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THE MANUFACTURE OF ORGANIC CHEMICALS AT THE UNIVERSITY OF ILLINOIS

BEFORE the outbreak of the present war, a large percentage of all the organic chemicals used in this country, which included dyestuffs, developers and drugs, as well as the substances needed exclusively in scientific research, were imported from Europe. The largest part of these chemicals came from Germany and as soon as trade relations with that country were broken off shortly after the war began, it was necessary for the United States from that time to depend almost entirely upon the small stock on hand. An immediate growth in the chemical industry in this country took place and manufacturers were busy filling the demand, first, for the simpler substances as phenol, aniline and beta naphthol, then the more complex substances as hydroquinone, aspirin, salol, amidol, etc. Recently commercial concerns have been working, and are at present working, upon the more fancy chemicals, particularly among the dyestuffs and drugs. Until within the last six months, however, no attempt has been made to prepare either the complex organic chemical reagents needed in analytical work or substances used exclusively in scientific research. The supply of such chemicals in this country in 1914, held chiefly by large distributing houses and university laboratories, was considerable so that by careful conservation on the part of the universities and greatly advanced prices on the part of the distributing houses, a serious lack of these compounds was not felt until this last year. Nevertheless, for the past two winters it has become necessary in universities where large amounts of organic chemical research have been carried on, for a student to spend a considerable part of his time which under normal conditions would be devoted to original investigation, in preparing various

substances which previously he had been able to purchase. The manufacturers have had good reason for not undertaking the production of such substances, because the number of chemicals of considerable commercial value not yet manufactured in this country is still large and it has been impossible for the various concerns to obtain even a sufficient number of chemists for this work. Moreover, the demand for organic chemicals used exclusively for research work or the demand for organic chemical reagents in the United States is small and the methods of preparation often difficult so that no profit could be expected from such a branch of the industry. In fact, a firm would be fortunate not to incur a considerable loss in such an undertaking, provided their selling prices were reasonable.

A number of the university laboratories, in order to overcome the trouble which thus arose, made during the summer months certain chemicals necessary for the winter researches. At the University of Illinois especially, this manufacturing was taken up extensively. It was started in the summers of both 1915 and 1916, a few graduate students working out the processes for, and then preparing, a few kilos of some ten or fifteen substances. Since this plan worked out successfully, it seemed worth while to develop the work further and also to give other institutions, where organic research was being done, the benefit of the experience gained in the Illinois laboratories. Consequently, last spring a letter referring to the manufacturing and the possibility of expanding the work to fill the demand of other laboratories was sent to the departments of chemistry of over twenty of the leading institutions of the country, as well as to the larger distributing houses that might be interested. Favorable replies came in and several orders for chemicals were received in spite of the fact that at that time no quotations could be given. About ten students were retained for the work during last summer and the manufacturing was carried on from the first of June until the first of September. Shortly after the work had been started, the news of it spread and more and more requests came until nearly eighty different chemicals were prepared in amounts ranging from a few grams to over sixty pounds. A business which during the summer it was expected would be about $1,000 turned out in the neighborhood of $5,000 and the only reason it was not larger was on account of the lack of men and laboratory facilities. Especial attention was paid to the development of methods from the laboratory scale to amounts of from one to two pounds and to the elimination of expensive and needless processes which are, almost without exception, used in the teaching of elementary organic chemistry. This kind of work is of first importance to the chemical industry at present so that in addition to the advantage of saving much time for the students during the winter, special training such as they could hardly receive in any other way in a university was given to these men. Moreover, the men were paid 25 cents to 35 cents an hour, a sum sufficient to cover their living expenses.

The whole undertaking proved to be very satisfactory and great help was given all over the country. More than thirty university laboratories, many technical concerns, and many of the large distributing houses were supplied. Because of the success of the plan, arrangements were made when the university opened last fall to continue the manufacturing. Two men were given so-called manufacturing scholarships and were to devote all their time to this work for one semester, with the exception of a few hours each week spent at lectures. Several other men were hired by the hour from time to time to attempt to keep up with the orders. It has been decided to continue the work and if possible to increase the staff to four or five men doing full-time work. Since last summer, demands for chemicals have continued to come so rapidly that only a small fraction of the compounds wanted could be furnished. The number of different chemicals already sold outside of this laboratory has increased to over one hundred twenty and the value of the manufactured substances now amounts to between $8,000 and $9,000. When one considers that for the most part

the chemicals have been distributed in lots of a few grams to a few ounces, in some cases in amounts of a few pounds, it is easy to realize the labor involved in this work. Although the above figures in dollars may seem insignificant compared with those of an ordinary commercial concern they seem large for this type of manufacturing when one is reminded that very little apparatus, a few copper cans and two or three large stoneware jars, was purchased outside of the equipment already available; that the amount of each chemical manufactured at one time was generally one to two pounds, sometimes less, and never over five pounds; and that the work is being done by comparatively inexperienced men.

