0. Abstract

A brief overview is given of various aspects that may be of importance in the assessment of the potentials of micro total analysis systems (μTAS) from the point of view of the user. It is concluded that some intrinsic features of μTAS such as low reagent consumption, portability, reliability and robustness may make them attractive for the employment in environmental, clinical and process monitoring. If the systems can be produced at relatively low costs it can be expected that there are large scale applications in these domains.

1. Introduction

The use of the word 'chances' in the title presupposes a future. The question whether there is a future for micro total analysis systems (μTAS) in chemical analysis can be answered only when the question is seen in the broader context of the developments of chemical analysis in general. These developments should be discussed in terms of demand and supply where the demand is determined by the prevailing problem domains and the supply by the technological and scientific achievements:

\[
\text{problem domains} \\
\begin{array}{l}
\quad = \text{environmental monitoring} \\
\quad = \text{clinical monitoring} \\
\quad = \text{quality control in production processes}
\end{array}
\]

\[
\text{technological/scientific achievements} \\
\begin{array}{l}
\quad = \text{possibilities of miniaturization} \\
\quad = \text{data evaluation} \\
\quad = \text{new sensing principles} \\
\quad = \text{new chemical compounds selectively complexing analytes}
\end{array}
\]

Both lists can be easily extended and made more specific. Especially with regard to the problem domains several studies have been made. In the following sections these points will be discussed further. Subsequently the basic question about the chances of μTAS in chemical analysis will be reconsidered.
2. Problem domains

For all three fields mentioned the "continuous" measuring function, indicated as monitoring, is essential. Because many analyzing systems cannot operate in a real continuous way, it is important to assess the frequency at which samples should be analyzed. This will depend on the role the analytical results have to play. When, for instance, the monitoring of the river Rhine is concerned, one may be interested in the variation of the content of sodium- and potassium chloride, ammonia, phosphate, nitrate, etc. Normally these compounds show a gradual variation so that the analysis of two or three times test samples a day is sufficient. However, when the analysis system is set up as a warning system aiming at the timely signaling of the appearance of a toxic pollutant, availability of results on the minutes scale is often a prerequisite because immediate action may be required. In general, it is important to assess the correlation between measurement result and the actual state of a process. The various aspects of interest are nicely combined in the concept of measurability as introduced by Van der Grinten [1]:

\[
m = \exp \left[ - \frac{\left( T_d + \frac{T_a + T_g}{2} \right)^3}{T_x} \right] \left[ 1 - \frac{\sigma_a \sqrt{T_e}}{\sigma_x T_x} \right]
\]

where \( m \) = measurability; \( T_d \) = delay time (time lag between sampling and analytical result); \( T_a \) = time between successive samples; \( T_g \) = grab time (time during which the sampling is performed); \( T_x \) = time constant of the process; \( T_e \) = time constant of measuring device; \( \sigma_a \) = standard deviation of measuring method and \( \sigma_x \) = standard deviation of process value to be measured.

As can be directly seen, the measurability varies between 0 and 1, where the value 0 means that the analytical results don't have any relation to the actual status of the process and 1 is the maximum value attainable.

To get a high measurability \( T_d \), \( T_a \) and \( T_g \) should be small compared to \( T_x \), and \( \sigma_a \) small with respect to \( \sigma_x \). Usually the effect of \( T_g \) can be neglected, whereas the value of \( T_a \), which can be simply selected by the operator, is taken equal to \( T_d \) which is determined by the total analytical system. This means that the next test sample is offered to the analytical system as soon as the analytical result of the previous test sample is available. As can be seen \( T_x \) is the key factor with regard to time. It is defined as the time span (DT) over which a reasonable correlation exist between two successive measurements in a 'time-series'(fig.1A). \( T_x \) can be evaluated from the auto-covariance function (G(DT) of this time-series Fig.1B)[2,3].