SCIENCE

VOL. LXXII FRIDAY, AUGUST 15, 1930 No. 1859

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.
Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE COMMERCE OF CHEMISTRY[1]

By J. N. TAYLOR

CHEMICAL DIVISION, BUREAU OF FOREIGN AND DOMESTIC COMMERCE, WASHINGTON, D. C.

I

A GLANCE at the pages of history will show the close relationship which chemistry has held with the advance of the human race. From earliest times, as evidenced by Biblical records, as well as by the monumental records of Egypt and the writings of Herodotus and Pliny, chemistry as an art played an important part in the life of ancient civilizations. Even as late as the fourteenth, fifteenth and sixteenth centuries the alchemical system attained wide-spread favor, and, as in the ancient Egyptian temples, chemical laboratories were to be found in Christian monasteries.

The chemist in the past has been somewhat inclined, like his illustrious predecessor, the alchemist, to lock himself up in his laboratory and keep his secrets to himself. In more recent years, however, he has come out into the light of day and now presents the results of his studies before meetings of our society and publishes his results in our journals.

Comment upon the retiring nature of the alchemists' successors, however, should not be taken in any sense as decrying the dispositions of our "fathers in chemistry" or deprecating their labors. None of us would think of criticizing the scientific habits of Boyle, Priestley or Bertholet; of Liebig, Kekule, Pasteur or of many of those who came after.

Many of these and other illustrious men did apply the results of their researches to practical ends, and the Industrial Revolution caused many industries to establish chemical laboratories at their own works. It was not until the trade associations came into being, however (particularly those forms of cooperative organization covering highly specialized fields), that capital may be said to have pooled its resources with

[1] An address delivered at Richmond, Virginia, May 2, 1930, before the Virginia Section of the American Chemical Society.

chemical science, looking toward the establishment of a community of interests. Scientific sections were organized, technical research instituted and the beginnings laid for studies that were later to advance both chemistry and commerce. To-day there is hardly a university in the country but has its fundamental and applied research available for industry or in the form of fellowships. For example, one well-known movement, sponsored by capital and initiated and administered by Professor Duncan first at the University of Kansas, later manifested itself in the establishment in 1911 of the Mellon Institute at the University of Pittsburgh with Dr. Duncan as the first director.

II

President Hoover, while Secretary of Commerce, in advocating and initiating the assembling of the $20,000,000 fund for research in pure science to be expended over a ten-year period by the National Academy of Sciences, insured, in his characteristic, practical way, the continuation of industry's source of strength. The reservoirs of knowledge must not dry up. The streams and rivulets flowing into the power basin of commerce must continue in volume. Fundamental research must go on, and chemistry while continuing its industrial cooperative program must not be neglectful of pure science.

Nevertheless, while fundamental research is necessary for further progress and while applied science must continue to be fostered, the resulting products of discoveries and inventions so made must be distributed in order that those who wish them may have the opportunity to get them. It would seem therefore that just as the second phase of the Industrial Revolution called for the more intensive services of chemistry, so to-day, in still another phase of our industrial life, a new science has developed calling for a sympathetic understanding between chemistry and commerce, a mutual relationship between chemical production and distributive mediums. In chemical parlance, the relationship partakes of the nature of a reversible reaction in that the fortunes of the one are bound up with those of the other.

So the industrialist of vision establishes and maintains a department devoted not only to working out problems involving plant operations but also to the coordination of this department with other technical departments and with the development and sales organizations.

At the last New York meeting of the American Association for the Advancement of Science, Dr. Redman presented a very interesting study in which he discussed mortalities in the several stages of a product between the time of invention and the time of successful distribution. While one would not go so far as to say that all these deaths could be averted, it seems reasonable to presume that economic research should diminish the casualties. Obsolescence, the price of progress, can certainly be met just as problems of supply and distribution are met and surmounted.

This necessity for a larger knowledge of economic conditions as they affect the chemical industry has evolved a new order of workers made up in large measure of those possessing both commercial and chemical training. It has introduced a new chemist classification.

Perhaps it may not be necessary for the chemical marketing specialist to have a chemical training, but basic knowledge of chemical science and its nomenclature should be extremely helpful in considering the fundamental aspects of chemical processes, the relation of one product to another, the possibilities for new and more efficient applications of them, as well as a more intelligent understanding of economic and commodity trends. Through these influences and trends, chemistry is recognized as basic to all industry, and chemical industry to-day exercises a profound influence upon the political economy of the world.

