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THE ENERGY USED BY PLANTS

THE world's total working capital—the food which we need for carrying on the world's work—depends on a process which, under present-day conditions, is only one half of one per cent. efficient. Such is the verdict of those who have measured the efficiency with which green plants manufacture sugar from carbon dioxide and water in the presence of sunlight.

That process, photosynthesis, is the primary means by which food which plants and animals require is manufactured. Yet photosynthesis, which is carried on in the green portions of all plants, makes use of only a tiny fraction of the energy from the sun which strikes the plant. This half of one per cent. efficiency compares unfavorably indeed with the 33 per cent. thermal efficiency of some modern steam engines and the slightly higher efficiency of the turbine. But the plant's sugar factory is shown in a better light when it is realized that the object of photosynthesis is not to do work, but to manufacture food.

Calculations by Professor Edgar N. Transeau, of the Ohio State University, indicate that the energy that will come from the corn crop now being planted will represent barely more than half of one per cent. of the energy contained in the sunlight which will strike America's cornfields during the hundred days from June to September when the corn is growing. Similar figures have been derived by Professor Walter Noddack, of the University of Freiburg, who made measurements on a large scale with various types of grasses.

More than the half of one per cent. is actually used by the plants in photosynthesis, but the excess goes to the manufacture of sugar which is burned immediately by the plant to provide some of the energy for growing and carrying on its life business. Only 33,000,000 of the 2,043,000,000 calories of energy that fall on a single acre of corn between June and September are used in the manufacturing process of the plant. Two hundred pounds of sugar is the daily output of Professor Transeau's acre, but only a fourth of the sugar made is still available by the time the corn plant has become large enough to harvest. By far the larger part of the energy which a plant absorbs from the sun's rays is used for carrying on other functions of a growing organism.

The water used by the acre of corn during the summer would cover the acre to a depth of 15 inches if it were not absorbed by the soil and if it were not otherwise lost. Actually 910,000,000 calories, a little more than 45 per cent. of the energy reaching the plant from the sun, is absorbed in order to evaporate the 408,000 gallons of water. The water is evaporated in the essential process of transpiration by which oxygen formed as a by-product of photosynthesis is eliminated. Fifty-four per cent. of the balance of the heat from the sun is of no use to the plants.

Plants operate at the maximum efficiency possible today, according to Dr. Earl S. Johnston, of the Smithsonian Institution. But they could operate more efficiently if they had more carbon dioxide available. At one time, during the Coal Age, when plant growth was luxuriant, the earth's atmosphere may have been richer in carbon dioxide and the plants of that day consequently more efficient. Professor Noddack measured the amount of energy used by a plant by calculating the amount of energy required to manufacture sugar by photosynthesis and then determining the amount of sugar that a group of plants manufactured during a given period of time. A sensitive electrical device was meanwhile registering the amount of light that fell on the plants.—LEONARD H. ENGEL.

SORBITOL

FROM the cornfields of America comes a chemical which helps to bind books, aids in printing, softens leathers and which is being investigated as an agent in cigarettes and as a food for diabetics. These uses and others have been found for sorbitol, made from corn sugar and once a rare chemical, according to a report made by R. M. Bashford, of the industrial chemical department, Atlas Powder Company, Wilmington, Del., to the recent meeting of the Fourth Annual Chemurgic Conference at Omaha, Nebraska. The conference, sponsored by the National Farm Chemurgic Council, presents a summary of the newest progress of scientific research in seeking to find new industrial uses of the products of agriculture.

Starting with corn sugar as the base it is possible now to make, on an industrial scale, the complex substance sorbitol which chemically is a complex type of alcohol. The outstanding property of sorbitol, Mr. Bashford indicated, was its ability to retain moisture and hence it finds usefulness in many articles which must remain in their original condition as long as possible. Thus sorbitol is used as a conditioner for glues in book-binding. In the same way a glue-sorbitol-glycerine mixture is used to give longer life to printers' inking rolls.

