could be accurately followed. We have found from our preliminary experiments with the phenylhydrazones as derivatives that just this can be done.

Briefly, the method is based on the familiar principles, used in analytical chemistry, of adding an excess, in a known amount, of the reagent. The reaction desired is allowed to go to completion and the excess, unreacted reagent is then determined. The amount having entered into the reaction is then found by difference. In this case, the amount of phenylhydrazones formed stands in a simple stoichiometric relation to the oxy-compounds present. The actual determination of the excess phenylhydrazine used is made by the method first developed by Strache[4] and later refined by Riegler.[5]

This is done by quantitatively decomposing the unused phenylhydrazine in an alkaline solution of the oil by adding a copper sulphate solution. The copper oxide formed reacts with the phenylhydrazine base yielding free nitrogen which may be caught in a eudiometer over caustic and measured in the usual way. The reaction is conducted under an atmosphere of carbon dioxide.

[4]Strache, Monat. *12*, 524, (1891).
[5]Riegler, Zeit. Anal. Ch. *40*, 94-5, (1901).

Briefly, the results so far show that the amounts of those compounds which are capable of forming derivatives with phenylhydrazine increases as the oil ages and becomes rancid. This is true whether the aging is natural or accelerated by means of ultra-violet irradiation. The values appear to be continuous and show no irregularities even after the development of a decided organoleptic rancidity.

The foregoing is a short resumé of the type of work now being attempted by the Mayonnaise Fellowship plant at the Bureau of Chemistry and Soils. It is hoped that this paper will serve not only as an introduction for this new work on behalf of the Mayonnaise Manufacturers' Association, but that it will be considered by those who are already in this field of investigation as a cooperative program attacking the problem from a new angle. In such a spirit of collaboration, the Mayonnaise Association wishes to assume its just share of the work involved in the effort to increase the acceptable life of vegetable oils and the products into which they enter.

Acknowledgement is hereby given the kind generosity of the Capitol City Products Company of Columbus, Ohio, for supplying the cottonseed and corn oils used in this investigation.

(A paper by Dr. Kilgore read at the Fall meeting, giving even later developments, will be published in an early issue.)

Chemical Analysis, Tool and Training

By C. S. MINER
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A PERIOD of belt tightening and bread lines, of diminishing or vanishing pay checks and disappearing departments is, perhaps, the best time to evaluate things as they actually are and to determine what are the ultimate necessities in the various lines of human activity. I haven't had either the time or courage to attempt the great indoor sport of questionnairing my colleagues, but I'm willing to hazard a guess that for every analytical laboratory that has fallen under the ax of the budget choppers, there are at least three research laboratories that have been cut off root and branch. While we all agree that the research laboratory is necessary to the future health and growth of industry, we know that the analytical laboratory is absolutely essential to preseve its very life; the operation of the factory is impossible without the help of the analysts. Research may be sacrificed to fill the gaping maw of the hungry creditors, but unless the factory is to stop functioning, the analysts must continue to turn out their daily quota of necessary control analyses.

I have a letter on my desk from a corporation that wants to hire a chemist. They started out with the idea that they must have a man to double in research and analysis, but when I told them that one chemist couldn't do their necessary analytical work and have any substantial amount of time left for research, they promptly decided that the research wasn't so important after all.

In general it appears to be true that there is a much greater degree of safety in analytical than in research positions. We know that in our own organization we have frequently hesitated to move a married man from an analytical job to a research job because we felt that there was a greater element of permanency in the analytical work. Wouldn't anyone of you advising a chemist with a family to support feel compelled to tell him that there is greater certainty of bread and butter in a job in the analytical laboratory than there is in the average research position?

Doesn't all this mean that we've been underestimating the importance of analytical chemistry through all these years when we have been ballyhooing research? After all industry can live for a time at least without research, and it can't live without analysis.

The low status of everything connected with analytical chemistry is so well established that probably it will not change. I don't really expect to accomplish anything by talking about this matter except perhaps to make those of us who have to do with analytical chemistry feel a little less modest about our status in the profession. Despite the Cinderella role that analytical chemistry normally plays, it's a mighty difficult thing for a research laboratory or a research chemist to get along without it. In fact the tendency of some research chemists to avoid the supposed drudgery of analytical procedures frequently operates as a tremendous handicap to the successful handling of their own research problems.