III

Economic trends or commodity tendencies may be caused by several factors among which may be noted (1) the influence of other industries upon chemical evolution and (2) the intrusion of synthetics into fields of use already occupied by natural products. To these factors of outstanding interest to the chemist may be added (3) those of availability of natural resources and (4) waste and co-product utilization.

Consider how the automobile has affected chemical trends. It has caused a demand for more durable materials, for new and brighter colors and new and better protective coatings. These latter have demanded solvents answering certain exacting specifications. The automobile industry is responsible for the development of anti-knock agents used as motor fuel constituents embracing a variety of substances useful for that purpose. Increased production of artificial leather followed the greater output of motor cars. This greater output was also reflected in a larger consumption of synthetic resins. Another industry that has affected the trend of certain chemical commodities is the rayon industry. Rayon—itself a group of chemical compounds—has exercised an influence over cellulose and the acids, both nitric and acetic. The demand for acetic acid, for instance, increased to such an extent that calcium acetate had to be imported to satisfy the demand for the raw material, despite a continued growth in synthetic production as well.

Not so long ago the number of synthetics entering into competition with natural products was small, but

the rapid progress in chemical discovery adds new ones to the list almost daily. Ammonia, acetic acid, methanol, ethanol and the aromatics are just a few. Glycerin is confronted with glycol, and butyl alcohol faces internal dissension. Citric acid from fruits faces the constructive activities of the molds. The scene of natural camphor production will quite probably shift from the wild highlands of Formosa where live the head-hunting savages to more refined scenes of synthetic production.

Every state and territory in the union is endowed with a wealth of natural resources, ranging from mineral deposits to forests and power sources. Abundant deposits of salt and gypsum, pyrites and sulphur, are to be found in certain localities; oil, coal, gas and limestone, clays, phosphate rock and bauxite in others. In short, our natural resources comprise practically everything to be found in a text-book on economic geology. The animal and vegetable kingdoms, likewise, to a great degree contribute a variety of materials which after processing finally enter into commerce.

Utilization of wastes and collateral products is constantly changing our ideas as to what are main products and what are by-products. Once kerosene was the principal product of a petroleum refinery; now the situation is reversed. Hydrochloric acid at one time was allowed to escape as a waste gas. Uses found for it soon made it a main product. The oils obtained from by-product coke ovens are to-day in as great demand as the residual product of distillation. Chemical history is replete with these reversals in relative economic importance of manufactured products.

IV

The consequent appearance of new products and the larger application of both old and new ones have brought about a situation not comparable with that of any previous period in history. The incidence upon life of enormous quantities of materials having manifold uses must be characterized as truly great.

In the twenty-five-year retrospect of the American Chemical Industry, recently issued by the Chemical Division at Washington, and in Professor Munroe's great work on chemical technology prepared for the Bureau of the Census in 1899, there are presented more than the mere chronology and statistics of the industry. Considering these along with the younger Silliman's contribution to American chemistry, presented at the Northumberland celebration in 1874, it would be possible to write the history of American chemistry.

The magnitude and scope of chemical industry to-day is tremendous when compared with that of a hundred years ago—even indeed within the past quarter of a century. A comparison of the 1899 production figures with present-day ones will afford an idea of how far we have traveled since that time.

Consider just a few outstanding examples:

	1899	1927	
Acetic acid	$ 400,000	$5,500,000	(for sale)
Nitric acid	1,500,000	3,500,000	"
Sulphuric acid	7,300,000	43,000,000	"
Mixed acids	1,100,000	3,800,000	"
All sodas and compounds	11,600,000	114,000,000	
Alums	2,400,000	9,500,000	
Cyanides	1,600,000	6,300,000	
Fertilizers	42,000,000	190,000,000	
Paints and varnishes	54,000,000	500,000,000	
Explosives	17,000,000	72,500,000	
Plastics	2,100,000	28,000,000	

Sulphur, in the 1899 figures, included pyrites, and production aggregated a value of $543,249. The 1927 production of sulphur alone was valued at over $38,000,000.

Rayon, first exhibited at the Paris Exhibition in 1889, is now a firmly established industry, total United States production in 1927 amounting to $110,000,000.

Medicinal and toilet preparations, crude drugs, essential oils, waxes, matches and a multitude of other commodities have also seen a remarkable development.

