Sources of Industrial Information

CHAMBERS OF COMMERCE:

Most southern cities have an active Industrial Development Department in their local Chamber of Commerce.

STATE DEPARTMENTS OF CONSERVATION AND DEVELOPMENT:

Several of the Southern States include an active development program as part of the state governmental policy. In some cases state departments of agriculture are serving in this capacity.

POWER COMPANIES:

All of the large power companies operating in the South conduct industrial surveys as part of their development program. A partial list of power companies includes:

Alabama—Alabama Power Company, Birmingham.

Florida—Florida Power Corporation, St. Petersburg; Florida Power and Light Company, Miami; Florida Public Service Company.

Georgia—Georgia Power Company, Atlanta; Georgia Power and Light Company; Columbus Electric and Power Company, Columbus.

Kentucky—Kentucky Power and Light Company, Chicago, Ill.; Kentucky Utilities Company, Louisville; Louisville Gas and Electric Company.

Mississippi—Mississippi Power and Light Company, Jackson; Mississippi Power Company.

North and South Carolina—Carolina Power and Light Company, Raleigh, N. C.; Duke Power Company, Charlotte, N. C., South Carolina Power Company, Charleston, S. C.; Lexington Power Company, Columbia, S. C.

Tennessee—Tennessee Electric Power Company, Chattanooga; Tennessee Eastern Electric Co., Johnson City; East Tennessee Light and Power Company.

Virginia—Virginia Public Service Company.

Additional information concerning southern power developments may be secured from such concerns as W. S. Barstow and Co., Inc., New York; Henry L. Doherty and Co., New York; Middle West Utilities Company, Chicago; Stone and Webster Engineering Corporation, Boston.

RAILROADS:

Industrial information may be secured from the Industrial Departments of practically all the railroads operating in the southern territory, or from the Southern Freight Association, 101 Marietta St., Atlanta, Ga. Some of the railroads maintaining industrial departments are: Atlanta, Birmingham and Coast Railway, Atlanta, Ga.; Atlantic Coast Line; Central of Georgia Railway, Savannah, Ga.; Chesapeake and Ohio Railroad, Huntington, W. Va.; Clinchfield Railroad Company, Erwin, Tenn.; Illinois Central System, Chicago, Ill.; Louisville and Nashville Railroad; Southern Railway System, Washington, D. C.

Some Notable Developments of Chemical Industry in the South[1]

Lemuel M. Aycock

COMMERCIAL RESEARCH DEPARTMENT, SWANN RESEARCH, INC., BIRMINGHAM, ALA.

SIXTY-FIVE years have passed since the signing of the terms of peace at Appomatox in April, 1865. At the close of the war the South found its man power crippled, its chief cities in ashes, its lands wasted, and its finances exhausted. The future was indeed very gloomy, for about all that were left were its vast natural resources and there were no apparent means for their development. This, then, was the setting from which the New South had to grow.

This glimpse into history is to serve as a background from which to project some of the more notable achievements of the New South, to show how some of these resources are being developed, and at the same time to indicate certain of its potentialities that will make sure its position in the industry of the nation. This article will be devoted to describing briefly some of the major industrial developments that have taken place in the Southern States during the past thirty-five years—with emphasis on eventful activities of the ten-year period that has just closed.

Cotton Textiles

Some thirty-five to forty years ago an infant industry took root in this part of the country. It located here because of the then cheap labor and because this section was the main source of its raw material. This industry has steadily grown, until today the South has become the textile center of the United States. Today 52 per cent of the spindles of the country are in southern mills, and here is manufactured 62 per cent of the cotton goods produced in the United States.

Other textile activities that are being engaged in at present are weaving, finishing, dyeing, and printing, together with the manufacture of knit goods, silk goods, rayons, and textile specialties. At present there are over 1825 textile plants in this part of the country, representing a total investment of something like one billion dollars. It can be seen from this then that the South is the chief consumer of its own greatest and best known crop—cotton.

Rayon

The coming of the rayon industry has given an added impetus to textile development, and it is now an outstanding feature of this industry. Some of the factors that influenced its coming south are: raw materials, efficient labor, a generally mild climate, relatively cheap factory sites, low industrial taxation, reasonable power, and a plentiful supply of water that is well suited for rayon manufacture. Every phase of the rayon industry is represented in the South, including the nitro, viscose, cellulose acetate, and cuprammonium processes.

