American Journal of Science and Learning for Development

ISSN 2835-2157

Volume 2 | No 1 | January -2023

Learning the Purpose and Essence of Analytical Chemistry

[1] Kurbanova Dilafruz Sobirovna, [2] Azizova Safina, [2] Usanova Surayyo, [2] Urazaliyeva Muhayyo, [2] Rakhimova Zukhro

[1] Assistant of Jizzakh Polytechnic Institute
[2] 2nd year student of Jizzakh Polytechnic Institute

Abstract: *This article discusses the science of analytical chemistry and its essence, purpose and tasks, brief historical development of analytical chemistry, classification of methods of qualitative analysis, study of basic concepts and methods of performing analytical reactions. Analytical chemistry is of great scientific and practical importance.*

Keywords: *qualitative analysis, method, indicator, litmus, reagent, precipitate, anion, cation.*

Analytical chemistry is about the methods that develop the theoretical bases and methods of chemical analysis, the chemical structure of elements of various objects in the environment, and the methods that provide qualitative and quantitative determination, i.e. analytical chemistry identification, quantitative determination and different elemental objects in nature , that is, the science that determines the chemical structure of atoms, ions, molecules, functional groups and other particles.

The main tasks of analytical chemistry are to introduce the general theoretical foundations of analysis, the main principles of chemical, physico-chemical and physical methods.

Analytical chemistry is of great scientific and practical importance. Indeed, modern chemistry has progressed due to the use of new analytical methods and measurement techniques. Physics, biology, geology, mineralogy, technical sciences, medicine, pharmaceutics, environmental studies widely use analytical chemistry in their fundamental scientific research. A characteristic feature of modern analytical chemistry is the wide development of instrumental analysis methods (these include physico-chemical and physical methods).

Some chemical analyzes were known even in ancient times. For example, at that time, metals were extracted from ores, alloys were made, glass was baked, medicinal substances, dyes, and aromatic substances were extracted from plants. It can be said that analytical chemistry was used in all the above-mentioned processes. As a result, analytical chemistry was gradually founded.

Analytical chemistry as a science began to develop from the middle of the 17th century. It began to develop after Robert Boyle (1627-1691) introduced the concept of a chemical element into science, a component of complex substances that does not break down chemically. He organized all the qualitative reactions known to him and recommended several reactions and founded the "wet method" analysis. In particular, he used for the first time "litmus", which is used as an "indicator" for determining acids and bases, and dyes obtained from plants. He introduced the term "chemical analysis" and "element" to science. He used $AgNO3$ to detect HCl, excess ammonia to detect copper salts, and so on.

In the 18th century, the method of separating metals (cations) from solutions by groups was introduced by T. Bergman (1735-1784). This was a great achievement in the development of qualitative analysis and the basis of a systematic analysis method was laid.

Based on the development of quantitative analysis, D. Dalton (1766-1844) established atomic theory in chemistry. The introduction of this theory accelerated the further development of quantitative analysis, because it was necessary to determine the atomic weights of elements as accurately as possible. In this field, the service of the Swedish chemist I. Berselius (179-1848) was very great, he found the atomic weight of 45 elements very accurately (for that time), developed many new methods of quantitative analysis and modified the old ones. Developed. He also developed a method of elemental analysis of organic compounds.

Successes of related sciences and more than them, production requirements accelerated the development of analytical chemistry. The development of various industries required the improvement of methods of chemical control of production, that is, of determining the composition of initial raw materials, semi-finished products and finished products. Such needs of production play a decisive role in the emergence and development of analytical chemistry as a science.

During the analysis, the qualitative composition of the substance is first determined, that is, the question of what elements, groups of elements or ions it is composed of is resolved, and then the quantitative composition of the substance is determined. It is the task of qualitative analysis to find and determine what elements and ions are included in the composition of the substance.

1. When working with chemical methods of quality analysis, the element or ion that needs to be found is converted into a compound with specific properties, and it is known that the compound was formed based on these properties. The chemical change that takes place is called an analytical reaction, and the substance that causes this reaction is called a reagent.
2. Physico-chemical methods of analysis are based on the dependence of the color intensity of the substance formed on the basis of a chemical reaction on the concentration of this substance, or on the dependence of the electric current passing through the solution of the substance to be determined on the concentration of this substance, etc., and many examples can be given.
3. Physical methods of analysis are based on the connection between the chemical composition of the substance and some of its physical properties. For example, in spectral analysis, depending on whether the radiation spectrum that occurs when a substance is introduced into a torch flame or an electric arc, there are characteristic lines for the elements being determined, an opinion is given about the presence of those elements in the given substance, and based on the clarity of the lines, about their amount. is conducted. This method is very sensitive and allows to determine the amount of elements up to 10-6-10-8g. Depending on the amount of substances used in analytical reactions, qualitative analysis includes macro-(0.5-1.0 g), micro-(0.005-0.01 g), semi-micro (0.02-0.05 g)-, and ultra-micro (1 mg)- methods are used.