We can not leave this discussion of the rise of the American chemical industry, however, without mentioning a branch constituting a key industry and occupying an important position in the chemical life of the nation—the synthetic organic chemical industry. In 1880, when the first mention was made in the census returns of coal-tar dyestuff manufacture, production amounted to 80,518 pounds of aniline dyestuffs. Expansion since the World War presents a magnificent record, preliminary figures for 1929 indicating the production of domestic dyes to have been approximately 110,200,000 pounds. Production of organic photographic chemicals totaled 581,000 pounds; synthetic flavors, 2,290,000 pounds; synthetic perfume materials, 1,596,000 pounds; synthetic phenolic resins, 31,471,000, and synthetic coal-tar medicinals, 5,000,000 pounds. An industry that can offer to purchase for a country, with one of its secret remedies, great areas in the tropics is not an industry to be neglected.

We have compared the present with the past in terms of production. A story of the expansion of our foreign trade would also read like a romance.

To-day the world is our market-place, and we are sending to all parts of the globe chemicals and allied products valued at over two hundred million dollars a year. On the other hand, our imports of materials for use in chemical and allied lines aggregate over

two hundred million dollars annually, two thirds of which are either exotics or supplements to our inadequate domestic supplies requisite for the promotion of our industry.

The saturation point is not in sight. Production is limited only by human needs and desires, and our economic horizons are constantly being pushed back in order to supply the rational cravings of teeming millions not yet acquainted with modern necessities, to say nothing of some of the luxuries.

V

The forward movement in American industry has been accelerated in recent years by a greater Southern participation. The creation of a New South, a new industrial South, has resulted from a recognition of its vast potential resources and the availability of cheaper power and new methods and lines of transportation. Other contributing factors are the supply of native labor, freedom for expansion and widening markets. This new state of affairs is reflected in a production value for all industries in the South in 1927 (the last census year) of $10,371,000,000, about one sixth constituting chemicals and allied products.

The textile industry particularly has exhibited a southward movement and the processing of natural fibers and the manufacture of artificial ones—essentially chemical processes—has been an important development. The cheese industry since the practical eradication of the cattle tick has moved in a southerly direction. Coincident with these migrations there has been the establishment of other new industries. Expansion of old ones is reflected in the carbon black and the naval stores industries, and to the vegetable oil industry has now been added tung oil. Finally to supplement increased phosphate rock production we have another fertilizer material—fixed nitrogen—added to the South's list of products. Carbon bisulphide is expanding; diphenyl is no longer a laboratory curiosity, and cotton seed bran, the lowly peanut-hull and the Jerusalem artichoke will probably be converted into xylose on a commercial scale.

VI

Statistical data for the South in general and Virginia in particular have been so admirably presented by one of your section, Dr. Hitchcock, that it is unnecessary here to more than mention the leading position occupied by Virginia in the production of chemical and allied products and to note some opportunities worthy of consideration.

"Down where the South begins," here in Virginia, you have entered into a new age. Already known as the "mother of industry on the American continent," the state in which "were established the first salt plant, the first glass works, the first leather tannery," you now have added another type of "first," first in production of rayon. You will also, it is said, soon be able to guarantee United States independence of foreign nitrogen.

In 1927, the value of all products manufactured in Virginia aggregated $671,000,000, a 14 per cent. increase over the total 1925 value. Of the 1927 value, chemical and allied products aggregated $129,000,000, divided into twenty groups, illustrating the diverse nature of Virginia enterprise.

At the same time, what has been done represents only a portion of what may be accomplished. A booklet recently issued by the Virginia State Chamber of Commerce impresses one with the great potentialities awaiting development. Water and rail serve not only a section that may be glimpsed from the deck of any steamer coming down the bay or in through the capes but a vast territory to the north, west and south, as well.

Hampton Roads Port is a gate of ingress to the West and South, and it is one through which a steadily increasing outflow of all sorts of materials will find their way to foreign fields. The Hampton Roads Port is especially favored by its location and the nearness to the east and west coasts of South America and by the territory which it is capable of serving. Mutual requirements of this area and the United States should ensure cargoes coming and going.