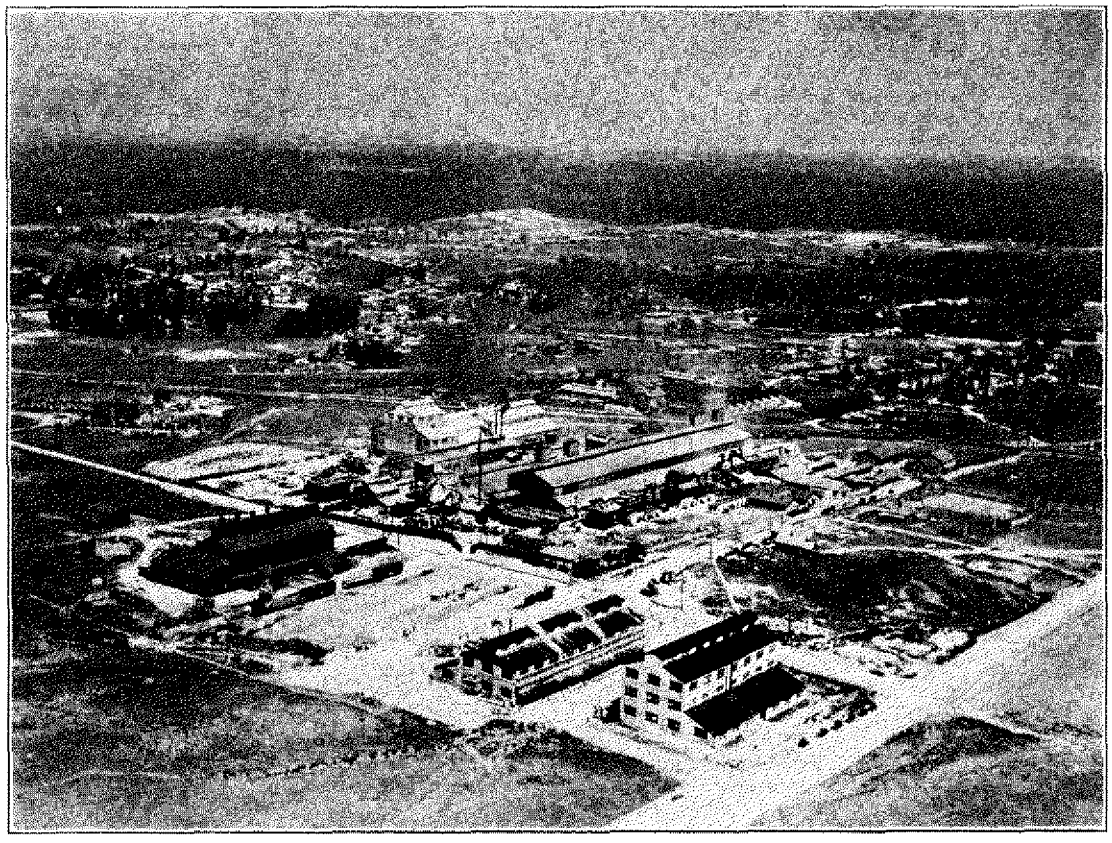
Cottonseed Hulls

An interesting side light comes to mind at this point. It is a process for the removal of cotton fiber from delintered hulls. The mechanical equipment required for this operation was developed by Thomas W. Kidd, of the Farmers and Ginners Cotton Oil Company, Birmingham, Ala. The machine consists of a rotary cylinder fitted with rows of staggered studs that have been ground flat on the ends. The cylinder is partly enclosed in a screen, a sufficient opening being left for putting in the hulls, and as the hulls pass through the machine all the fibrous material is removed from their surfaces, thus separating it from the bran. The cylinder has a slight vacuum that serves to carry off the linters into a suitable receiver to be baled and shipped to the rayon mills, where it is used in the production of either acetate or viscose silk. The bran will find a possible use in the production of xylose.

Rosin and Turpentine

Another industry in which the South is the acknowledged leader is that of naval stores. The states of Alabama,

[1] Received March 5, 1930.



Airplane View of the Swann Corporation Plant, Anniston, Ala.

Florida, Georgia, Louisiana, Mississippi, and South Carolina supply the bulk of this output.

Within the past ten years great improvements have been made in this industry. The old destructive method of collecting the rosin from the trees has been abandoned, and a new and more satisfactory one substituted. A process has been worked out for the extraction of turpentine, pine oil, and rosin from old stumps and dead trees. This process, briefly described, consists of hogging the wood to form chips, and then pulverizing the chips in a hammer mill. The pulverized chip is fed into extractors where it is distilled with live steam. This operation is continued 3 to 4 hours, during which time practically all of the turpentine and about half of the pine oil are distilled off. The distillate is then fractionated to obtain commercial spirits of turpentine and pine oil. The woody fibers left behind in the extractor are next treated with gasoline or some other petroleum solvent to remove the rosin. The solvent is then distilled off and recovered while the rosin remains as a residue.

A more recent development in this industry has been the perfection of a steam still by the Bureau of Chemistry and Soils to take the place of the old-style fired still. This new still has already been tried out in a number of turpentine plants, and the reports received indicate that it makes higher grades of both turpentine and rosin possible.

A wide-awake turpentine producer in Georgia has devised a plan of reforesting his turpentine lands, so that he will have a crop of new trees ready to yield rosin as his old ones have to be cut down. He is carrying this work of reforestation along with his work of production.

