TEACHING OF CHEMISTRY FROM THE FACTORY VIEWPOINT

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The vocational outlook of the student in chemistry and chemical engineering has been greatly broadened in the last two decades. Twenty-five years ago, when I first became interested in chemistry, it was for strictly academic reasons; if chemistry were to be a means of livelihood, the greatest probability was that it must be by teaching, research at some educational or governmental institute, or by means of chemical work incidental to some such related industry as cement, fertilizer, zinc smelting, soap, coke, steel, brewing, sugar, water supply, paint, petroleum, or pharmaceuticals. It is true that in the east the opportunities of a chemical student were not quite so barren, but here in the great Mississippi Valley the graduate had an excellent chance to become the protuberance of the potato instead of the tuber itself. When I think of the men of my acquaintance who finished a chemical course in those days, this statement finds ample justification.

Today the picture has changed. Now the young chemist who is industrially minded finds ample chance to enter a strictly chemical industry where his opportunity is limited only by his own native ability, his personality and his chemical training. In fact, the chemical industry of the country today finds itself in much the same position as the aviation industry where expansion is limited only by the number of trustworthy pilots available.

Formerly, the greatest need of the chemical industry was financial; chemistry was a legerdemain that bankers and fiscal agents did not understand and consequently were prone to distrust. But in recent years American chemists have succeeded in translating the language of chemistry into the language of the balance sheet, and to bankers, as well as to the general public, this is not a foreign tongue. The manufacture of chemicals is a highly technical matter and for this reason a chemical plant, to manufacture at low cost must be more thoroughly manned with technical men than most other manufacturing plants. Because of this fact, improvements and changes in processes—even long established ones—have been very rapid and the resulting obsolescence has been

and is tremendous. This situation has made chemical manufacture highly competitive and has introduced a state of flux through which every industry must pass before stability is reached. The ascending road of chemical manufacturing progress is littered with the wrecks of inefficient organizations and individuals, but the survivors have forged ahead with ever increasing power and stamina.

What is the effect of all this on technical personnel? Simply this: Standards required have been consistently raised until the mediocre finds scant consideration and the chemist or chemical engineer of proven ability is at a premium, and the supply of proper calibre newcomers is far enough short of the demand at present as to prove a handicap to the industry. Technical schools, universities, and manufacturers are alive to this situation and measures are gradually being taken to meet it. However, only a beginning has been made in this direction and much more remains to be accomplished. It is my opinion that few, if any, technical courses offer the same opportunity to the young man of energy and creative ability as do chemistry and chemical engineering today.

The matter of training young men to fit them for a place in the chemical industry is an important one. It is now 13 years since I have had the pleasure of being actively engaged in such an important work, and it would therefore be preposterous, if not indeed ridiculous, on my part to venture more than the opinion of the layman on the subject. It is with such a point of view that I continue.

In our industry, the activity of the chemically trained man finds outlet in various days. These may be catalogued as follows:

Research
Analytical control
Supervision of manufacturing operations
Engineering
Executive
Sales

The requirements of each vary considerably with respect to positive characteristics of the individual and even more so in so far as negative characteristics are concerned. Men of widely divergent personality, ability and training may find marked success in one or the other of these activities, and it is the duty of the manufacturer to fit the man to the place for which he is best suited. But for all, a thorough knowledge of the fundamental laws and

principles of chemistry and physics is an absolute necessity. The teaching of such fundamental laws and principles must be accompanied by a sufficient amount of fact to amplify, explain and fix them indelibly in the student's mind. At best, a technical course can only supply a man the tools with which to work. The graduate is not a finished product; he must always continue to be the student and the investigator; his curiosity must always be alive and his imagination must ever be keen and active; but these avail him little if he can not solve his problem when he meets it and recognizes it, and it is a grievous thing to find how often technical men of real accomplishment lack the ability to apply fundamentals such as gas laws, thermal laws, vapor pressure, mass action, or centrifugal force to the problems confronting them.

The courses which teach these fundamentals to the students are general inorganic chemistry, qualitative and quantitative analysis, general organic chemistry, elementary physical chemistry, elementary physics and mechanics, and elementary mathematics. My experience leads me to believe that too often these courses do not receive the attention that they should on the part of teacher and student. They should have the place of prime importance in any technical curriculum. After the student is well grounded with these fundamentals, it becomes the duty of the teacher to see that he gains resourcefulness in applying them; that he learns to make use of such imagination as he possesses and that he acquire reading habits that will enable him to gain knowledge and information on his own account.

Advanced courses in the numerous branches of chemistry serve to broaden the student and to accomplish this result, but I believe that in addition to the laboratory work that usually accompanies such courses, rather complete written reports on special subjects related to the course should be required. I also think the teacher in chemistry would do well to follow the example of the English teacher in giving outside reading assignments to students and requiring reports on such assignments. Nothing has such a narrowing effect upon the student as to get the idea that all that is required of him is to master the contents of a certain textbook from cover to cover. What is he to do in a factory if the problem confronting him can not be found in such a textbook?

The student who is looking forward to work in a chemical factory does well to acquaint himself in a general way with numerous processes such as are outlined in various industrial chem-

istry texts, but such acquaintance should be gained by outside reading rather than by class room instruction. Class time is too valuable to be used for such a purpose. Rather use it to discuss relative merits of different processes for the same product under a given set of conditions; or have the student work out the design for an installation to manufacture some simple product such as glauber salt or sodium thiosulfate, and criticize and discuss his work. Has he chosen the most economical crude materials, and can he show that he has? Can he show that his different pieces of equipment match up properly in size with each other? Is his design ample for the purpose or is it in need of simplification? Does he use the proper type of filter? Should he employ line shafts or direct drives for stirring equipment? Can he justify his choice? Is his equipment properly arranged for the correct routing of material through the plant? Has he an idea of what his cost sheet will look like? Has he chosen the proper material with which to fabricate the several pieces of equipment? It does not matter so much that he has designed his equipment properly, but it does matter what points have occurred to him and whether he has given them due consideration. It does matter whether he has the ability to think for himself. To illustrate: from his most elementary course in chemistry the student uses chemically pure acids, chiefly hydrochloric, nitric, and sulfuric. Does it ever occur to him to ask himself how they are produced from the commercial product? By distillation, perhaps, but in what kind of equipment? I confess that personally as a student I was very little troubled by such a foolish question. I was later, however.

I put first in importance teaching the student fundamentals. Second, teaching him to think. He will have to do it when he enters the factory. He should have the habit when he leaves school.

A course may equip a student admirably for his work in the plant and still fall short of its duty to him. It should awaken in him the ability to use his leisure time pleasantly and agreeably in some other way than reading chemistry, the Saturday Evening Post, and the daily newspapers. There should be some place, however small, in his curriculum where he can at least get a glimpse of some of the humanities, economics, sociology, law, literature, music, art, or whatnot. Let him not lose his ability to become interested in something besides his profession. It will make him a better chemist, a more useful citizen, and a happier man.