tance. I am grateful to him for the many favors shown me. The manuscript was in process of preparation at the time of the San Francisco fire, and a small portion of the work cannot be chronicled here, owing to the destruction of the notes. As opportunity offers, the research will be extended.

FOOD LABORATORY OF THE
SAN FRANCISCO HEALTH COMMISSION,
May 15, 1906.

[CONTRIBUTION FROM THE COMMITTEE ON PURITY OF REAGENTS, NO. 1.]

SOME SOURCES OF IMPURITIES IN C. P. CHEMICALS.[1]

BY J. W. SCHADE.

Received June 30, 1906.

THE elimination of impurities in chemically pure chemicals has long been the desire of chemists; but owing to a seeming indifference on their part, the manufacturers have not exerted themselves to make their products better than they deemed absolutely necessary to meet the demands. During the past year or two much increased interest has been manifested in the movement to secure the best grade of laboratory reagents consistent with economy in manufacture. To ask for a reagent "absolutely pure" is to ask, in most cases, for the impossible in economical manufacture. The object of this paper is to present some sources of impurities in chemical reagents and to point out that there are limits of purity obtainable by manufacturers.

With few exceptions all reagents are shipped in glass containers. The dry salts probably do not take up impurities from the bottles, but acids and ammonia after standing in containers for a few days are contaminated with impurities from the glass. These impurities may be one or more of the following: iron, potassium, sodium, silica, calcium and from bottles of Jena or "Nonsol" glass, zinc. In the case of ammonia, silica is the principal impurity from the glass; in the case of acids, iron. The latter is due mainly to the fact that small chips of iron oxide flake from the blowpipes used by the glassblowers and although acid is allowed to stand in the bottles before they are washed for use, there are undoubtedly minute particles that escape immediate solution. Acids shipped in carboys having glass covers secured by zinc rings are liable to contamination from the zinc, owing to the

---

[1] Read at the Ithaca Meeting of the American Chemical Society.

splashing of the acid into the neck of the carboy. Hydrofluoric acid shipped in lead carboys takes up that metal as an impurity. The nature of these impurities is such that the liability of contamination cannot be entirely removed, though it may be diminished by the use of more resistant glass and of glass stoppered carboys.

The second source of impurities is in the chemical works. It is the vessels in which the chemicals are manufactured. These vessels—tanks, stills, condensers, crystallizing dishes, and so on—are made or lined with lead, silver, copper, iron, aluminum, nickel, zinc, platinum, porcelain, earthenware, or glass. The impurities from this source are the metals of which the vessels are made, and from the non-metallic receptacles silica, sodium, potassium, calcium and iron. Iron vessels give rise to other impurities than iron, notably manganese. In the manufacture of sodium bismuthate, for instance, iron vessels cannot be used, owing to the contamination of the product with manganese which, of course, is inadmissible in that reagent. Nickel is found in the best grades of caustic alkalies from the dishes in which they are made. Copper, aluminum, or silica are found in acetic acid from the condensers used in the distillation. Lead tanks are very generally used, especially for crystallizing organic acids such as tartaric and citric. The author has also found it in hydrofluoric acid, ammonium chloride, potassium sulphate, and sodium chloride. The amount of impurities of this class is minimized by the judicious selection of vessels to meet the needs of each case. As with the first class, however, the liability to contamination cannot be entirely removed.

There is another class of impurities introduced during the purification of the salts. These impurities are reagents used to precipitate certain foreign substances or the salts formed by the reaction. For instance, the author once analyzed a sample of sodium chloride in which sulphate had been precipitated by means of barium chloride. This salt gave decided tests for both barium and sulphate, an anomalous condition often met in testing reagents. Another example of this is the presence of calcium in ammonium oxalate. Samples of ammonium oxalate giving clear solutions sometimes contain some hundredths of a per cent. of calcium though the solution from which the crystals were obtained was alkaline. It is evident from these facts that the socalled "insoluble precipitates" are dissolved to an appreciable extent by the concentrated solutions from which the salts are crystallized.