In microanalysis, very sensitive reactions are used, reactions are carried out using the microcrystalloscopic or drop method.

a) In the analysis by the microcrystallographic method, reactions are usually carried out on a glass plate, and by looking at the shape of the formed crystals, an opinion is reached about whether the desired ion (or element) is present.
b) In the drop method, reactions are used in which the color of the solution changes or colored precipitates are formed.

Analytical reaction methods.

Analytical reactions can be carried out by "wet" and "dry" methods.

1. In the dry method, substances and reactants are obtained dry and the reaction is carried out by heating.

2. In the wet method, the interaction of the substance under investigation with the relevant reactants is observed in solutions.

Classification of cations and anions in qualitative analysis.

Classification of cations.

There are several methods (schemes) for classifying cations in quality analysis:

1. Hydrogen sulphide method: it is different solution of metal sulphides based on
2. Methods without hydrogen sulfide:

a) acid-base

b) ammonia-phosphate

c) Acetate-amide, etc.

In recent years, the acid-alkaline method has been used in quality analysis. According to this method, cations are divided into 6 analytical groups.

Table 1

Group	Group reagent	Cations
I	There is no group reagent	K^+, Na^+, $NH4^+$
II	HCl	Ag^+, Hg_2^{2+}, Pb^{2+}
III	H_2SO_4	Ba^{2+}, Sr^{2+}, Ca^{2+}
IV	NaOH (precipitates dissolve in excess NaOH)	Al^{3+}, Cr^{3+}, Cr^{6+}, Zn^{2+}, As^{3+}, As^{5+}, Sn^{2+}, Sn^{4+}
V	NaOH (precipitates are insoluble in excess NaOH)	Mn^{2+}, Mg^{2+}, Bi^{3+}, Fe^{2+}, Fe^{3+}, Sb (III, V)
VI	NaOH (precipitates dissolve in excess NH4OH and form complexes)	Cu^{2+}, Co^{2+}, Ni^{2+}, Hg^{2+}, Cd^{2+}

Classification of cations according to the acid-base method

1. Group I cations (K+, Na+, NH4+) have no group reagent.
2. Group II cations (Ag+, Hg22+, Pb2+) group reagent is diluted HCl.
3. Group III cations (Ba2+, Sr2+, Ca2+). group reagent diluted H2SO4 or SO42- ion. All cations of this group precipitate with SO42-.
4. Alkaline solutions of group IV cations (Al3+, Cr3+, Cr6+, Zn2+, As3+, As5+, Sn2+, Sn4+). The formed precipitates dissolve in excess alkali.
5. Alkaline solutions of group V cations (Mn2+, Mg2+, Bi3+, Fe2+, Fe3+, Sb (III, V)). The resulting precipitates are soluble in excess alkali, unlike group IV cations.
6. Alkaline solutions of group VI cations (Cu2+, Co2+, Ni2+, Hg2+, Cd2+). The resulting precipitates dissolve in excess NH4OH and form complexes.

Now let's get acquainted with a brief classification of group 1 and 2 cations

General description of group 1 cations.

Cations of the first analytical group include K□, Na+, NH4+, Mg2+ cations. All cations of this group are colorless, so their salts are colored only if the anion is colored. Almost all salts and hydroxides of potassium, sodium, ammonium dissolve well in water. They (except for the magnesium cation) have one valence. Cations of this group have no precipitates.

Ammonium salts are hydrolyzed in their aqueous solutions, decompose when heated, and ammonia volatilizes. This property is used to remove ammonium ions from solutions.

General description of group 2 cations.

Analytical group II of cations includes Ca+2, Ba+2 and Sr+2 ions. These ions combine with various anions to form sparingly soluble salts. For example: their sulfates, phosphates, oxalates and carbonates are difficult to dissolve.

It is somewhat convenient to separate group II cations from group I cations in the form of BaCO3, SaCO3, and SrCO3, because it is much easier to transfer the precipitate to a solution for further analysis. Finally, the excess of precipitating SO3-2 ions can be easily removed from the solution. To do this, it is enough to add a little acid to the solution, which produces H2CO3, which immediately decomposes into H2O and CO2.

Sulfides of group II cations are as soluble in water as sulfides of group I cations, in this respect they differ from group III, IV and V cations.

The group reagent of Group II cations is (NH4)2CO3. But if there is not enough pH, the complete precipitation of ions of this group cannot be achieved. Therefore, NH4OH (approximately equivalent amount) is added to the solution together with the reagent of the group, that is, the pH should be 9.2.

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