CHEMISTRY

Lignin Put to Work

This partner of cellulose in wood may some day be the source of gasoline, dye stuffs and insecticides; is already being used to improve soils and build roads.

By MARTHA MORROW

➤ LIGNIN, partner of cellulose in wood, may some day be the source of gasoline, dye stuffs and insecticides. Metals may be kept from rusting by a coating of lignin, and bridges and buildings made of odd pieces of wood bonded together by lignin.

Today lustrous ebony plastics and inexpensive building materials are being made from this natural substance, all too frequently regarded as mill waste. Lignin is already being used to improve soils and build roads. It is well adapted for electrical insulation equipment.

The future of lignin, the uninviting and often unwanted product left when cellulose is extracted from wood, depends on the skill, ingenuity and knowledge of chemists. Once we know more about lignin, a vast new field will open up, possibly as broad and varied as that of cellulose, one of the great fundamental materials of modern civilization.

Secret Sought

Chemists in secluded laboratories throughout the country are today seeking to discover the secret of this raw material. Some, interested in our woodland streams, strive to make the streams purer by discovering a profitable use for this material which today is polluting them. Others seek more remunerative ways of employing sawdust and wood chips, millions of tons of which are wasted annually. Others, desiring to keep our country green with trees, hope to develop new uses for wood products which would help make the business of growing trees economically more attractive.

If a use of lignin can be found which would raise the selling price only one cent a pound, it has been estimated that the cost of producing ethyl alcohol from wood waste in a plant now under construction in Oregon would be cut almost in half. If salvaging lignin from the waste liquors of pulp mills could be proved worthwhile, added profits would go to the paper industry for keeping the streams, formerly polluted with mill waste, more inviting to wild life and vacationists.

Lignin is found along with cellulose in most plants, in their leaves as well as in the wood itself. It may well be conceived as the cementing material that binds the cellulose fibers together in the wood structure. Without it wood would be limp and flexible.

Composition Known

Chemists know in general what lignin is composed of, but they don't yet know how it is put together. A typical wood lignin contains approximately 64 per cent of carbon, 5.6 per cent of hydrogen and 30.4 per cent of oxygen. It is not a carbohydrate because the atoms of hydrogen and oxygen are not in the proportion of two to one, which is a characteristic of the molecular structure of carbohydrates such as cellulose.

The atomic proportions in lignin are, roughly, carbon 46, hydrogen 48, and oxygen 15. Just how these are linked together is a question chemists today are trying to solve. After it is separated from wood, lignin is found chiefly in the form of dissolved lignin or insoluble lignin.

Dissolved lignin is a by-product left from paper pulp manufacture. Some of it comes from the sulfite cooking process and some comes from the alkaline cooking process, both of which are used in making the pulp from which paper is manufactured. Papers made by the first process are largely bond papers, book papers and writing papers. When such pulp is highly purified, it is a raw material from which rayon is made. Papers made by the alkaline-cooking process consist largely of kraft papers, most of which is used in wrapping and making containers.

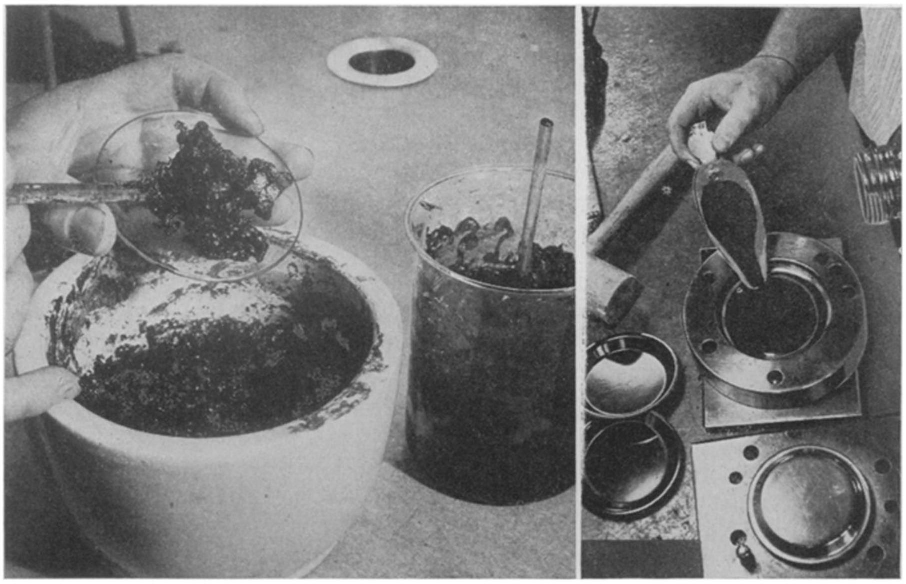
Lignin solutions from sulfite mill wastes may be evaporated. Concentrated lignin of this type has been used rather extensively as a road binder to control dust. Lignin may be recovered from the wastes of the alkaline pulping process by a simple chemical treatment which causes it to become insoluble. In this form it is used chiefly as a bonding agent for plastics with a fiber base. There are possibilities of utilizing the ability of lignin to combine not only with fiber but with other proteins as well.

