

out. Being loaded directly into the ships' holds as ballast and transported by water, the freight costs are also considerably less.

In 1893, the output of Carolina monazite sand was 130,000 pounds; in 1894, 546,855 pounds; in 1895, 1,900,000 pounds; and in 1896, for reasons above named, it fell to 17,500 pounds.

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## CHEMICAL SECTION.

*Stated Meeting of April 20, 1897.*

DR. JOSEPH W. RICHARDS, President, in the chair.

### THE CHEMISTRY OF FOOD ADULTERATION.

[ABSTRACT.]

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BY HENRY LEFFMANN.

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In addressing an audience of professional chemists, I feel that I must deal with this topic from a laboratory point of view only. General considerations would be out of place, as would also be any discussion as to the extent and effect of food adulteration or the legislation needed to limit it.

A marked tendency of modern analytic chemistry is toward uniformity of method. In certain departments this has been brought to a high degree of perfection, the routine of analysis having been developed with much detail, and hence a satisfactory uniformity of results will be attained by different chemists. In many of the departments of food analysis such uniformity has not been secured, and hence differences of results are not infrequent. I may note, however, a special cause of confusion, namely, the uncertainty of standards of purity. In many of the industrial applications of chemistry the analyst has no duty except to state the results in technical form. The interpretation of the data may be left to those to whom the report is made. In sanitary chemistry, however, there may be a wide margin for "inferences," and two chemists may differently interpret the same analytic figures. Sometimes an arbitrary rule is established either by the influence of some espe-

cially prominent scientific authority, or by official, *i. e.*, legislative, decision. These points are well illustrated by the now numerous laws applicable to milk adulteration. Not only are the methods of analysis somewhat variable, but an attempt also is made to fix an arbitrary standard below which all milk shall be deemed to be adulterated. This standard is not the minimum, as found by comparison of a large number of samples, but is fixed above that, under the assumed right to encourage the production of a high-grade article. Moreover, when milk analyses are reported it is not uncommon to affix a calculation of the "added water." This is based on a purely arbitrary assumption, namely, a minimum limit of solids—not fat. I contend that no chemist is justified in such an assumption. When a statement is made in court to the effect that a milk sample showed "10 per cent. of added water," the jury and all persons not familiar with milk analysis are led to believe that the water has actually been detected as such, whereas it is merely an arithmetic inference based upon an arbitrary assumption. Actual experience shows that in many cases milk just as taken from the cow would show a considerable percentage of "added water" by the methods of calculation now in vogue. The object of chemistry is the ascertaining of facts, not the encouragement of the breeding of high-class cattle.

A minuteness of routine is often needed to secure uniformity and comparability of results, but this minuteness must be more than a mere form. In some cases attention to minute detail is prescribed, although the processes are inherently approximate only. Such criticism, for instance, may be brought against the "official process" for the determination of the volatile acids in fat. The total amount of volatile acids cannot be obtained by the method, and the percentage present in normal samples of butter varies within wide limits. The practical purpose for which this process is used, namely, the detection of the admixture of foreign fats with butter, can be attained with certainty without the minute routine prescribed and the variations in normal butter far exceed the errors of experiment, even when the process is conducted somewhat roughly.

Another important point is the want of uniformity in the

statement of results. Some of the data in analytic statements are not infrequently obtained indirectly, or by difference, and these facts should be in some way indicated in the report. In a State official report published some years ago, a list of many analyses of iron ores is given, the figures in each analysis adding up to exactly 100. It is obvious that some ingredient was determined by difference, yet there is no indication of this in the tables. In a neighboring State, reports on milk analysis are frequently made, which give separate figures for the fat, sugar, proteids and ash, and no information is given as to which of these ingredients are determined directly. If any ingredient is determined by difference, it should be stated; on the other hand, if all had been determined directly, there should have been a special determination of total milk solids as a control.