In connection with the South's naval stores industry the following comments taken from an address delivered by Charles H. Herty before the Savannah Chamber of Commerce are highly appropriate. It might be stated here that this industry is greatly indebted to Doctor Herty for a considerable part of the advancement it has made during the past fifteen to twenty years. Doctor Herty's remarks are:

> I think it is rather a reflection upon our chemical manufacturers that some of the very turpentine which we produce here in South Georgia should have to find its way to Europe, there to be manufactured into synthetic camphor and sent back into this country for commercial uses, such as celluloid manufacture, etc. In other words, down here we sell the raw product, which may bring 49 cents per gallon, or about 7 cents per pound, but allow the consumer to buy back from abroad a material worth about 35 cents per pound. There is food for thought in that. Why should we not have that industry here in our own midst, utilizing our own materials and employing our own people?* * * We must think of naval stores in the chemical sense, because as we go on we are going to find that the application of more chemistry to naval stores problems is going to open up more lines of wealth to this section of the country.

A Wood Distillation Refinement

Another subject that follows logically at this time is the direct production of acetic acid from crude pyroligneous acid by absorption or extraction. Such a process is now in operation at Memphis, Tenn. The acetic acid vapors are passed upwards through a copper column at the same time that the solvent or absorbing medium is flowing downwards. The tarry oils from the wood-distillation process, boiling above 200° C., are used for this purpose. The acetic acid is removed from the wood oils by fractional distillation and the oils are returned to the process. An acid of fairly high concentration is obtainable by this method. Wrigley, Tenn., is the seat of one of the most modern wood-distillation plants in the world. It produces a complete group of wood chemical products.

Fiber Board from Lumber Waste

Here is a product that is formed by the utilization of waste wood from sawmill yards, that was worked out by William H. Mason and is now being manufactured at Laurel, Miss., and sold under the name of "Masonite." It is being employed as a building and insulating material, and for card-table tops and radio cabinets. The plant producing this board now has a capacity of about 2,500,000 square feet per month.

Fiber Board from Sugar-Cane Waste

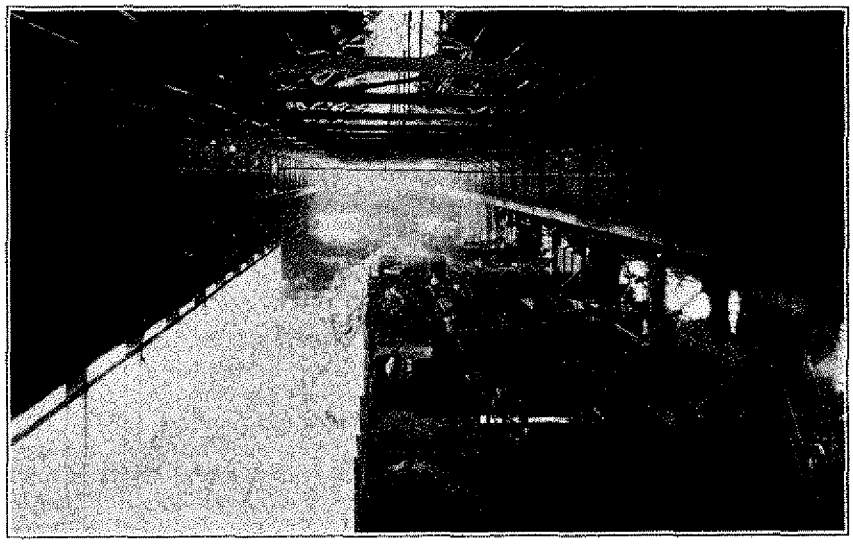
The subject of waste utilization recalls the work that has been done on bagasse, the spent sugar-cane stalk after the juices have been expressed. The Celotex Company has erected a plant near New Orleans at a cost of something like $6,000,000 for the purpose of converting this material into a pressed board. The bagasse must be shredded, cooked, washed, and ground. This changes it into a fiber pulp that is converted into a board, which is then dried and cut into proper lengths and marketed as a heat-insulating material for buildings and also for use in the construction of refrigerator cars.

Pulp and Paper

It now seems that the Southern States are going to become prominent in paper production in the years that are just ahead. The Forest Products Laboratory, of Madison, Wis., has worked out a modified sulfate process that will make possible the production of a strong white pulp from yellow pine. This fact is of great industrial significance, for it promises a paper from southern pine that will compete with that coming from the highest grade pulp woods of the North.

Other important factors in this connection are the large timber reserves of the South and the reasonably rapid growth of pine forests—within 15 to 20 years a tree is ready for the pulp mill, while in 30 years it is ready for the saw mill.

At present the chief paper product of the Southern States is a kraft or brown wrapping paper, but there is a mill located at Kingston, Tenn., that produces a grade of paper suitable for book manufacture. This mill supplies the paper for what is said to be the largest book printing and binding establishment in the world. During 1929 this plant turned out ninety-four railroad cars full of books, which is equivalent to 1,750,000 stitched books. Other pulp and paper mills are located in Alabama, North Carolina, South Carolina, Louisiana, and Mississippi.