Insoluble lignin is derived chiefly as a residue from the wood sugar process. In the saccharification of wood, the cellulose is converted into sugars by hydrolysis and these sugars may be fermented to ethyl alcohol or used to produce feed yeasts, and thus make protein feed for livestock. One ton of dry soft-woods, such as pine or fir, will yield approximately 1,100 pounds of sugars. As a by-product of this process, about 600 pounds of lignin are produced which may be dried to a fine powder.

What to do with this highly complicated and potentially valuable material is engaging the attention of chemists in both public and private laboratories.

Since it contains about 64 per cent of carbon, lignin can be used as a fuel. It gives off as much heat upon burning as

PRACTICAL APPLICATIONS— Dr. Eduard Farber, chemist with the Timber Engineering Company, is primarily concerned with finding practical uses which can be made of this little-known material. Photograph by Fremont Davis, Science Service staff photographer.



BASIC MATERIAL—The black, messy substance with which lignin chemists must work (left), promises to be the basis for a wide variety of new uses. Jet black ash trays (right), are made in the experimental production of plastics from lignin at the Forest Products Laboratory by filling the polished mold with powder made from wood wastes.

brown coal or lignite, and ignites in air at a temperature of 150 to 200 degrees Centigrade. But this is a relatively low-grade use of lignin.

One use of lignin now being explored is as a soil conditioner. Insoluble lignin, like other lignins, is related to humus in the soil, both humus and lignin having the same parents. One of its outstanding characteristics is that it is adsorbent. Because of this quality and its close relationship to humus, it will adsorb and hold chemicals valuable as plant nutrients, from simple inorganic substances to highly complicated proteins, and release them in a form readily utilized. Lignin isolated from sulfite liquor wastes may also be used after special treatment for this purpose.

May Be Purifier

This same quality of adsorption suggests the use of lignin as a purifier. From the air it will take acid, benzine and other gases. From solutions it will adsorb heavy metals, phenols and other chemicals often found in waste waters from chemical manufacturing plants. The insoluble form of lignin may be valuable in the war against stream pollution.

Wood alone, untreated, is somewhat plastic at high temperatures and by the application of sufficient pressure small particles, such as sawdust and shavings, can be pressed into a compact mass. Such pressed material, however, is not strong and disintegrates rapidly when soaked in water.

Lignin, when separated from the other constituents of wood, is more plastic, although it tends to crack and crumble when used alone. Much attention is being given to the use of lignin as a plastic when combined with plasticizers and fibers.

If wood is partially hydrolyzed, only part of the cellulose is converted into sugar. This wood product, with a high lignin content, may be mixed with auxiliary plastics or plastic-forming constituents and be molded under heat and pressure. The resulting materials are highly resistant to water and acids, and have considerable flexural strength because of the cellulose fibers they contain.

A similar product is made by removing all the natural lignin from wood, leaving the cellulose. Then lignin of the type obtained from the alkaline-cooking process is introduced. It not only covers the fibers, but also impregnates the cellulose cells and pores. The product is hard, resistant to water and acid, a poor conductor of heat and electricity, and can be molded.

