LETTERS TO THE EDITOR. SCIENTIFIC DISCUSSIONS

Concerning the Concentration Factor

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Separation and preconcentration of components is a step of chemical analysis used to improve the sensitivity and selectivity of the determination. An important characteristic of a method or a preconcentration procedure is the concentration factor (K_{conc}), which, according to its definition, is equal to the ratio of substance concentrations in the concentrate and the initial solution. The value of K_{conc} is calculated using the values of concentrations expressed, as a rule, in weight percents ($\mu\text{g/mL}$, etc.) or mass fractions (% , ppm, and so on). The value is dimensionless; therefore, one should bear in mind that identical values of K_{conc} in calculations using different units of measure can be obtained only upon taking into account the densities of the initial solution and of the concentrate, which is often forgotten. In preconcentrating substances from water to obtain an aqueous concentrate with a low acid concentration, the densities of the solutions before and after the preconcentration are very close to each other, and it does not matter what units are used to express the concentrations. However, when an “organic” concentrate is obtained, the densities of solutions can significantly differ, and when the density of the concentrate is unknown, one should calculate K_{conc} using the concentrations expressed in mass fractions. It is obvious that the values of K_{conc} for concentrations expressed in weight-volume percent and mass fractions will differ much more if solid concentrates are obtained.

Let us consider a hypothetical version of preconcentration when a pure trace component is obtained after preconcentration from a solution or a gas phase. With the development of preconcentration techniques, such or similar extraction versions became possible. For example, cadmium pyrrolidine dithiocarbamate complexes are effectively extracted on non-polar adsorbents (also on the inner surface of fluoroplastic capillaries) and are easily desorbed by ethanol [1]. After the evaporation of ethanol, these complexes in the pure state are obtained on a substrate. Another example is the analysis of sedimentary rocks by electrothermal atomic absorption spectrometry, where the sample is first atomized and then cadmium vapors are condensed on an auxiliary cold surface, thus removing alkali and alkaline-earth metals [2]. Cadmium in this

case occurs on this surface in the pure state (we do not discuss the behavior of the remaining trace impurities in the above cases). Then the next atomization is performed by heating the auxiliary surface. In this or similar preconcentration methods, one cannot calculate the value of K_{conc} using the concentrations of the trace component expressed in weight percents, because the volume and density of the concentrate obtained are unknown. However, it can easily be calculated using mass fractions of the component. Thus, in extracting a 100% pure substance from a solution, $K_{\text{conc}} = 100\%/c_0$, where c_0 is the concentration of the substance in the initial solution, %. It should be noted that, in the extraction of a pure substance, the concentration factor can be considered the maximum at the given initial concentration of solution, because the concentration of a substance cannot be higher than 100%. It is interesting that K_{conc} at the same initial concentration of a substance in the solution will be equal in all preconcentration procedures giving pure substances and cannot be a criterion of the selection of one of them. To select an optimum preconcentration procedure in this case, one should draw other characteristics—rapidity, cost, etc.

There is one last item. In using preconcentration procedures that give a pure substance, the lowest detection limit for this substance is attained using an instrumental method. Certainly, here again, there are some nuances, such as the effect of an inert support on the analytical signal and the possibility of the injection of the whole concentrate obtained into the detector of a certain type. However, it is clear that these preconcentration procedures are most promising for lowering the detection limits of substances.

REFERENCES

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