THE DEVELOPMENT OF PUERTO RICO'S CHEMICAL INDUSTRY

By

R. MUNOZ - CANDELARIO

Puerto Rico is the smallest and most easterly island in the Greater Antilles chain of big islands which flank the Carribbean Sea on the north. Seventy miles west is the island of Hispaniola, where the Dominican Republic and Haiti are at, and forty miles southeast is the island of St. Thomas, in the American Virgin Island group.

Puerto Rico is just under a hundred miles in length, about 35 miles in width, and about 650 people to the square mile live in it making the island one of the most densely populated areas in the world. The mountains fill the center of the island, rising from a coastal plain. There are no navigable rivers, though about fifty small, short rivers come tumbling down out of the mountains. Dams holding them back in the mountains provide electric power and good fishing in mountain lakes.

Although Nature made Puerto Rico a forested, semi-tropical, and beautiful green island, it did not provide it with enough raw materials to make it a wealthy country. No petroleum or natural gas supplies have ever been found, mineral deposits are scarce, abundant wood supplies are lacking, and there are no natural fertilizer deposits whatsoever in the island. Traditionally then, the economy of the island has had agriculture as its basis throughout centuries. About 45 years ago its most importan. agricultural crop was sugar cane. This was grown abundantly throughout the plain zones of Puerto Rico by a relatively small number of very rich landowners who also had control of the factories in which the crop was processed to produce cane sugar. Most of the residual molasses from the mills were either used as cattle feed or exported to the United States for use as raw material for the production of alcohol by fermentation. The sugar industry was at that time the largest single provider of employment throughout the island, a privileged position which it still retains in spite of surmounting economic difficulties.

A look at the engineering professional of that time in Puerto Rico sees it logically tied to this main industrial activity. Mechanical and chemical engineers were employed in relatively large numbers at the sugar mills and at the few rum distilleries in operation. They held there important supervisory positions to guarantee proper plant performances, and it can be

correctly stated that the economy of the island was in their hands. Electrical and civil engineers did not have at that time as good opportunities available as the first two had.

During the last 25 years Puerto Rico has gone through a drastic change in the basis of its economy from an agricultural one to the semi-industrial one of the present time. The change started with the establishment of one plant which produced Portland cement from limestone and clay deposits available in the island, and of another plant which made glass bottles and containers from locally available feldspars and limestone ($Na_2 CO_3$ imported).

A few years later the government of Puerto Rico initiated Operation "Bootstrap", to attract industry into the island. This plan offered factory space to investors, assisted in financing new enterprises, and granted a ten-year exemption from corporate income taxes to all new manufacturing concerns. The results of Operation "Bootstrap" have been spectacular, for in about two decades the 700 new factories established under it have created over 60,000 jobs and helped raise the per capita income from $121 to about $600. In the same period Puerto Rico's annual net income rose from $225,000,000 to over $1,500,000,000. In the middle 1950s industrial earnings started pulling ahead of agricultural ones.

At the start of Operation Bootstrap there seemed to be an emphasis on manufacturing wearing apparel, but the factories established later have been more diversified. Chemicals, machinery, scientific instruments and consumer goods other than apparel are all represented. Many of these new factories are branches of U.S. mainland corporations.

Of course engineers have played a vital role in this industrial development of the island. The explosion in housing and other constructions which the improving economic conditions brought about has been a financial boon to civil engineers and architects, with the result that at present civil engineers in the island out number mechanical, electrical, and chemical engineers put together. Electrical and mechanical engineers have very expertly handled an increase of 1600% in the amount of electrical energy produced since the start of the industrialization program. Mechanical engineers have also been the backbone of the most important manufacturing operations established, for they have had the main responsibility in keeping the plants running. Chemical engineers in Puerto Rico have met satisfactorily the technical requirements of vastly diversified enterprises which include, among other products and operations, petroleum refining, plastics processing, fertilizers, Portland cement, glass, paper, petrochemicals, rum and other alcoholic beverages, food canneries, cane sugar, salt, detergents, drugs and cosmetics, water and sewage treatment, and nuclear power generation.

