Assembling detonator plugs for high explosive shells

In the packing room of a Canadian shell factory

The Training of the Analyst*

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THE education of the scientific man, to be of practical utility, should have the broadest foundation. Excellent as the instruction may have been, the period of tuition is with many, probably with most students, too much curtailed. A chemical student on leaving college may have obtained a very good degree, and yet may know little of the practical side of the analytical profession. Is it not true that to many such even the recognition of a simple salt of a common metal is by no means easy, and is arrived at frequently only after an undue expenditure of time? And is there possessed that thorough knowledge of the British system of weights and measures so that ordinary problems can be worked out without a long circuitous process of calculation? Or give a sample of boiler incrustation and ask for the constituents present, and roughly the proportion of each. Is it not a fact that, although a correct answer may be given in, the amount of time expended has been altogether disproportionate to what should be taken over such an examination? It is not here asserted that all newly qualified men are lacking to the extent indicated, but there seems to be with many a deficiency of analytical experience, which is likely to hamper them in after life. This article is not written for any controversial purpose, but is rather the reflections of one who, after long absence from England, is able to take a detached view of what seems to be some defects in our educational system as applied to the analyst. A graduate who has adopted a chemical career may go direct from his college to a public analyst's laboratory, and there it may be that he will not suffer much from having had academic training only. He would be given work to suit his capacity, and as he obtained more experience the analyses given him to perform would become more difficult. There, with a large variety of examinations, the processes used will be of a standard and rapid kind, and after a year or two the assistant of ordinary ability becomes highly useful. Take the case of this same student supposing he has entered a works laboratory. Here, also, by constantly going over routine processes, he may become very helpful to his employers. But here there may be plant difficulties to be solved, and now, although well trained and capable of carrying out analyses satisfactorily as long as he is given unlimited time, he may be found wanting on account of his lack of knowledge of good rapid analytical methods. Here, for the most part, difficulties have to be solved with as little interference as possible with laboratory routine, and it is reasonable to suppose that an employer feels disappointed when an assistant, well recommended from his college, seems unable to carry out in a commonsense practical manner a very ordinary analysis. Perhaps it is desirable to go outside routine work and ascertain accurately the composition of some new material used on the works, such as an oil, alloy, or cement. Now, in a laboratory where such substances are examined frequently, the analysis would be concluded after at the most three or four hours. In a laboratory where such an examination is outside the usual scope, much longer might be necessary, but at any rate the training of an analyst ought to be such that he can work out a process from a work of reference, and apply it successfully to the substance in question without interfering greatly with his routine duties.

It may be of interest to young analysts to know that almost any system of analytical examination may be so carefully studied with a view to speed as to be almost incredibly shortened. A cement analyst informed me

that, working single-handed, he was able to determine quantitatively in one hour the silica, iron, alumina, lime, magnesia, and loss on ignition of ordinary cement. Another wrote me that he was now able to determine the amounts of antimony, iron, lead, and arsenic in *antimony ochre* in two hours, and the same in two *stibnite* ores in three hours. Perhaps a few remarks as to speed in performing analyses may be found useful. It may frequently be obtained by bearing in mind that it is most helpful in performing a new analysis to write down in what direction the process may perhaps be shortened by the introduction of, say, a volumetric for a gravimetric process, which is nearly always possible in inorganic work. And when a good process of estimation has been arrived at it may be better understood by ascertaining the effect of varying conditions—such as the concentration of the solution to be examined, the strength of the volumetric reagent to be added, and the rapidity with which the latter may be run in, and so on. In this way sources of error may be discovered and guarded against and invaluable experience obtained. On no account should it be considered that no improvement is possible in a process, even although such is taken from a good textbook. Many excellent methods of examination are locked up in laboratory journals, and are not likely to be published except, perhaps, after the lapse of some years. When physical constants, such as the relative density and refractive index, are to be determined frequently, a table of corrections for temperature is simply invaluable.