Many different types of chemicals have been synthesized. Of those badly needed in analytical work may be mentioned dimethyl glyoxime, nitroso beta naphthol, cupferron, nitron, ninhydrin. Dimethyl glyoxime, before it was ready for sale by the University of Illinois, was entirely off the market. This reagent is most valuable for the quantitative determination of nickel and without it nickel steel manufacturers and analytical laboratories had to use less satisfactory methods in their nickel analyses. Although only extremely small amounts of this substance are needed for a determination, over 60 pounds were sold within the first month. Nitroso beta naphthol is a reagent for the quantitative separation of cobalt and nickel, nitron for the quantitative determination of nitric acid and nitrates, cupferron for the quantitative separation of copper and iron, and ninhydrin is used as a delicate testing reagent for alpha amino acids. The demand for these has been comparatively small but, nevertheless, urgent. Other chemicals widely used in synthetic organic chemistry have been made, such as malonic ester, acetoacetic ester, ortho and para nitro benzoic acids, dimethylamine hydrochloride, allyl alcohol and acetonitrile. In one or two instances, chemicals as amyl alcohol and amyl acetate of a very high degree of purity have been prepared for certain biological laboratories, or again, as ethyl benzene, for certain physico-chemical work. Various rarer chemicals to be studied for their insecticidal action as furfural and chloropicrin, others for their various physiological properties as tetranitromethane or mercury dimethyl have been synthesized and finally many uncommon chemicals needed purely for scientific research. Especial attention has been given to the purity of all the chemicals sold. They have been carefully tested and in many cases have been compared with samples of Kahlbaum's products which had been obtained before the war. Wherever this was done, it was found that those manufactured at Illinois were certainly as good and in many cases much better than the imported materials.

In general, the chemicals have been sold at a price which would cover labor, raw materials, and a general overhead charge and when sold to commercial concerns, a slight profit was added. Whenever chemicals were made which in ordinary times had been manufactured on a large scale, for the most part in Germany, it was generally impossible to make them at a price approaching that which existed before the war. If, however, the chemicals were those which had never been manufactured on a large scale, it was found that even though the raw materials were much more expensive than previous to 1914, in practically every case the cost was either below, or never much above the 1914 Kahlbaum price. If only a few grams of a substance were made, it was natural that the charge had to be high if expenses were to be covered. Thus whenever it seemed probable that there might be a future demand for these substances, a larger amount was synthesized and kept in stock, thus lowering the price and possibly being of aid to other laboratories at a later time.

Recently a committee has been appointed by the President of the American Chemical Society consisting of five organic chemists, one from each of five of the leading institutions in the country, Johns Hopkins, Chicago, Michigan, Columbia and Illinois. The purpose of this committee is to arrange for cooperation in this work among the scientific schools, hoping thus to cover much more ground than one university possibly could.

Innumerable difficulties are involved with such a plan but it is hoped it may be successful.

Within the last few months, two small commercial concerns have started developing this same branch of the industry. They have confined themselves as yet to preparing the more important reagents for which there is constant demand and to manufacturing the bacteriological stains needed so badly in physiological work. The prices charged by these firms are necessarily high, in fact so high that they are almost prohibitive to most of the university laboratories. These prices in the course of time will undoubtedly be lowered and the universities can then devote their energies exclusively to compounds required only for scientific research. It may be possible in the near future to have cooperation between these firms and the university laboratories, an arrangement which would be an advantage to all concerned.

Whether such small companies can live after the war and expand and so supply the demand for rare chemicals in this country is a question. It seems improbable that they will be able to compete with the foreign supplies unless a high tariff is levied. It is hoped however that the present work of these concerns may continue not only until the war stops but until such a time as a large chemical manufacturer as the National Aniline & Chemical Co. or the DuPont Co. will be in a position to undertake this branch of the industry in a thorough way and enter the business, not for profit but to be of real service to the country and to make the United States independent of foreign laboratories in this as well as other chemical lines. It is the present intention, at any rate, at the University of Illinois, to continue the work permanently, so that regardless of the great help that can be given outside, there may be a university where a graduate student in organic chemistry may be drilled in commercial methods before he goes permanently into technical work.

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SHALL WE EAT WHOLE-WHEAT BREAD?[1]

The shortage of wheat and wheat flour, due to the excessive demands of the allied armies and neutral nations, has forced Federal and State Food Administrations to adopt certain policies in regard to the consumption of these very important foodstuffs. For example, steps have been taken to control the distribution of flour in a manner similar to that applied in the retail distribution of cane sugar. An educational campaign has been inaugurated with the view of educating the people to the consumption of larger quantities of the other cereals such as oatmeal, barley, rye and corn in substitution for wheat products. Another suggestion, which has met with some opposition, is that of milling a larger proportion of the wheat berry into flour, making what is usually termed a whole-wheat flour. The advocates of this idea argued that by milling a larger portion of the wheat kernel into the flour there would be less bran, shorts and middlings to be sold for stock feeds, wheat would go farther as a human food, and the amount saved would be available to assist in meeting the increased demand for wheat. The scientists and administrators supporting this view also contended that whole-wheat flour contained certain nutrients that standard patent flour did not contain and therefore was a better food and on account of the content of bran or "roughage" in the former it possessed a distinct advantage over the standard patent flour on account of its laxative action.

A counter campaign of education was immediately launched by certain of the milling interests represented by Professor Harry Snyder, formerly of the University of Minnesota. Professor Snyder has maintained throughout, both in public speech and in published articles, that "white bread is the best war bread" on account of the fact that it is more nutritious than the breads made from 82 per cent. extraction flour or flour milled from the entire

[1] Address before the University of Minnesota Section of the American Chemical Society, November 23, 1917.