View of Electric Furnaces for Phosphoric Acid Production, Swann Corporation

Tung Oil

An industry to which the South can point with pride is that of tung or China wood oil production. This industry is confined largely to Florida, but it is now being developed in Louisiana and Texas. The first commercial plantings are now bearing nuts, and crushing plants are being constructed for the purpose of breaking the nuts into small pieces, so that the oils can be expressed. The quality of the American oil is far superior to that imported from China. The Chinese still produce their oils by antiquated methods, and are rather careless about the handling of the nuts after they have been gathered. This careless handling leads to the production of an oil much darker than the American and also to one that is higher in fatty acids. The Chinese at best get only a 20 per cent yield of oil, while the Florida operators get an average of 34 per cent. It can be very readily seen, then, that the competition from Chinese products is becoming of decreasing importance to the American market. The residue from tung-oil manufacture contains ammonia, potash, and phosphates, and is now being utilized as a fertilizer.

Petroleum

Among the greatest of the chemical investors in the South are the oil companies. One of these big companies is on the threshold of a new development in petroleum production. For years costly research has been in progress for the purpose of finding a way to hydrogenate crude petroleum so that it could be made to yield a gasoline of good quality. Now this research work has commenced to bear fruit, and is to take form in three plants, two of which are to be located in the South, one at Baton Rouge, La., and the other at Baytown, Tex. This process adds hydrogen to crude oil or "ends" to form a high-grade gasoline and other light petroleum bodies. It is understood that by this process a barrel of crude petroleum can be made to yield a barrel of high-quality gasoline.

Natural Gas

Going hand in hand with the petroleum industry is that of natural gas. The Monroe and Richland fields in northern Louisiana are the greatest gas reserves in the world. A 450-mile pipe line leading from this section to the St. Louis District has already been completed. It will also be used to supply certain wayside communities in Louisiana, Arkansas, and Missouri. Another gas line has just been completed that leads from the same area, and it will supply Birmingham, Atlanta, and the adjacent towns and districts.

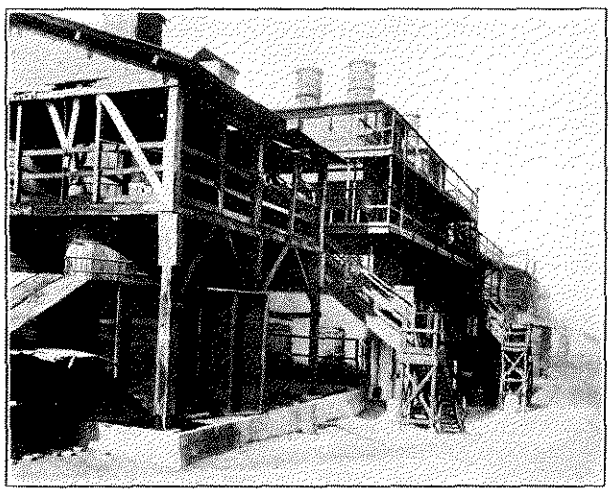
The carbon-black industry of the United States has its center in the Louisiana gas fields. The Monroe field alone furnishes 75 to 100 million pounds per year.

Anhydrous Aluminum Chloride

No more brilliant achievement has been recorded in the pages of industrial chemistry within the last ten years than the development of a process for the preparation of anhydrous

aluminum chloride by the Gulf Refining Company, Port Arthur, Tex. Research work on this process was begun in 1915 and it required something like two years and an expenditure of one million dollars before the production costs could be brought to a reasonable figure.

Briefly, this process consists of calcining crude bauxite to drive out the moisture, adding three parts of a good grade of coking coal for every part of bauxite and pulverizing, then briquetting the mixture with wax tailings or melted



Precipitators and Agitator for Phosphoric Acid Production, Swann Corporation

asphalt as a binder, heating the briquets until all volatile matter has been driven off, and finally of chlorinating the briquets at 875–1000° C. The Gulf Refining Company has lately announced that the briquetting step is to be eliminated from the process, that refinery coke will be used instead of coal, that certain improvements with respect to chlorinating are to be put in practice, and that the conditions of the entire operation are to be made better. In 1913 aluminum chloride sold for $1.50 a pound; it is now being made at Port Arthur at the rate of 75,000 pounds a day for 5 cents a pound in carload lots. Indications are that the price will be still lower as the process is further improved.

Cheap aluminum chloride is an important commercial factor in that it makes possible by its catalytic action the low-temperature cracking of hydrocarbons and also the large-scale production of the anthraquinone dye intermediates by means of the Friedel-Crafts reaction.