Sometimes in routine examinations the use of a pipette to deliver a constant weight (*Chemical News*, July 28, 1916, p. 41) may prove a great time-saver. Also standard solutions can be made often so that 1 cc. corresponds to 1 per cent when 1 grm. of substance is taken. This is a good system, and saving of time and error. With every analyst the time comes when, from some cause or other, there is an apparent deficiency of work in the laboratory. This period in reality is most valuable for maintaining efficiency. Everyone during his busy days will see matters, such as the testing of new processes, that cannot at once be attended to, and these inquiries should be entered at the end of his note-book for further consideration when opportunity permits.

Now, the student in his academic course of practical work has no time to do more than carry out typical analyses, so that the writer desires particularly to support the useful and practical recommendation of Mr. A. Chaston Chapman, formerly President of the Society of Public Analysts and Other Analytical Chemists, set out in his Annual Address (*Chemical News*, 1916, cxiii, 69) that:

"So far as our colleges are concerned I feel very strongly that a more thorough training in analytical chemistry is desirable, and I would in addition venture to suggest that the present curriculum of those chemical students who intend to become professional chemists should whenever possible be amplified so as to include a further year of study.

"During this post-graduate year the student should be trained by thoroughly competent and specially selected teachers under conditions approximating more to those of the technical than to those of the academic laboratory."

It is a matter of opinion as to what would be the course of study during this year that would develop best the powers of the student. The program might include:

Water analysis for industrial purposes. Fuel (coal), determinations of volatile combustible matter, water, ash, sulphur (by several methods), and calorific value by calculation and by experiment. Oils, fats, and waxes—determination of constants and examination of several adulterated specimens. Alcohol—estimation in beer, wine, and spirits, by several methods, and determinations of very small quantities in liquids. Metals and alloys—

quick methods for ascertaining the amount of the principal metal in commercial tin, lead, antimony, copper, zinc, and in molybdenite. Also working over a few alloys of these metals in order to determine the proportion of each constituent metal. A good working acquaintance with the microscope, polarimeter, various forms of refractometer, and spectroscope.

In this course some time should be given to the recognition of substances, organic and inorganic, and if the student does not feel able to determine with precision after a few minutes the nature of any ordinary simple inorganic substance not requiring fusion with other substances to bring into a soluble form, he should practice until he finds out where he is deficient. As regards so-called insoluble substances, those characteristic should be studied individually together with the best means of recognition. Commonly occurring organic substances should be examined so that a fair number may be recognized. Out of the way compounds may occasionally be met with, but for these considerable help ought now to be obtained from the text-books which should have formed, or are forming, part of the student's ordinary reading course. Students would now have an opportunity of getting more proficient with the slide rule in their calculations. And a good sound knowledge of the British system of weights and measures might be acquired by expressing some results in grains per gallon, per pound, or per cubic foot. In order to promote business habits the students should be expected to be industrious and to observe closely laboratory hours. After the completion of each kind of analysis they should, from their laboratory note-books, either card-index the process used, or adopt some other means of permanently recording their work in good detail.

Students who have been through a course such as that suggested would read current literature with much more interest, and would ever be seeking out new methods and labor and time-saving devices. Moreover, they could not fail to obtain a sounder knowledge also of theoretical and physical chemistry—a knowledge which, in their careers, will allow no technical process coming under their cognizance to pass without understanding thoroughly, as far as it is possible, the chemical or physical effect produced by each and every substance employed. Such a course could not fail to improve the capacity of a student for research. It would give him a good sound grip of analytical chemistry, and would tend to render the student's knowledge much more assimilable, and the student himself much more valuable to his future employers.

Measure of Atmospheric Pressure

OFFICIAL information has been received from Paris that from January 1, 1917, the millibar (1000 C. G. S. units) will be used in the publications of the Bureau Central Météorologique for atmospheric pressure, instead of the millimetre of mercury. The same unit has been in use in the publications of the British Meteorological Office since the beginning of 1914; the Colonies of British Guiana and Mauritius have already adopted the unit, and it has also been used in some of the publications of the Weather Bureau of the United States, of Harvard University (Blue Hill Observatory), and of Berkeley University, California. The question raised by Prof. McAdie, of Blue Hill, as to whether the proper name for the unit is not a "kilobar" has still to be considered, on the ground that the name "bar" was already appropriated by chemists to mean 1 dyne per square centimeter. It is one of the questions which should have been discussed at an international meeting projected for September, 1914.—*Nature*.

**Chemical News*.