The idea that a chemist can learn just as much from reading the report of an analysis which has been made by someone else, as he can by making that same analysis himself is a *highly mistaken* one. There's a story illustrating this fact that's a classic in the Chicago area. It discloses how our good friend, Dr. Thurnauer, got his very successful professional start.

Briefly the facts are that in analyzing a bearing metal he found in one of his solutions a few black specks which most of us might have guessed to be dust but which enabled him to prove the presence of a minute quantity of sulfide.

On the discovery that the trace of sulfide in this bearing metal was responsible for its peculiar quality, Gustav Thurnauer based his first important success, and it is highly improbable that if he had turned the analysis over to an assistant any such pleasant outcome would have resulted.

Some time ago I had a great deal of trouble diplomatically persuading one of our organic men who had just developed a very hopeful looking process, that he himself ought to analyze some of his product. I did persuade him just short of issuing an ultimatum and when he made the analysis, a trace of color in the ash suggested to him a catalytic factor which probably never would have been dreamed of if the analysis had been made by someone less thoroughly informed with regard to the process.

Latterly I have been very much interested to learn that in one of the research groups in Chicago each research man does his own analysis, and that this system has proved highly satisfactory. Evidence could be piled up but I assume it isn't necessary to prove the general usefulness of analysis as a tool.

Yet analytical chemistry is not only a most useful tool of the chemist and of chemical industry, but its practice furnishes a training for which nothing else constitutes an adequate substitute. As a means of fitting young chemists for the best positions the profession has to offer, some of its advantages are obvious. I am not urging the importance of analytical chemistry as a means of teaching the fundamental facts of the science. That doctrine has many eminent proponents in the teaching profession, but it is not that phase of the subject that I am asking you to consider. I want to emphasize the importance of the analytical laboratory as an agency for the training of graduated chemists in certain elementary matters essential to their success which are not specific to chemistry.

First of all two great essentials, speed and accuracy, are taught here. The requirement that work shall be rapid and at the same time accurate is more rigorous here than in other branches of chemical activity, not because accuracy and speed are more important in the analytical laboratory but because they are more easily measured there. If two chemists are making protein determinations on cottonseed meal, and one turns out 20 per cent more completed and accurate analyses than the other, it is relatively easy to determine the comparative value of the two men for that particular line of work.

There is even a great advantage to the man himself. He can accurately measure the rise and fall in the quality of his performance and see whether or not his work is improving from day to day. I have even known analytical laboratories where speed records were kept unofficially and where they made informal economy-in-motion studies that resulted in cutting seconds and minutes from the various weighings and titrations. I am not recommending this procedure because of the natural tendency to sacrifice accuracy to speed, but despite that drawback there are some great advantages inherent in the scheme.

Another essential taught in the analytical laboratory is the necessity of hard work. I know of no place where the requirements for quantity output are so brutally definite as in the analytical laboratory. I remember the terrific shock one newly graduated young chemist received when he was being initiated into his first job as routine analyst for one of the factories of a large corporation. His mentor, a chemist who had spent a great many years in the industry, showed him the report blank which contained spaces for more analytical determinations than the young chemist and all his classmates had made during a six months' course in analytical chemistry and told him that all those analyses were to be made and reported every day. The older man saw the youngster's amazement and so he added, "Don't worry, the management is very lenient about getting these reports in. The reports are supposed to go into the main office every day but that's always left to the discretion of the chemist. It's quite all right if he doesn't get his report ready in time for the last mail because he always has the option of sending his resignation instead," and there was a lot more truth than humor in the statement. So night after night the young chemist performed the daily miracle of getting that completed report on the 8:45 train, though there were plenty of nights when he finished it just in time to mail it on his way home from work. He lived through the experience, however, and I'm sure that he now values it very highly.

I don't think I need to dwell on the fact that no such rigorous requirement of performance could ever be set up except in a routine analytical laboratory, and that as a consequence only the analytical laboratory can give such training in hard work.

