

five) and four, and differ therefore for each element. Upon this fact is based the system of structure symbols, and in Fig. 6 some of these symbols are given. It is evident that with this simple principle to each organic compound, a definite and different symbol can be given, for the atoms of the respective elements are thought to be points, and the points are determined by lines, thus where a line begins or ends an hydrogen atom is supposed to stand; where the line makes an angle or two lines come together, oxygen stands; where three lines meet or radiate, nitrogen exists, and at the point where two lines cross or four lines come together, an atom of carbon is thought to exist. While these symbols at first might seem to be complex, they make in reality the study of organic chemistry much simpler, for a little practice in deciphering and constructing these "valence-structures" will enable the student to form clearer images of the structure of a compound. They are the structure-skeletons; for any structure formula can then be taken, each atom has to be written down by its symbol, and the symbols connected by the bonds, and then all the symbols are erased and the bonds left standing will yield the "structure-symbol."

The elements H, O, N, and C, have been called bio-elements, for they constitute over 99 percent of all living matter, less than 1 percent is filled up by other elements. Similarly the elements which constitute the rocks and stones are mainly the oxides of Na, Mg, Al and Si, forming, as silicates, the larger part of the known earth crust, although of their structure we know little, for their composition is complex and defies the ordinary methods of structure-analysis. Nevertheless, the new researches on crystal structure, with the help of X-rays, will, perhaps in the future, throw more light upon the chemistry of the silicates, and if the structures should become better known and established, the same method of representation can be employed. Like in the structure symbols of organic compounds the valencies are made the basis in the system, so could also the valencies of Na —1, Mg —2, Al —3 and Si —4 be employed to form the basis of structure symbols for the rock-forming silicates, distinguishing them from the bio-elements, *e. g.*, by a circle.

The evolution of the chemical symbols is an interesting chapter of chemistry and illustrates the attempts of human mind to represent its conception of facts in a concise way, from the allegorical symbols of the alchemist, to the structure-symbols of to-day, which illustrate our present conception of organic structures.

COLLEGE OF PHYSICIANS AND SURGEONS,  
SAN FRANCISCO, CAL.

## PROBLEMS OF THE MANUFACTURER OF MEDICINAL CHEMICALS DIRECTLY RESULTING FROM WAR CONDITIONS.\*

BY B. L. MURRAY.

It may safely be said that all manufacturing enterprises in the United States have encountered problems directly resulting from war conditions. It is not possible that one industry, or indeed one individual, has remained isolated and unaffected by the war now four years old. We may not perceive in our casual observance of an industry, in just what manner war conditions have had their

\* Read before Scientific Section A. Ph. A., Chicago meeting, 1918.

effect, but it is unthinkable that any can remain undisturbed when all the great nations of the world, and many of the lesser, are engaged in the most stupendous war of all time.

The steel industry, for example, has its problems. You have read of them. The largest and most highly organized steel industry in the world is at this minute straining every nerve to produce enough to meet war's demands. And it will meet them. The textile industry, highly organized for years, is to-day turning out quantities of its products hitherto unheard of, especially for the forces of ourselves and allies. And the textile industry will meet the situation as presented to it. The farming industry—probably the greatest in the world—has combed the country and the city in its search for workers, both men and women, to sow more acres and harvest more bushels than ever before in the history of farming. And it is harvesting those bushels this day. The ship-building industry—need anything at all be said of this industry? You are familiar with it. Every paper rings with its acclaim. In April 1917, no shipbuilding industry of note; to-day our ships seek the waters literally in fleets! Before hostilities broke out with our own country, we built almost no ships. Our commerce, broadly speaking, was done in ships of other nations. Great Britain, one of our most powerful allies, carried much of our shipping. Some was carried by our other allies, and a portion by Germany. Great inconvenience to our business world occurred when the German shipping was suddenly stopped. But we had the help of Great Britain and others to fill the gap. Thus shipbuilding and shipping had good support. And when we entered the war in 1917 our shipbuilding industry was promptly created by government capital. Our ships are launched in fleets! Only 24 days from the laying of the keel to the launching!