The final class of impurities includes those occurring in the original source of the chemicals, *i. e.*, in the minerals, and in those substances used in manufacture. These impurities will vary in number and kind, depending on whether the treatment of the mineral is simple or complicated. Sometimes it is impossible for the manufacturer to get rid of certain impurities without putting a prohibitive price on an article. Iron, alumina, and silica, appear in all but the highest-priced grades of caustic alkalies and alkali carbonates. Nickel and cobalt cannot be entirely separated on the large scale cheaply. As has been pointed out above, calcium cannot be entirely removed from ammonium oxalate, strange as it may seem, without considerable trouble and expense. Again, strontium sulphate will not precipitate barium from a solution of strontium chloride or nitrate unless a large excess is added, in which case sulphate is introduced as an impurity. Here the manufacturer is compelled to choose the lesser of two evils. This is the inevitable alternative in many instances.

Calcium persists in barium salts and if considerable calcium is present in the mineral from which the barium is obtained, it is no easy matter to remove it. The removal of iron from copper sulphate is not as simple as one would imagine. Some of the "iron-free" copper sulphate sold on the market contains several thousandths of a per cent. of iron. To separate the two iron must be in the ferric condition. Hydrogen peroxide is theoretically an ideal oxidizing agent in that it introduces no impurity into the copper sulphate, but in practice, nitric acid works somewhat better. Here is a case in which nitric acid is introduced as an impurity in preference to iron. Lead is sometimes found in copper salts and is difficult to remove from the chloride and nitrate. Ferric salts always contain free acid, fused magnesium chloride always contains ammonia, and caustic alkalies and alkali carbonates, as has been said, almost always contain iron, alumina and silica.

These illustrations serve to show that at ordinary prices chemical reagents must be limited in purity. This, however, is not a serious difficulty except in cases when extraordinarily accurate work is to be performed; and the manufacturer can supply at a reasonable price reagents that will give accurate results when put to the ordinary uses.

LABORATORY OF THE J. T. BAKER CHEMICAL CO.,
PHILLIPSBURG, N. J., June 28, 1906.

THE CLASSIFICATION OF COALS.[1]

BY S. W. PARR.

Received July 3, 1906.

THE fundamental properties of coal are directly involved in the decomposition products which are in evidence as a result of geological processes. These products have certain characteristics which manifest themselves in practical every-day use under the two notions of behavior and quality. A scheme of classification, therefore, to have any intelligent significance should be an expression of these two ideas. But while it should be susceptible of practical or commercial interpretation, it should have for its fundamental and ultimate basis, correct analytical facts and scientific data. The methods of classification thus far proposed have seemed to the writer deficient in one or the other of these two phases: either they were devised wholly with industrial ends in view and gave little heed to scientific considerations or they were too profoundly scientific to be capable of translation into any everyday meaning. The work here outlined has been done in connection with the State Geological Survey of Illinois and the effort has been made to embody both of these phases in the consideration of the topic.

The scheme of classification at present most widely recognized is that proposed by Frazer.[2] It has the merit of being intelligible from the industrial standpoint. It does not, however, embody certain phases that seem desirable if any meaning attaches to our discussion of the essentials from a scientific basis as above set forth. Indeed in his recent admirable defense of this classification,[3] Frazer recognizes the lack of data which at the present time would be embodied in the ordinary results of proximate analysis.

It is proposed by Campbell[4] to base a classification on the ratio of the total carbon divided by the total hydrogen. The argument

---

[1] Read at the Ithaca Meeting of the American Chemical Society.

[2] Trans. Am. Inst. Min. Eng. 6, 430.

[3] Bull. Am. Inst. Min. Eng. March, 1905.

[4] Report of Coal Testing Plant, U. S. Geol. Survey, St. Louis, Professional Paper U. S. G. S. No. 48, Part I, pp. 156–173.