The necessity of honesty seems too obvious to be discussed, and yet it may not be wholly amiss to suggest that one of the advantages of analytical chemistry is the fact that it so rigorously proves the truth of the old saw "Honesty is the best policy," for we have all seen repeated and striking demonstrations of the uselessness of all methods of getting results other than those based on sound analytical procedures and accurate mathematical calculations. The classic graphite-cellulose method of Ananias and his descendants has again and again proved a complete failure, and many a young chemist has received a needed final demonstration of the value of honesty during his experience in the analytical laboratory.

In addition to its value as a training in honesty, accuracy, and industry, experience in analytical chemistry is extremely helpful to every man who assumes the responsibility for directing the work of any large number of chemists. Since there is no type of large laboratory organization that can be operated without involving a considerable amount of analytical chemistry, the man who attempts to direct such a laboratory without himself having had experience in the field is as seriously handicapped as the housewife who has to direct servants without having had hand to hand contact with housework. Analytical problems will inevitably arise, and then the practical experience in the analytical laboratory will be of the greatest value in determining policies.

To sum up, then, analytical chemistry occupies a position of unique importance as an unrivaled tool for chemists and for chemical industry. It furnishes an invaluable post graduate training for the industrial chemist and yet despite these facts it has come to be greatly under-valued. What I am campaigning for right now is more respect for analytical chemistry not only by the profession in general but by analytical chemists themselves. Industrially, at least, there is no more useful branch of chemistry and without a full sense of its values we ourselves will certainly fail to realize profes sionally the complete benefits of this important section of our science in its dual capacity of tool and training.

Abstract of Experiments on the Physiological Action of Glycerol in the Animal Organism*

By VICTOR JOHNSON and A. J. CARLSON

(From the Dept. of Physiology, University of Chicago)

AN extended study of the effect of glycerol on the animal organism was undertaken because: (1) glycerol is now being used in food preparations, and its use may be even further extended, and (2) reports have been published of various toxic effects, from glycerol administration. With regard to the latter point, a survey of the literature reveals that it is essenitally in cases of intravenous or subcutaneous administration that there may be such injurious effects as red blood cell destruction, anemia, albumin excretion by damaged kidneys, tissue damage, and even death. Our own studies have in part confirmed these findings, at least as far as red blood cell destruction and appearance of albumin in the urine are concerned following intravenous or hypodermic injection of glycerol. But when glycerol is given by mouth with other food materials the results are strikingly different.

In three separate growth experiments (run for 40 weeks, 25 weeks, and 21 weeks), involving 80 rats, it was found that normal growth occurred when glycerol was substituted for starch of a normal diet to a point where glycerol comprised 41 per cent by weight of the total food intake. Even more striking, rats receiving quantities of a normal diet insufficient to support growth, were made to grow by the addition of glycerol to the diet.

Also reproductive virility, as determined by the number of pregnancies, young born, and young weaned, was not affected in rats 41 per cent of whose diet was glycerol. On the other hand, a diet containing 61 per cent glycerol and no starch failed to support growth or to permit reproduction.

Growth experiments run for 50 weeks on six dogs clearly indicated that when 35 per cent of the diet is glycerol, dogs grow quite as well as control animals receiving no glycerol. In these dogs there was no red blood cell destruction, anemia, or appearance of albumin in the urine. The general appearance of both rats and dogs was excellent, and post-mortem examination of the tissues revealed no pathology. In general, the feeding experiments, besides indicating that the quantities of glycerol fed were non-toxic, confirmed the findings by others that glycerol is utilized as a food, probably by being first converted into glucose, in part at least.

The work on human subjects involved 14 students who took 110 grams of glycerol daily (with meals) for 50 days. These subjects showed a slight tendency to gain weight. They showed no change in the red or white blood cell counts or hemoglobin content of the blood. There was no excretion of albumin or hemoglobin and no change in uric acid excretion (a possible source of renal calculi). Body temperature curves, basal metabolic rates, and colon activity as determined by the daily number and consistency of the stools, were not consistently affected.

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