The chemical industry do you ask? No less wonderful than the shipbuilding! Relatively small foundation to build on, but has grown to gigantic proportions. The chemical industry is making good! It is not top-heavy. Not going to crumble soon. Held down by sober business men. Held up by American chemists, the best in the world to-day. Upheld, as are all our industries, by the *civilized* peoples of the world. You know what the American chemical industry is to-day. You can not fail to hear about it. We have chemicals to spare—and we are exporting them to those who want them. The chemical industry does not intend to quit when the war is over. Plans are not laid with that in view. Our new and highly developed chemical industry will stick, and no man or group of men will be able to pry it out of its honestly won position.

The chemical industry and the shipbuilding industry may be considered as in somewhat the same positions although there are differences. When war first confronted the world as an actuality in 1914, the United States, Great Britain, France, Italy, Japan, Russia, in fact the world itself, depended almost entirely on Germany for its chemicals. This is true of chemicals in general, but particularly true of medicinal chemicals, in which you are especially interested. The United States depended almost entirely on Germany for the medicinal chemicals! And Germany became an enemy country! American chemical manufacturers rose at once to the occasion. Factories sprung up like weeds, and others greatly expanded. Chemists became sought after, and soon, to the astonishment and satisfaction of all, we were producing in quantities previously undreamed of. The government

did not do this. Government aid has been more recent and mostly in munitions. Individual enterprise produced our great chemical industry.

It is indeed a great privilege to stand to-day so entirely independent. America is proud of her accomplished works, even though impelled to the performance of them by the greatest war of history. And the chemical industry is proud to stand side by side with the shipbuilding industry as one of the new and most remarkable results of the war.

One of the first problems with which manufacturers were confronted was shortage or lack of raw materials. Supplies of raw materials that had given no particular trouble in the past were suddenly shut off. For example, in peace times opium came mostly from Turkey. Its list price was about \$4.50 per pound and manufacturers were familiar with its behavior in their laboratory processes. But Turkish opium suddenly became unobtainable and prices rose to \$20.00 or even \$30.00 per pound. Persian opium came into the market. It is somewhat different in its nature, so that processes of manufacture of opium preparations had to be revised. One interesting feature of this example is that from Persian opium plenty of codeine is obtainable, whereas less is yielded by Turkish.

Coca leaves came mostly from Java. Supplies became obtainable with difficulty because shipping was so limited. South American leaves again came into the market, necessitating in turn changes in the processes of manufacture of preparations from coca leaves, since the leaves from various sources are different in their make-up.

Cinchona affords another example of difficulties encountered with raw material. The Dutch owners of the East Indies, the principal source of cinchona, have placed its sale on a restricted basis by means of licenses. It was difficult and expensive enough to obtain supplies heretofore, owing in part to limitations of shipping, but it is more so now.

Pharmacy, happily, consumes relatively small amounts of potash, but has, nevertheless, suffered to a considerable extent from shortage of potassium salts. All potash came from Germany in the past, but many new sources have now been found. They are, as yet, too limited in their output to meet our national requirements fully, although the demands of pharmacy and medicines are being met reasonably well now. Because Germany had potash to sell she told us to use it. And because she told us to use it we did so. Its use was not really so necessary in pharmacy and medicine as we allowed ourselves to think. Physicians now tell us that in general the corresponding sodium salts are just as useful therapeutically, in fact in many cases are preferable. Of course they are cheaper, and for the two reasons, usefulness and cost, sodium salts should be employed wherever they can be. But we should also use them because by so doing we release an equivalent amount of potash for war purposes.

Manufacturers that were successful in obtaining their raw materials, even though with great effort, were even then by no means in smooth waters. Apparatus is constantly needed both for renewals of the present equipment and for manufacture of new articles. We were surprised to have the war bring to our attention the fact that much of the apparatus used in chemical manufacturing came from enemy countries. This was especially the case with glassware, porcelain ware and stoneware, but to a great extent also with enameled iron and other wares,

particularly acid-resisting wares. You will readily see what a great demand and burden was suddenly thrown upon our makers of glassware, porcelain ware, and stoneware. Many new and very extensive, as well as most urgent, demands were made upon them. And our foundry men too, producing the great pans, kettles, vacuum dryers and such, encountered orders for supplies entirely beyond their ability to supply promptly.

No doubt the experience of Merck & Co. in getting apparatus for renewals and for new work was similar to that of other manufacturers. It was simply necessary to wait for many of the pieces required. Thus plans for making new products were formed, methods of manufacture worked out, buildings erected, raw materials provided, outlets for the finished goods arranged, and all were then held up for an indefinite period while waiting in line for turn at the factory of the apparatus maker. These almost interminable waits for apparatus were exasperating, to say the least. It is very much like being all dressed up and nowhere to go. Weeks elapsed, then months. An important piece of machinery ordered in November not yet obtainable in August!