It is really a surprising fact that Puerto Rico's chemical industry has been able to reach the advanced stage of development which it presently has in spite of the island's lack of important natural resources. However a close look at the situation reveals two factors which fully explain this apparent disparity.

The first of these is that the island is now exploiting its raw materials nearly to a maximum, taking advantage of the favorable economic conditions which prevail. Thus, the two Portland cement plants which now operate in Puerto Rico using mineral deposits which are available locally are undergoing expansions to keep up with the demand for the product. The island is self sufficient in salt at the present time. Production of glass bottles and of heavy clay products (terra cotta, drain tile) is increasing steadily. Agricultural products other than cane sugar are now being industrialized, including items such as pineapple juice, tomato juice, instant coffee, frozen orange juice, pineapples, and a wide variety of other fruit nectars and vegetables. On the other hand the production of cane sugar is falling steadily and a large number of sugar mills has been forced to close operations. The Government of Puerto Rico has undertaken a vigorous program to help bring back the sugar industry on its feet. The rum industry deserves a particular comment at this time, since it is a very healthy outgrowth of the sugar industry. The rum industry is one of the most important contributors to the economic growth of the island. During the last 30 years it paid the Treasury a total of $858,956,374; it bought 250,000,000 gallons of final molasses from the sugar industry at an approximate cost of $30,000,000; its payroll totalled about $25,000,000; and it produced over 163,000,000 gallons proof of rum. It consumes at present from 40 to 50% of the island's production of glass bottles and cardboard containers. It is estimated that by 1970 rum production will have to be duplicated to satisfy the demand of the U.S. mainland and of Puerto Rico.

The second factor mentioned before, and perhaps the most important one, which accounts for the vigorous growth of the island's chemical industry are the operations carried out with imported raw materials. This group includes the largest plant investments and the most modern processes of manufacture. The outstandingly important ones are those based on petroleum and its derivatives. There are two petroleum refineries in the island which process about 150,000 barrels per day of crude oil imported from Venezuela. These plants supply fully the island's needs of all fuels, and some of their production is exported into the United States. The largest of these refineries supplies naphta and gases as raw materials for an adjacent $72 million dollars Union Carbide plant which produces ethylene glycol. This same petroleum refinery just finished building this month a plant to produce aromatics-benzene, toluene, and xylene - at a total cost of $41 million dollars. This will be the largest benzene plant in the world. The construction of a plant to produce phtalic anhydride from this refinery's xylene has also been started at a different point in the island, and this will eventually make the island self-sufficient in polyester type paints It has also been announced that a cyclohexane plant will be added by 1966, to produce cyclohexane by hydrogenation of benzene, and this will eventually lead into the production of nylon in the future. As a last significant sign of the island's bright perspectives in petrochemicals it should be mentioned that the U.S. Government approved this year an additional crude petroleum quota to the Phillips Petroleum Co. which will allow it to operate a petrochemical complex in the island, with an estimated investment of $500 million dollars during the next 20 years.

There are carried out in the island a number of other important chemical processes using imported raw materials but which do not involve petroleum

One of these is a fertilizer plant which manufactures anhydrous ammonia, sulfuric acid, and ammonium sulfate. Synthetic detergents, of the dodecyl bencene sulfonate type are also being produced in large amounts, as are also a wide variety of pharmaceutical products. Plastic resins are brought into the island in huge amounts to produce all sorts of molded and foamed articles, including reinforced wallboard from bagasse. Most of the compressed gases used in the island are also produced locally. Cardboard containers also fall under this classification.

Economic experts believe that in the future the island's chemical industry will keep on growing in variety, in magnitude, and in complexity. These developments will require, as an additional raw material, the technical contribution of more and better prepared Puerto Rican engineers. Thus arises the continued strive of the School of Engineering of the University of Puerto Rico towards improved, modern and first-class curriculae and teaching staff. For in the future, as in the past and at present, the economic welfare of the island will rest on its engineers.