In the export studies included in the traffic survey previously mentioned is one on coal, and the thought occurs that some could be processed in ovens and the by-products utilized. Coke production could mean a metallurgical industry, and an increased tar production could mean more road materials and more domestic creosote with a short haul and perhaps an expanded creosoting industry. The manufacture of other products ranging from crudes to finished products, from motor fuel constituents to dyestuffs, is not incapable of consideration. The import study on cacao beans suggests theobromine and caffein, this thought in turn suggesting the field of fine chemicals. The molasses study not only suggests industrial alcohol but also images the booming solvents industry. Reflection upon the pork and pork products study visualizes slaughtering and packing-house activities, with consequent production of biologicals, soaps and glycerin.

In addition to these suggested lines of chemical endeavor may be added casein, not only to supply the coated paper industry, but also as a basis for the casein plastics now finding wide application.

VII

Suggestions such as the few just given inadequately present our possibilities. They seem so very meager. Could we but transport ourselves into the future—let us say to 1950—we should, no doubt, be amazed at

what had happened in the intervening score of years.

The historical glance backward has shown us the great forward strides made since earlier times by American chemistry. We are quite aware too that scientific discovery and invention are proceeding at an ever-increasing rate, and in the light of history our progress in the future is to be more rapid than in the past.

The functions, then, of chemistry in the future must be more comprehensive than at present and must certainly embrace an understanding of its economic importance. The service of chemistry must be not only in the discovery and the application of scientific and technological facts, but chemistry must also serve by solving the larger problems of distribution in its broadest sense. We must lay more emphasis upon the commerce of chemistry, upon the economical distribution of chemical wares. New uses must be found for old products. Old industries may justify expansion, and new ones would logically be inaugurated if deemed advisable.

It is not enough to visualize the great potential awaiting development—to view the perspective—and stop at that. Practical and efficient methods for bringing about the desired ends must be formulated, and happily, chemical industry itself, as well as governmental institutions, have made a beginning along this line.

A general method of approach, capable of specific application, of arriving at a program of effort, is through the chemical-economic survey. Such a survey, when completed, should show fairly conclusively whether or not a given material shall go into production, how long an industry can continue its current program, whether it should switch immediately or gradually or whether it should pick up and move to some other part of the country.

In building the survey structure the technique to be followed will, of course, depend upon the problem at hand, but no matter what the survey, whether of some particular branch of industry or of some particular commodity or group within the industry, the foundation upon which the superstructure is to be raised must consist of immediate, reliable, adequate and permanent records.

VIII

The Department of Commerce, because of its relation to other government establishments and to industry, has at hand or can point the way to the many sources of information so important in determining the position or status of a specific chemical industry or commodity, or in determining their trends. Cooperation in this respect is gladly accorded through the Chemical Division of the Bureau of Foreign and Domestic Commerce, which, established eight years ago by Mr. Hoover when he was Secretary of Commerce, with Mr. Concannon as chief, endeavors to render practical service in the application of commerce to chemistry.

Nearly every day one or more interesting problems are presented. Some one may ask, "How are the solvents?" or "What is the future of acetic acid and how?" Or the question may be, "Where and in what quantities can rotenone-containing plants be found? Has it been synthesized yet?"

The functions of the division are essentially trade promotive and do not include any of a regulatory nature. Through regional surveys and immediate services available in fifty-eight American cities the bureau assists domestic commerce. To promote foreign commerce the bureau also has available the services of its fifty-six offices abroad and the collaboration of the consular service.

The information thus made available covers a multitude of points: Magnitude of the situation as affected by foreign competitors, climatic conditions, advertising, make-up and habits of the population, purchasing power, chemicals and allied products manufactured locally or other sources of supply. Questions related to transportation facilities, customs tariffs and internal regulations affecting the importation or sale of American products in oversea countries are looked into and reported upon.

In addition, the bureau maintains lists of prospective agents in each country and keeps a complete commercial report on each one for the confidential use of American firms. Not only is up-to-date information given regarding trade conditions, but each week the bureau publishes a number of "trade opportunities," which are inquiries from parties with a definite interest in buying who wish to get in touch with manufacturers here.

A thousand men are at your service in the four corners of the world to gather together data bearing directly upon foreign trade promotion, and at the Washington headquarters and the district and cooperative offices throughout the country you will find the department's facilities at your disposal.

OBITUARY

GEORGE NEIL STEWART, PHYSIOLOGIST

April 18, 1860, to May 28, 1930

BY Stewart's death science has lost a brilliant physiologist "of the old school," a pioneer, a builder of bridges between the founders of modern physiology of the modern era. He was a pupil of the old masters, but most of all he was a scientist of high merit in his own right and a man of personal great-