But there were good and sufficient reasons for all this waiting. New industries, those of the apparatus makers, were being born or recreated in the United States. They are now with us strong and sturdy. Long may they live!

Given the raw materials and apparatus, men and women, skilled and unskilled, are required. The labor question arises. Long before our country entered the war there was such a demand for labor that employers were alarmed. The allies were making such great demands on us for food, munitions, clothing and supplies in general that our laborers were in unusual demand. It was difficult to find a man to stick to any task for more than a brief period of time. There was much shifting about from one employer to another, thus creating great uncertainty in factory production.

With the calling of the United States Army the difficulties, of course, greatly intensified. Factories sent their best men with willingness and eagerness to the army and navy, displaying with proper pride the service flag of our country. But the problem of renewing the forces of chemical labor had none the less to be met. The problem has been met, and is being met daily, but it is one of the real problems of chemical manufacturers. Chemists, engineers, mechanics and skilled help in general were properly included in the draft. Many volunteered, others were drafted, so that from day to day the manufacturer's personnel was apt to change. So much uncertainty arose as a result of this that production was seriously threatened. Finally, however, the government came to our assistance. To-day unskilled labor is employed through government agencies; and chemists for important work in essential industries are returned from the ranks of the army to the ranks of the industries.

Chemicals, even medicinal chemicals, produced from suitable raw materials, in proper apparatus, by conscientious labor, are of small value unless containers in which to sell them are available. And the problem of containers has been a trying one. Bottles are very difficult to obtain and supplies must be arranged for well in advance, even several months in advance of requirements. Tin cans became very uncertain, because the war's requirements on tin must of necessity be met before any other. Cartons, carboys, barrels, boxes, and in general all

containers demand special consideration. And, in addition, much larger quantities of them are needed; to such an unusual extent have demands for the products of our own country increased.

How ship your products to your customers? Not by freight; not by express; for both these are greatly congested and positive embargoes abound. The mails are useful for small shipments, autos for short haul shipments only. It became necessary to employ a representative, who could be in Washington or elsewhere as needed, for the purpose of demonstrating to those in authority over questions of shipping, that medicines, and, especially medicinal chemicals, should have preferential treatment. The *sick* are waiting! Delays in shipping such material as medicines should not be allowed, much less required! Orders giving your products priority over other less essential shipments had to be earnestly sought. Such priority orders became obtainable but only after due effort. It developed into a real burden, however, when such special efforts were necessary in order to obtain each shipment of your raw material, your coal and your containers; and in addition to send out each shipment of your finished products. Lately this matter has been greatly cleared up and medical and surgical supplies, as well as the essentials for their production, are given proper priority. It has been a great relief.

Just at the moment when many of the troubles above related had, by dint of strenuous and concerted efforts, been overcome, or had at least been put in temporary abeyance, the telephone brought the startling news to Merck & Co. that "at five o'clock *to-day* the electricity for your motors and machinery will be shut off until further notice." It was the voice of the Public Service Corporation that spoke. Of course, they could not furnish current, because the ice was so thick that the coal barges could not get up the river to their power house. And besides there was no coal to come up the river. Priority orders for coal had failed to materialize for the Corporation that lights our houses and our streets, that propels our street cars and that turns our motors. Twenty minutes' notice to give up electricity! And our works running night and day!

I would not have you think that there is in all of this any tendency to find fault or to complain. Such is not the case. The situations as they arise singly and collectively in the American chemical industry are new, and they have to be met. They are being met! And met successfully! And it is in this success that we find pleasure in striving. And pride in our accomplishments. Let the government commandeer all the acetone in the country. We'll make our chloroform from something else. Let them send their questionnaires. Let them have our ammonia and our acetic acid, and anything they need. The chemical industry of America is working for and with the government, not in spite of it. They ask for a million cans of ether to be ready in a few days! They want thirty-eight million pills! There is an urgent call for five hundred thousand bottles of carbolic acid. All together with a will and the demands shall be cheerfully met. For does not every American here with red blood in him know that every such deed *accomplished* helps to defeat the hated enemies of our country in their desperate efforts to impose their ghastly Kultur on America, even as they have already imposed it upon Belgium!

---