Fertilizer Industry

The status of the fertilizer industry has not changed greatly within the past forty to forty-five years. Possibly the concentration of the fertilizing constituents of mixed fertilizers has been increased, but apparently few seem to be devoting much study to the possibilities of a concentrated fertilizer—one that will eliminate the unnecessary filler on which the farmer is now paying freight. And this in one of the greatest fertilizer-consuming centers of the world! This subject of concentrated fertilizers is being given considerable thought by European fertilizer chemists. A process to which they are now giving attention consists of treating phosphate rock with nitric acid in the presence of potassium sulfate. The nitric acid acts upon the tricalcium phosphate, forming phosphoric acid, calcium sulfate, and potassium nitrate. The calcium sulfate is immediately eliminated as a precipitate, and the solution containing the potassium nitrate and the phosphoric acid is treated with ammonia, thus giving potassium nitrate and ammonium phosphate. These salts may be separated or worked up into a highly concentrated fertilizer. The calcium sulfate can next be converted into ammonium sulfate and calcium carbonate by means of carbon dioxide and ammonia, and the calcium carbonate in turn can be treated with nitric acid to form calcium nitrate, and the carbon dioxide can be returned to the process. This work is merely mentioned here to show what foreign fertilizer people are thinking about, and to hazard a guess that our industry might do well to follow their example.

The South has been and will continue to be the chief consumer as well as the chief manufacturer of mixed fertilizers in the United States. Of the 791 plants in operation in the country today over 500 are located in the Southern States. In 1928 the Southeastern States alone consumed 5 million tons of mixed fertilizers. Assuming for an average figure that this was an 8–4–4 fertilizer, this represented an actual tonnage of 800,000 tons of plant food. Out of the 5 million tons the farmer obtained only 800,000 tons, or 16 per cent, of useful material. He had to buy, pay handling charges, and freight on 4,200,000 tons of ballast or filler. In other words, 84 per cent of his fertilizer was valueless to him.

There are today available for import concentrated fertilizers that range from 32 to 78 per cent actual plant food. Each of these contains two or more fertilizer constituents.

The South produces first-hand all of its fertilizer materials except potash. Phosphate rock comes chiefly from Florida and Tennessee, and ammonia is now being manufactured synthetically from the air. In this respect it is worth while noting that the by-product coke-oven gas from the Birmingham District could be utilized in the production of 1000 tons of fixed nitrogen per day, or 350,000 tons per year. This operation could be carried out without affecting the rest of the coke-oven gas service. A plant producing this quantity of fixed nitrogen in this section by such a process would increase the value of the coal coked in the Birmingham District by $25,000,000 a year. At the present time there are in the world something like thirty plants producing ammonia by processes that are most economically adapted to the unusual conditions obtaining in the Birmingham District.

Rubber

A noteworthy chemical undertaking that has met with remarkable success has been the establishment of the rubber industry in the South by the Goodyear Tire and Rubber Company. In February, 1929, ground was broken at Gadsden, Ala., for the erection of an automobile tire factory. Four months and nineteen days later an initial shipment of one carload of tires was made. There is now operating in connection with this tire plant a rubber-reclaiming plant that has a capacity of 50,000 pounds per day.

Electric Power

One of the greatest factors in the industrial development of the South has been its enormous hydroelectric power. Within recent years one-half of the gain in installed hydroelectric plant capacity in the United States has been in the Southern States. Within twenty years the South has more than trebled its developed water power, while the best that the remainder of the country has been able to do is to double its water power. This vast amount of water power is backed up by abundant deposits of coal, lignite, and natural gas, which makes it possible to produce fairly cheap electrical power from supplementary steamplants. The nine leading states in developed hydroelectric horsepower are, in their

order: California, New York, Washington, Alabama, North Carolina, South Carolina, Maine, Wisconsin, and Georgia. Their total horsepower is 7,821,482, and of this total 2,328,122 is developed in Alabama, North Carolina, South Carolina, and Georgia. These four states, then, develop roughly 30 per cent of this total horsepower.

The total potential water power available in the Southern States in 1924 was 3,810,000 horsepower. These figures are for 90 per cent of the operating time.

Phosphoric Acid

Almost one year ago there was put in operation by the Victor Chemical Works near Nashville, Tenn., a blast-furnace process for the production of orthophosphoric acid. At present there is at least one other plant under construction in the South that will employ this method.

The electrothermal development of this compound has been of great interest to chemists and chemical engineers. It is one of the many products now coming from the Swann Corporation's plant at Anniston, Ala. This particular electrothermal or electric smelting process, producing directly a highly concentrated and fairly pure acid, was the first of its kind to be worked out on a commercial basis. Up to the time of its establishment, many attempts had been made to produce phosphoric acid in this manner, but none of them were successful from either a technical or a commercial standpoint.

An important by-product from the phosphoric acid furnaces is a 24 to 26 per cent ferrophosphorus.

By virtue of its quality and its cost the larger portion of the food and chemical grades of phosphoric acid consumed in the United States during the past decade has come out of this plant. A larger plant located in southern France is now operating with this process under a license from and with the technical advice of this company. The French product is used largely in the production of soluble concentrated fertilizer chemicals.

