

WHAT IS ANALYTICAL CHEMISTRY?

by K.-G. Wahlund

BACKGROUND

Analytical-chemical operations are divided in two parts: **quantitative analysis** and **qualitative analysis**. Together they constitute **chemical analysis** (sw. kemisk analys). The latter represents the work necessary to obtain quantitative and qualitative analysis. Quantitative analysis means that the *amount* or *concentration* of a chemical entity (compound) is determined. Qualitative analysis means that the *characteristics* of a compound is determined, hence certain properties. The corresponding operations make up chemical *characterisation*. Likely, the primary characteristic of a chemical compound is its identity, hence the compound will have to be subject to *identification* using some identification method. Further characteristics could for example be molar mass, colour, other spectroscopic properties, density, mass spectrum, melting point, element composition, and more. For example, to perform elementary analysis there is a need for quantitative analysis (hence, a quantitative analytical method), but the results themselves rather represent qualitative analysis.

CHEMICAL ANALYSIS

Chemical analysis may have to be performed by any chemist that needs it in the work. For example, identification is a standard method performed by synthetic chemists in direct combination with the synthesis. A person may be employed as an **analytical chemist**. In this profession it is almost always quantitative analysis that is in focus*. Many have wondered what analytical chemistry is and hence what analytical chemists do†. The present text is an effort to answer such questions.

ACADEMIC SUBJECT

As an academic **teaching** subject **analytical chemistry** is a part of university studies in basic and advanced courses‡ and further in PhD courses. This means an education in *how to perform chemical analysis*.

* People who perform chemical analysis often say they are analytical chemists. Since long this usually means that they do quantitative analysis. To be an analytical chemist is a profession in the society outside the academy and the person may have had university courses in general chemistry or, preferably, in basic analytical chemistry, advanced analytical chemistry, and very often today also a PhD in analytical chemistry.

† The well-known scientist in analytical chemistry Dr. Gary D. Christian answered this question by "Analytical chemistry is what analytical chemists do". I do not agree immediately unless you have first defined what is an analytical chemist. I think he meant persons that have a job in which they are doing chemical analysis and usually such jobs are entitled "analytical chemist" and the persons call themselves "analytical chemist". That is fine. By the way, Christian wrote a most excellent text-book "Analytical Chemistry" (7th Ed., 2013, Wiley).

‡ Usually these are dominated by quantitative analysis whereas qualitative analysis may be taught within inorganic and organic chemistry courses.

The academic *research* within the subject *analytical chemistry* is a *science* which is directed towards creating *new knowledge* so that chemical analysis can be improved to respond to increasing and *new demands*. In the science of analytical chemistry we use existing knowledge in the other chemistry subjects (inorganic, organic, physical, and biochemistry). Sometimes however, but rarely, it could happen that an analytical chemist stumbles over a new, hitherto unknown, phenomenon and thereby contributes also to the other subjects, and vice versa. Many analytical-chemical methods have been created out of the needs by researchers in the other subjects and other fields.

“METHOD SCIENCE”

Chemical analysis, necessarily, is a practical work, like all other chemistry subjects (except theoretical chemistry and theoretical physical chemistry). To perform it one needs a *method* that describes *how to do it*. Such sciences are sometimes termed “method science”. To understand what a method science is you can make a parallel to everyday work in the society. In preparing this text I wanted to present it as a pdf-file, hence I used a laptop computer to type it. A plumber needs specific tools to do the work correctly. A cook (like perhaps yourself) needs a specific tool to prepare whipped cream. The carpenter needs a hammer, and so on. To build a house we need many different tools such the hammer, the ruler, the pencil, the saw, and many more. Without these tools no house could be built. To conclude: to *build* something requires certain *tools* (sw. redskap). To build a *new kind* of house construction we may need *different* and *new tools*. If a completely new kind of house construction would be invented we would need a number of completely new tools that would have to be *invented* or *developed* by someone. If we turn our interest again to chemical analysis this “someone” may well be an analytical chemist who is facing a *new kind* of *analyte* or a new kind of *sample* for which there does not yet exist any method for chemical analysis.

Academically, there is an important difference between the terms analytical chemistry and chemical analysis. *Analytical chemistry* is (1) a *science*, more closely, a *method science*, since the ultimate goal is to create new and improved ways (*read: tools and methods*) of performing chemical analysis. The term analytical chemistry also represents (2) the *field of knowledge* in chemical analysis. Tools are required as well in all other chemistry subjects, even theoretical chemistry (the answer here may be the computer; I exclude the human brain as a tool, but it really is a tool, quite necessary too). It would be a simple matter to present a long list of such tools but I leave this to yourself (and only a few examples would be enough for you to get the idea right).

In summary, the *essence* of the *academic research subject analytical chemistry* is to *create new tools for new needs*.

Academic analytical chemistry strives to serve the community of chemists, especially the analytical chemists, with the new necessary tools (analytical-chemical methods) that may be needed as a response to new needs occurring in chemical analysis. Without the new tools there could never be the necessary improvement in chemical analysis.

WHAT IT IS NOT: “method development” and “applications”

Chemical analysis should be understood as *applied analytical chemistry*. In chemical analysis the quantitative and qualitative analysis is done according to existing accepted methods (*read: knowledge*) or after modification of existing methods, using established tools, to make them suited for a particular sample or compound. This modification work is often called *method development* and involves adaptations necessary in relation to the specific sample or compound. The adaptations are based on

existing knowledge. *Applications* of analytical chemistry simply means that existing analytical-chemical methods are used in their standard way to analyse a variety of compounds or samples.

The lesson to learn is:

academic research analytical chemistry \neq chemical analysis

academic research analytical chemistry \neq method development

academic research analytical chemistry \neq "applications"

analytical chemistry \neq chemical analysis

analytical chemistry \neq method development

analytical chemistry \neq "applications"

If you perform method development you are not necessarily an /academic/ analytical chemist.