Other uses cited are: Impregnation of coating paper and fabrics where resistance to oils and gasoline is essential. In the textile field for preventing loss of fiber strength due to decrease in moisture content. In the tobacco industry where it is tested (but not as yet used) as an agent preventing the drying out of tobacco. In the leather industry sorbitol preserves the desirable "hand" and softness because it does not evaporate or volatilize. Sorbitol has been favored in Europe for several years as a diabetic food. In America, Dr. E. S. West, of the University of Oregon, and Dr. C. J. Carr, of the University of Maryland, have made extensive studies of its toxicity, which indicate that its non-toxic properties in reasonable amounts are less than glycerine or cane sugar.—ROBERT D. POTTER.

THE MANUFACTURE OF SULFAMIC ACID

CHEMISTRY, by a new process, is now able to make cheaply and in vast quantities an acid from which can be made a unique flameproofing chemical. The chemical,

known as ammonium sulfamate, does not change the appearance or feel of fabrics or paper impregnated with it. Moreover, it is not affected by dry cleaning methods so that it will safeguard draperies, upholstery and other household furnishings during their lifetime. The parent raw material of the flameproofing chemical is sulfamic acid which, while known for more than a hundred years, has previously been made only by costly laboratory processes. Thus its flameproofing ammonium salt was too high-priced to be readily available to most people.

That a method for the large scale production of sulfamic acid has now been devised and put into operation, was reported by Martin E. Cupery, chemical engineer of E. I. du Pont de Nemours and Company, at the recent meeting of the American Chemical Society at Dallas, Texas. Sulfamic acid is made from urea and fuming sulfuric acid by the new process which, by one of the coincidences of science, has almost simultaneously appeared in Germany and in the United States independently. The new large-scale commercial method of making sulfamic acid, according to Mr. Cupery, has made available for many uses a new industrial raw material. As prepared, it is a colorless, crystalline substance looking something like the naphthalene of moth balls but without the odor, for sulfamic acid is odorless. A particularly useful property of sulfamic acid is its inability to take up water. Because it is non-hygroscopic this very strong acid can easily be shipped and stored without danger of wetting. However, the salts of sulfamic acid, of which the flameproofing chemical is only one, are soluble in water with one exception. Immersion, in fact, is the way the flameproofing chemical is applied to fabrics or paper. For this reason the materials flameproofed can not be washed without destroying the fire-combatting effects. While this may limit the utility of the chemical for some clothing, dresses and suits which must be dry cleaned are potential sources of use, as are many articles in the home.—ROBERT D. POTTER.

SYNTHETIC GASOLINES

SYNTHETIC, "tailor-made" gasolines which the petroleum chemical industry will soon be producing in quantities of 550,000,000 gallons yearly, mark the fourth, and adult stage of this major industry.

Dr. Per K. Frolich, director of chemical laboratories of the Standard Oil Development Company, Elizabeth, N. J., in an invited report to the American Chemical Society, described the growth of these "tailored" gasolines which are now giving airplanes a 15 to 30 per cent. increase in power take-off and climbing, or a 20 per cent. reduction in cruising fuel consumption when compared with the best previously available fuels.

The growth of the petroleum industry, Dr. Frolich indicated, closely parallels that of the motor car. The first stage was straight distillation of gasoline from petroleum. Even as late as 1918 some 86 per cent. of the nation's gasoline was obtained in this way. Next came the methods of thermal "cracking" of oils so that high boiling point fractions would be split into others which came within the gasoline distillation range of temperatures. This process was an enormous help to the petroleum industry at a time when there was much more worry, than there is to-day, about the available oil reserves. By cracking, the yield of gasoline from petroleum was increased from 25 per cent. by older methods to 50 per cent. Half the nation's gasoline is made now by cracking. The third step consisted in adding extra hydrogen atoms under pressure to the gaseous elements of petroleum and hence obtaining gasolines. This was another major improvement which permitted still greater yields. Finally, is the stage of synthetic gasolines which have been produced to match the demands of improved motor car and airplane performance.

