The application of flow injection analysis in process analytical chemistry

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The growing interest in quality control of production processes where chemical compounds are involved asks for automated methods of analysis. This is the case not only in the chemical process industry but also in industries in the field of biotechnology , food processing, etc. Important aspects that have to be considered when screening analytical methods for their suitability for the measurement of, for instance, process streams or the content of(batch)reactors, are reliability, speed of analysis, sampling frequency, reproducibility/ repeatability, selectivity and concentration range. Although in-line measurements (according to the classification by Callis et al.[1]) would be advisable in this respect, only a limited number of such sensing systems are commercially available nowadays which meet the required standards. Therefore, on-line measurements in which a sample stream is drained off the process stream offer often good alternatives.

It is in this context that flow-injection analysis (FIA) can play an important rôle. On the one hand because FIA forms an attractive means to transport samples of small volume to a detecting system without too much band-broadening, on the other hand because FIA allows the manipulation of samples on their way to the final detector. This manipulation may comprise chemical reactions in order to enhance selectivity and/or sensitivity, but also enrichment or separations to eliminate or reduce the effect of interferents. In this respect membranes can be very advantageous especially when the process stream contains unwanted solid particles (debris) which is almost always the case. An additional advantage of using membranes is that they not only safeguard the detector against these solid particles, they make it also possible to transfer the analyte to a solution which is most suitable for the long term operation of the detector. This is of great importance when, for instance, ion-selective electrodes are used because this can lead to a considerably prolonged lifetime [2].

In a recent study membranes were used also for the introduction of samples of well-defined volume, thus making an injection valve superfluous [3]. In this system a hollow fibre

membrane through which an acceptor solution can be pumped was kept in contact with the process stream. For a certain time the acceptor stream was stopped during which period the analyte, permeating through the membrane, can accumulate in the acceptor solution. After this fixed period the acceptor stream is pumped through the manifold towards the detector. A similar system was used for the analysis of CS_2 in ambient air by just suspending the hollow fibre membrane in the room to be monitored. It can be expected that the development of new membranes will offer many new opportunities in the field of process FIA.

One other interesting aspect of the intermittent injection of samples in the analyser system is the well-known transient behaviour of the recorded signals. The peak shaped signals make it possible to distinguish clearly between changes in background/drift or actual changes in the concentration of the analyte. A feature that has not been fully utilized until now is the regular analysis of the peak shape in view of fault detection. It must be possible to implement a small diagnostic expert system in which deviations from the correct peak shape are evaluated and translated in warning messages to the operator. Work in this field is in progress in the author's laboratory.

In conclusion, straight forward application of FIA is well-established nowadays and should be a routine to the analytical chemist just like titrating, etc. The challenge for FIA at the moment is to further explore all the potentialties of the technique more than to adapt all existing analytical batchwise procedures in flow-injection methods. A journal of Flow Injection Analysis can play a rôle in this process.

References

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