Phosphate Compounds

Practically all of the phosphate salts for which there is a market are produced with phosphoric acid as a starting point at the Anniston plant. These include the meta, pyro, and ortho forms. An exceptional grade of monocalcium phosphate, physically and chemically, is now being prepared by a spray drying process. This process is a development of the research department at Anniston. A novel and economical process for the production of diammonium phosphate has also been worked out on a large commercial scale by this staff.

Concentrated Plant Food

Another product of the Anniston research staff is a completely soluble and balanced fertilizer that stands well up among those of highest concentration on the market today. It contains 17 per cent nitrogen, 33 per cent P_2O_5, and 17 per cent K_2O, thus giving a total of 67 per cent plant food. The remaining 33 per cent consists of oxygen and hydrogen that are necessary to hold the constituents in chemical combination. No sulfates, chlorides, or other ballast are used.

Aluminous Oxide Abrasives

Considerable research and development work was required in order to establish this industry in the South. Furnace operations and control had to be standardized. Grinding, screening, and sizing methods had to be carefully studied from the standpoint of the shape and quality of the abrasive grain. All of these problems have been successfully met, and as a result a higher market standard exists today for abrasive grains than ever before. A number of new forms and characteristics of abrasive grains have been developed at Anniston to meet the exacting requirements of the consuming industries.

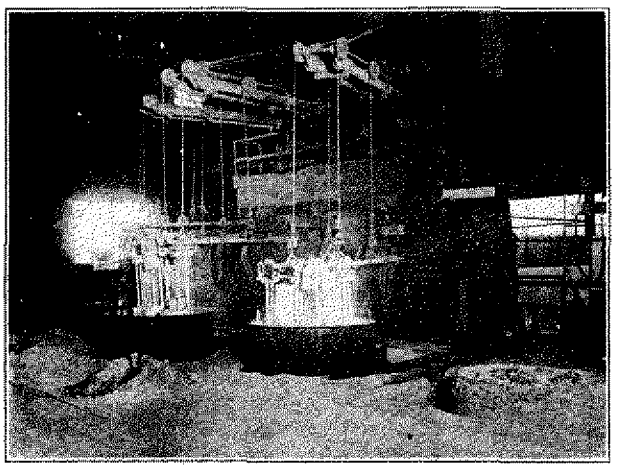
Textile Chemicals

Another instance of this plant's diversification is its entry into the field of textile chemicals. With the greater part of the textile industry situated in the South, and with the main source of their chemical supply located in the North, this movement seemed opportune. As a result of this step a series of special oils for rayon processing has been developed, a new wetting agent of promise has been synthesized, and a textile service laboratory is in process of establishment.

Diphenyl

The most interesting part of the story now comes—a story that records a chemical achievement, that proves the worth of properly conducted research, and that has added a chapter to the already brilliant history of organic chemistry.

During the latter part of 1927 an urgent demand arose for a stable heat-transfer medium for use in a distillation process for the preparation of lubricating oil. It was found that an organic compound—diphenyl—was the best suited material for this purpose, but it was known only in the chemical laboratory, and as a rare organic chemical. It is true that it could be bought, but at a price of $40 per pound. To meet this demand an intensive research program was immediately begun and a careful study made of diphenyl reactions and conditions. Three months after this work was begun a full-sized pilot plant based upon the laboratory research work was constructed and placed in operation. Less than two months after operation of this plant had commenced, an order for a carload of diphenyl was filled at a charge to the



Aluminous Abrasive Furnaces, Swann Corporation

customer of 40 cents a pound—exactly 1 per cent of the former market price. A larger diphenyl plant is now in operation, producing this compound to serve the needs of the original purpose, and to meet a greater demand for this substance in the form of diphenyl derivatives.

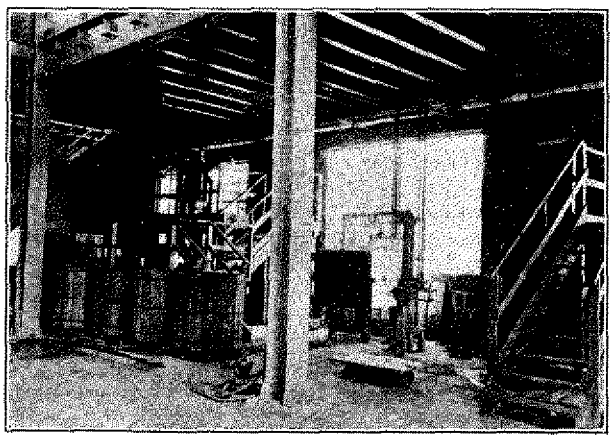
Diphenyl, when pure, crystallizes in glistening white plate-like crystals. It melts at 69.0° C., and has a boiling point of 254.9° C. The pure compound has a very faint odor. Technical diphenyl is light yellow and has a rather appreciable aromatic odor. It has a melting point of approximately 68.6° C. and boils at 255.6° C.