In water analysis there is much to be criticised, as regards the methods of stating results. Water analysis differs from most other analytic work, in that the results are never expressed in percentages, and hence has arisen much variety and irregularity of statement. At the present day, four forms of statement are used: grains per United States gallon, grains per imperial gallon, parts per million, and parts per hundred thousand. Some chemists, in the United States and England, use two methods in the same analysis, stating most of the ingredients in grains per gallon, but using parts per million (or per hundred thousand) for the so-called "ammonias." This is highly absurd, and it is surprising that anyone should adopt it. Its perpetuation is doubtless largely due to slavishly following Mr. Wanklyn, whose work in this field has been a curious medley of the ingenious and preposterous. When a statement of an analysis of water contains such data as sulphuric acid, carbonic acid, phosphoric acid or nitric acid, there is a vagueness which will closely interfere with a close calculation of results. Does the chemist mean by sulphuric acid,  $\text{SO}_3$ ,  $\text{SO}_4$  or  $\text{H}_2\text{SO}_4$ ? Similarly, does carbonic acid mean  $\text{CO}_2$ ,  $\text{CO}_3$  or  $\text{H}_2\text{CO}_3$ ?

The main object of furnishing the actual figures of a water analysis is to place on record the facts and to permit of the formation of an independent judgment, and it is in this

light that we must proceed when we frame a method of statement. There is no reason why our methods of statement should not conform to the highest requirements of modern theories. It is often impossible and generally difficult to determine exactly how the various elements constituting the mineral residue of water are combined. Chemists follow certain conventional methods, based on probable controlling affinities, each case being in a measure decidedly independent, but in fairness these statements ought to be accompanied by information that the arrangement is largely supposititious. The proper way is to give a list of the individual elements or radicals, and thus permit any one familiar with the subject to re-calculate the data as deemed advisable. I consider it highly inadvisable to state any element in terms of a combination that cannot possibly exist in the water. We see much incongruity in reporting the very important data of the various conditions in which nitrogen exists in water. This element may occur in water in five states, namely, free and as nitrite, nitrate, ammonium and so-called organic compounds. The free nitrogen has little significance. Many valuable inferences may be drawn by the proper estimation of the last four forms. The brilliant work of Mr. Wanklyn has given a world-wide prominence to the last two data, and has fastened upon them two highly inappropriate titles. The nitrogen existing as ammonium compounds he called "free ammonia," which it is not; and the nitrogen obtained by his method from the organic matter he called "albuminoid ammonia," an equally inaccurate term. A still more absurd system has frequently been adopted for expressing the oxidized nitrogen; that is, that existing as nitrites and nitrates. The probability is that calcium nitrite and nitrate are the forms of combination usually present, certainly the acids themselves do not exist as such. Yet it is not uncommon to see the oxidized nitrogen expressed in terms of nitrous and nitric acid, which is as ridiculous as if a chemist would report the carbon in steel in terms of carbonic acid, or the silver in an ore in terms of silver nitrate.

The proper method of expressing the data of a water analysis is in terms of the elements and ascertained radicals present.

This commits the chemist to no theory, but allows any one to recalculate the data according to conventional methods of individual preference. Such a plan has the advantage of presenting the combined nitrogen so as to permit immediate judgment as to the ratio between the different conditions, a point that is of especial advantage in tabulating comparative results.

Uniformity in methods of analysis is highly desirable, but it is difficult to secure the consent of all chemists to some processes. A partial benefit will be gained if the methods are indicated in some manner in the report.

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*Stated Meeting of May 18, 1897.*

## NOTES ON THE DETERMINATION OF INSOLUBLE PHOSPHORUS IN IRON ORES.

[ABSTRACT.]

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BY CHARLES T. MIXER AND HOWARD W. DUBOIS.

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The authors referred to the greater necessity than formerly of determining the insoluble phosphorus in Bessemer iron ores, owing to the increasing demands for a lowering of the phosphorus content in what are considered standard Bessemer ores.

The usual method of fusing the insoluble residue with sodium carbonate has been found impracticable where a large number of determinations are to be made daily.

Experiments were instituted to devise a shorter method that would give accurate results.

The use of hydrofluoric acid to dissolve the siliceous residue from the acid treatment of the ore was found to be of no advantage as regards economy of time.

A mixture of ore and sodium carbonate subjected to a red heat (without producing a fusion) gave fair results with low silica ores, but was not adapted to high silica ores on account of the fusion of the mass.

Calcined magnesia mixed with the ore and ignited to a red heat (without fusion) extracted all the phosphorus, even with high siliceous ores.