for gasoline sold in its territory, probably to the actual disadvantage of retail customers. Odor and color tests are equally wide of the mark.

With lubricating oils flash-point, boiling-point, and various other tests have also grown obsolete, but customers continue to demand goods up to the so-called standard. Frequently the fault lies with a shrewd salesman for a company which happens to have a reasonably good oil with some one particular high test. Much publicity is given to the numerical figures of this test. The test itself has nothing to do with the merits of the oil, but it does keep customers from wandering to other producers, none of whom happens to be able to meet it.

Large purchasers of petroleum products are urged to coöperate with competent chemists, now established with all reputable refiners, in an appraisal of the real merits of gasoline and oils on a modern basis, rather than to hold up a producer to unreasonable and useless tests.

ITEMS

REMAINS of dinosaurs have been brought back to the U. S. National Museum by Dr. Charles Gilmore, staff paleontologist, who has returned from a season's work in northern Montana, in the heart of the great happy hunting grounds for dinosaur remains which stretches all the way from Texas far up into Canada. Dr. Gilmore's finds include one specimen which may turn out to be a species new to science, and another which is the second of its kind ever to be discovered. The total weight of the fossils brought in runs between two and three tons. Represented among the remains are dinosaurs of the armored, flesh-eating and duck-billed varieties.

THE unlocking of vast stores of atomic energy must remain a twentieth-century alchemists' dream for a while, if results of researches at the Physico-Technical Institute of Germany are substantiated. It requires too much bombardment to crack an atom. According to quantitative measurements made at the institute, the demolition of a single atom of aluminum or magnesium requires on an average one million alpha particles, or free electrons. For the destruction of one boron atom 100,000 alpha particles suffice.

GAS for fuel and illuminating purposes can be made satisfactorily from lignite, recent experiments at Marburg on the Drau in Styria indicate. This work is being watched with much interest by Austrian engineers and industrialists, because up to the present Austria has had to import high-grade anthracite for its gas-works.

A GERMAN scientist, Dr. F. M. Litterschied, has recently found that valuable information can be gained by examining milks by ultra-violet light. In this way he can decide whether dirt in milk is due to external contamination or to the milk itself. When coated with Japan lacquer, the vegetable residues from cow's excreta give a bright red luminescence which serves to distinguish them from the ordinary milk residues (casein or albumin curd), for the latter are not affected by the lacquer. Dr. Litterschied considers that his method will prove to be of great value in the routine examination of milk.