Diphenyl Derivatives

When it had been proved that diphenyl could be produced at a low cost, attention was turned to its derivatives and

their possible applications in industry. To learn something of these possibilities, a number of leading chemists and chemical manufacturers in the United States were asked for opinions. From the information gathered by this survey a broad research and development program was outlined and followed out. At the close of the year just past, forty-six different diphenyl derivatives and products together had been developed. Of this number those that have attracted the most widespread attention have been the Aroclors, products that are produced from the chlorinated derivatives of diphenyl.

The Aroclors are made up of two series. The first comprises a group of water-white to light yellow mobile oils of high boiling points, and a group of both crystalline and non-crystalline solids that are transparent and amber-colored. The non-crystalline materials are resinous in character.



Interior View of Development Building, Swann Corporation, Showing Section of Xylose Plant

The second series of Aroclors is composed of black oils of varying properties, black-brown resins or gums, and gray crystalline solids. The Aroclor resins and viscous oils do not support combustion, they are freely soluble in the common organic solvents, and they undergo no condensation or hardening upon repeated heating. The vaporization loss of the resins is low, and the refractive indices of the Aroclors are above 1.612. They are decidedly non-drying, and the waxes and resins have pronounced adhesive properties. These last-named materials have almost no odor or taste at ordinary temperatures, while the oils have a faint aromatic odor. The Aroclors have no apparent toxic or vesicant action, but their concentrated vapors have an irritating effect upon the mucous membranes of the nose and throat. The Aroclors as a group are stable to long heating at 150° C. and to boiling in a 10 per cent caustic soda solution. The oils distil at atmospheric pressure without appreciable decomposition, and the resins can be distilled under reduced pressure.

Other interesting derivatives that the research department has prepared are 2-chlorodiphenyl, 4-chlorodiphenyl, 4,4′-dichlorodiphenyl, 4-hydroxydiphenyl, 4,4′-dihydroxydiphenyl, 2-aminodiphenyl, 4-aminodiphenyl, 2-nitrodiphenyl, 4-nitrodiphenyl, 4,4′-nitrochlorodiphenyl, 4-nitrodiphenyl-4′-sulfonic acid, diphenyl-4-sulfonic acid, and diphenyl-4,4′-disulfonic acid.

Xylose

Another interesting piece of work that has taken place at Anniston within the past twelve months is the development of a method for the manufacture of xylose from cottonseed hull bran. This work has been carried out in conjunction with the Bureau of Standards, the University of Alabama, and the Alabama Polytechnic Institute by means of the plant facilities, equipment, and coöperation of the Swann Corporation.

An Example of Chemical Diversity

The preceding description of the Swann Corporation, its products and processes, illustrates a unique chemical industry that has very recently grown up in the South. It is unique in that it gives to the world of chemistry electric-furnace products, heavy inorganic chemicals, and organic chemicals of both technical and C. P. grades—all from a single plant. It is unique in that it is the pioneer in the electric smelting of phosphate ore to give phosphoric acid—unique in that this today is a major industry of the world, yet barely ten years old.

Organization of Swann Research, Incorporated

No thinking man will today deny the value of research work, although at times its results may appear rather intangible. The accomplishments of any research staff depend largely upon its personnel and direction, and the company's attitude toward it. No research organization will function coöperatively and with the maximum degree of efficiency if an attempt is made to operate it after the manner of a plant or on a mass production basis. The self-imagined highly efficient and hard-boiled superintendent type who holds his place just because he can manage plant labor has no place in a research department. In such a position he would be a destructive force.

Research work is creative work. It requires individuality to a high degree, resoucefulness, mature judgment, and clear thinking. When these factors are appreciated, research will bring rich rewards to any industry and the costs will take care of themselves.

With such principles as these as a foundation the Swann Corporation has set up a unique system for the conduct of its research organization. All of its research activities have been unified and brought under the direction of a separate corporate body—Swann Research, Incorporated—that has for its sole function the study and solution of problems arising in any one of the several companies, and of developing and assigning processes to one of the operating companies on a royalty basis. All such factors as research programs, expenditures, and organization are subject to the action of this body's own board of directors. Such an arrangement as is described here will enable the maintenance of a proper outlook on the research projects that are under way, and will afford a means of studying the research objective with a view to profits. Since the research organization develops all projects on a royalty basis, it will eventually have sufficient funds to maintain itself independently of the associated companies.

Swann Research, Incorporated, is divided into three separately directed divisions that function coöperatively—the Chemical Research Department, the Development Department, and the Commercial Research Department.

The function of the first department is the study of the scientific and fundamental aspects of all problems. It investigates possible adaptations and new uses. It improves processes of production, and works out the necessary data on which to base pilot plant and semi-plant scale operations.

As soon as the Chemical Research Department has developed a problem to the point where it is ready for the pilot plant or for the semi-plant scale operation stage, it is turned over to the Development Department. This department takes up the problem at this point and works out the engineer-

ing details, plans and constructs the necessary equipment, handles all electrical and mechanical features, and studies any operating difficulties that may arise—in short, the Development Department carries the problem through the difficulties of semi-plant scale operation to the point where it can be turned over to the Operating Department for actual operation on a full plant scale basis.