Sheets of laminating paper, made by running pulp with a high lignin content on a paper machine, after being treated with phenolic resins, are bonded together under heat (*Turn to page 300*)

Do You Know?

New York state has over 4,000,000 acres in *farm woodlands.*

Game species of *migratory waterfowl* in North America have increased nearly 400% in the past nine years.

About 90% of all *salmon* caught by United States fishermen is taken in Alaska.

Fruit production in the United States may be at least 20% greater this year than in 1943, according to national estimates.

While *natural gas and petroleum* are found together and much of the gas supply is obtained from wells yielding both, the greater part is from wells which contain gas only.

The *bonehead dinosaur,* known to scientists only in relatively recent years, had a dome of solid bone with bumps and knobs; more properly it is the troodont dinosaur, technically *Pachycephalosaurus.*

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and pressure. An extremely hard, board-like material results which is quiet different from the paper itself. This material, named papreg by the U. S. Forest Products Laboratory, which has done much research on lignin, is being used for electrical insulating panels. It can be sawed, turned and drilled just like hard wood. It is durable enough to form skids for planes landing on ice and snow.

The grain of the individual sheets of laminating paper may be made to run in the same direction. Or the grains may be crossed, in the same manner that grains of plywood veneers are crossed, thus creating desired strengths in various directions.

Another lamianted product in which lignin has an important role consists of sheets of partially hydrolyzed wood, to which some phenolic resin has been added. These sheets may be run out something like paper and compressed together into panels. They are, in a sense, a sort of synthetic plywood which may come to have wide uses as a cheap structural material.

By controlling the proportions of lignin and cellulose under special treatment, products entirely different from wood may be made which meet needs that wood, in its natural state, cannot fill.

If you would like to have samples of the dry lignin powder, plastic made from lignin and a little cellulose, and a sample showing how the individual sheets are laminated into a solid, hard board, you can secure the Lignin Unit of THINGS of science, a kit prepared by Science Service, by sending 50 cents to SCIENCE NEWS LETTER, 1719 N Street, N. W., Washington 6, D. C., and asking for THINGS unit No. 47.

Science News Letter, November 4, 1944

ELECTRONICS

3-Dimension ElectronView

Pictures revealing the shape of ultra-microscopic crystals of magnesium and other metals demonstrated; pin point looks like a vast mountain range.

➤ THREE-DIMENSIONAL pictures of views through an electron miscroscope, revealing the shape of ultra-microscopic crystals of which magnesium and other metals are composed, were demonstrated publicly for the first time at the 29th annual meeting of the Optical Society of America. The point of a common pin can be made to appear as vast and rough as a mountain range when photographed through an electron miscroscope, and enlarged to 100,000 diameters on a three-dimensional Polaroid vectograph. In these three-dimensional pictures, it is now possible to study and measure the shape and space characteristics of minute structures that are extremely difficult to see in ordinary photographs.

The demonstration of techniques in applied electron microscopy was made by Robert D. Heidenreich of the Dow Chemical Company, Midland, Mich., where the electron microscope has been used in the investigation of corrosion phenomena in magnesium alloys.

"The combination of the electron microscope and the Polaroid vectograph process offers metallurgists a peep hole into the microcosmos," Mr. Heidenreich declared. "We can now examine the shape of micro-structures just as one can examine the formation of rock in a quarry. The increasing store of knowledge of new characteristics of metals will doubtless be utilized in the development of new alloys that perform even better than those we have today."

Science News Letter, November 4, 1944

INVENTION

Vehicle Inside Own Tread For Use in Marshes

➤ A VEHICLE that runs inside its own tread is the unique invention on which O. F. Arthur of Belle Vernon, Pa., has received patent 2,361,165. Tanks and tractors ordinarily ride between their treads, rising above them. In Mr. Arthur's invention a very wide, mat-like tread, wider than the whole track of the truck or other vehicle, loops completely overhead, with suitable guides to keep it from going astray. This type of vehicle is expected to be useful especially in very marshy country.

Science News Letter, November 4, 1944

Zacaton root, *Pirelemia crinitum,* is raised and used in Guatemala for making brooms and brushes, sold largely in Cuba and Argentina.