The addition of tetraethyl lead to gasoline to give it higher octane rating was the first phase of this "adult" side of America's petroleum industry. In 1937 66,000,000 pounds of tetraethyl lead were marketed. This is sufficient to increase the octane number of the 20,000,000,000 gallons of gasoline sold in the United States by some six or seven points. There is a definite trend toward higher octane number fuels, and Dr. Frolich pointed out that "as we are reaching these high levels, it is becoming increasingly difficult to continue the upward trend without departing from the petroleum industry's policy of not letting the consumer bear the burden in the form of added cost." This may mean that extra-price premium gasolines are here to stay, at least for a while.—ROBERT D. POTTER.

NEW FLUORESCENT LAMPS

A NEW type of electric lamp, that uses ultra-violet light and fluorescent chemical-coated walls to produce white or colored light with an efficiency ranging up to 200 times that of present-day filament lamps, has been announced simultaneously by the Westinghouse Electrical and Manufacturing Company and the General Electric Company. The new tubular fluorescent lamps were recently demonstrated before members of the New York Electrical Society, the American Institute of Electrical Engineers, and the Illuminating Engineering Societies. Ward Harrison, of the General Electric Company, and S. G. Hibben, of the Westinghouse Manufacturing Company, described the lamps at the meeting. One of the new lamps, Mr. Harrison claimed, produces the nearest approach to natural daylight ever achieved by any artificial illuminant.

Differing entirely in principle from existing types of lamps in general use, the new lamps convert invisible ultra-violet light into white or colored light through the phenomenon of fluorescence. The efficiency of the new bulbs is far higher than that of the incandescent lamp, one type of the new lamp producing 60 lumens of light per watt in the 30-watt size, while the equivalent standard bulb produces only three tenths of a lumen per watt. Efficiencies in terms of colored light have been stepped up in some cases as much as 100 to 1.

Fluorescent powders compounded and specially heat-treated hold the secret of the color-producing qualities of the new light sources. Within each tube is a trace of mercury, a small amount of argon gas at low pressure and a coating of fluorescent powders, selected and blended to produce the colored light desired. When current is applied, the argon serves as a "starter" and in a frac-

tion of a second a feeble blue light with a large component of invisible ultra-violet radiation is generated inside the tube. This radiation strikes the fluorescent coating and is re-radiated in the visible range of the spectrum.

ITEMS

ISOLATION of chemically pure crystals of vitamin B_6 was reported by Dr. Paul György, of the School of Medicine of Western Reserve University, to the recent meeting of the American Chemical Society. This part of the vitamin B complex cures a skin disease in young rats which occurs when the animals eat a diet lacking in vitamin B_6.

A REVISED circular containing computations and "corrections" that must be made in computing the heating value of different kinds of fuel gases has been issued by the National Bureau of Standards. Revised by E. R. Weaver, chief of the gas chemistry section of the bureau, the circular contains information making it conveniently applicable to a wider range of compositions of gases and conditions of testing. In issuing the circular, the bureau calls attention to the importance of the heating value of fuel gas, as that is an important factor in determining its usefulness.

"VEGETABLE SHEEP"—plants covered so thickly with long, white-woolly leaves that from a distance they look like grazing sheep on the hillside—are the newest additions to botanical knowledge at the U. S. National Herbarium. They are described through the agency of the Smithsonian Institution by Dr. S. F. Blake, of the Bureau of Plant Industry. The plants belong to the aster family, and come from the Santa Marta Mountains in Colombia, South America. The only "vegetable sheep" hitherto known were from New Zealand. Another strangely shaped plant from the Santa Marta Mountains is known as the "monk plant"; at a little distance, especially through a light fog, a group of them looks like an assembly of robed priests.

NORTH met South in an ancient cavern death-trap, where Ice-Age beasts perished and left their bones in great masses, near the site of the present mountain city of Cumberland, Md., as shown by investigations by workers of the Smithsonian Institution. Remains of northern creatures like wolverine and marten are mingled with those of southern animals like tapir and alligator. The West is represented with fossils of such prairie or plains animals as wild horses and coyotes. Notable were some enormous cats, as big as lions or tigers, and much larger than any modern representative of their tribe in the Western Hemisphere. Dr. C. Lewis Gazin, paleontologist of the Smithsonian Institution, interprets the strange intermingling as meaning that the natural trap stood open over a good many thousands of years, while changes in climate influenced shifts in types of animal population.