The Commercial Research Department is in many respects a technical sales department; it introduces and exploits new products and sees the new product safely through that period when it is no more than a marketable possibility. It makes market surveys, production studies, and investigates locations for new plants. It reports on the advisability of acquiring new processes or entering new manufacturing fields. The maintenance of a patent file, patent literature searches, and an oversight of the general business and economic situation are also duties of this department. The Commercial Research Department is similar to a foreign relations department.

This brief record of achievement serves as an index to the attitude of the South toward industrial growth, and the era under discussion here marks the evolution and building anew of industry in this section. The New South has for its watchword—Progress.

Pressure-Synthesis Operations of the Du Pont Ammonia Corporation[1]

SHORTLY after the World War the Ordnance Department of the Army estimated that the maximum military consumption of nitrogen in time of war would be 12,000 tons per month, or approximately 500 tons of ammonia per day. Ten years later, in 1930, this country has two major synthetic ammonia works, with production capacity in excess of this military requirement. One of these plants, that of the Du Pont Ammonia Corporation at Belle, W. Va., is particularly well located for national defense purposes, since it is far inland. In the future it is expected that the demand for cheap fertilizer nitrogen will further stimulate investment of large sums in extensions to these plants, with the result that the supposed need for government-owned nitrogen works will remain but a political ghost.

Development of Organization

Organized originally to provide ammonia for use in nitric acid manufacture within the parent company (E. I. du Pont de Nemours & Co.), the Du Pont Ammonia Corporation is, in addition to satisfying this demand, now marketing large quantities of ammonia to the refrigeration, explosives, fertilizer, and various other industries. The original plant capacity of 25 tons anhydrous ammonia per day has been increased many fold. Furthermore, methanol, which was produced at first only in small quantity as part of the gas-purification process, has now become a distinct and major part of manufacture at Belle. Additional operations comprise sodium formate and aqua ammonia manufacture, both of which are logical subsidiary operations.

In its brief existence the company has made connections and has experienced developments of considerable fundamental importance. Starting originally with a synthesis process based upon the designs and experience of L'Air Liquide, which developed the well-known Claude process, the company subsequently acquired exclusive American rights to the Casale ammonia process. This occurred at the time the assets of the defunct Niagara Ammonia Company were purchased.

Through arrangements effected by the parent du Pont organization, the Du Pont Ammonia Corporation acquired the National Ammonia Company, a long-established and well-known manufacturer and distributor of anhydrous ammonia, aqua ammonia, and ammonium carbonate, together with its subsidiary, the Pacific Nitrogen Corporation, of Seattle, Wash. Thus the Du Pont Ammonia Corporation now comprises ammonia-synthesis works in Belle, W. Va., and Seattle, Wash., and the marketing organizations of the National Ammonia Company and the Pacific Nitrogen Corporation in addition to its own marketing facilities.

Coincident with these various organization developments there has been carried out a vigorous program of technical development in the field of ammonia synthesis and alcohol synthesis. As a result the Du Pont Ammonia Corporation process has decidedly new and advantageous features and represents a radical departure from the original Claude process.

Layout of Belle Works

The accompanying illustrations indicate fairly well the magnitude of present operations at the Belle works. Figure 1 is a general view of the Kanawha Valley at Belle, which is about ten miles up stream from Charleston on the Kanawha River. The Du Pont Ammonia Corporation property occupies the central part of the illustration. The coal-handling equipment, which is designed to receive barge shipments of coal, is distinguishable on the river bank. Proceeding from left to right in the group of factory structures are the mountain power-recovery system, coke storage, works office building, machine shop, experimental gas holder, coke-handling equipment, compressor and synthesis house, water-gas generator house, steam plant, gas holders, coal-handling equipment, another compressor and synthesis house, alcohol storage, alcohol purification, and experimental synthesis plant. Farther to the right are the buildings of the Belle Alkali Works. In the foreground are the tracks of the Chesapeake & Ohio Railroad and on the far side of the ammonia plant are the tracks of the New York Central Railroad. The Kanawha River, a navigable tributary to the Ohio River, is plainly distinguishable in the middle distance.

Water-Gas Generators and Compressors

Figure 2 shows the water-gas generator house. The generators have a total capacity of about 70 million feet of blue water gas per day. The coke used in the generators is obtained from near-by beehive ovens. Beginning next autumn, coke will be obtained from by-product ovens which are now being installed alongside the water-gas plant by the Du Pont Ammonia Corporation. Coal will be delivered from the mines by barge. The coke-oven gas will not be used in hydrogen manufacture, but instead will be burned under boilers. Recently various writers in the technical press have advocated the use of surplus coke-oven gas for ammonia synthesis. Du Pont Ammonia Corporation experience shows that manufacture from coke water gas provides far cheaper hydrogen than can be obtained from coke-oven gas, even

[1] Received April 2, 1930.