Flow - Injection Analysis in the Czech and Slovak Republics

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At present, Flow-Injection Analysis (FIA) ranks among progressive analytical methods, which are being gradually improved and developed. Like any new analytical method, FIA still searches for and gradually finds its position in routine practical use. Though the Czech and Slovak Republics belong to relatively small European countries, they can boast of a long tradition in the analytical chemistry research; no wonder that the novel FIA method made the Czechoslovak analytical community aware of itself soon after its introduction in 1975 (1). A number of Czechoslovak research teams and laboratories began to deal with the FIA technique in the early 1980s.

The development in the surrounding countries of East and Central Europe was similar, e. g. in Russia there was Prof. Shpigun's (2) team and in Poland a group around Prof. Trojanowicz (3-5).

There are two reasons for this great interest in FIA in the Czech Republic and the Slovak Republics. The first one is economical. FIA, thanks to its simplicity, does not require costly apparatus since the FIA set-up can be assembled from individual parts already available in an ordinary analytical laboratory. The second reason, and not an irrelevant one, is that Prof. J. Růžička, who was the first to publish the method (1), is of Czech origin; though his FIA research was carried out abroad, Czech and Slovak analysts have been much interested in his findings and discoveries.

The most distinguished centres of the former Czechoslovakia engaged in the development, new findings and application of FIA include the Department of Analytical Chemistry, Faculty of Natural Sciences, Masaryk University, in Brno, headed by Dr. Kubáň, the team of Dr. Melnik in Košice in Slovak Republik, and the Department of Analytical Chemistry, Faculty of Pharmacy, Charles University, in

Hradec Králové, where a team of several workers headed by Prof. R. Karlíček has been engaged in the development, application and promotion of the FIA technique since the beginning of the 1980s (6,7).

The contribution of the above-mentioned laboratories consists in the development of apparatus, in the fundamental research of new techniques and methods increasing particularly the selectivity and sensitivity of FIA determinations and in the development of the methodologies of determination of a number of substances. Last but not least, the promotion of the FIA technique showing the versatile possibilities of its use by Czechoslovak analysts is also of importance, as evidenced by a number of review papers and overviews. (8-25).

A simple FIA 20 analyser, composed of two three-channel variable-speed peristaltic pumps, a double sample injector valve , and a manifold with reaction coils was developed for versatile application and utilisation particularly in agrochemical laboratories. A separate flow-through detector (most frequently a commercial spectrophotometric one - SPEKOL 10 with a flow-through cell) and a chart recorder are connected to the FIA 20 apparatus. In 1986 - 1989, the Agricultural Co-operative Hradec Králové - Pouchov manufactured and sold about 100 sets of these simple and accessible analysers with a series of application notes, which greatly helped to spread the method of FIA in the Czech Republic (26, 27).

Also the firm Laboratorní přístroje Praha made an attempt to develop and produce an apparatus for FIA but this set-up involving also a photometric detector was destined to fail in the market already at the very moment of its origin in 1987 because of its limited possibilities of application and its high price (28).

A slightly different way was selected by the team headed by Dr. Melnik, whose automated PIA-01 analyser with a sample feeder and a photometric detector has been employed for carrying out serial analyses in a number of laboratories (29-32). Unfortunately a more advanced version of such an apparatus operated by a PC failed to find its manufacturer (33). Nevertheless most Czechoslovak research laboratories used

FIA-apparatus assembled from individual modules tailored to meet their particular requirements.

The basic research in the field of FIA at the above-mentioned laboratories is mainly directed at new ways of detection - a pneumatoamperometric detector (34-37), use of a diode-array detector for multi-component analysis (38-40), adjustment of the sample into a state suitable for quantitation directly in the flow through system with the use of immobilised enzymes (41, 42), and analyte pre-concentration on chelating sorbents or activated silica gel (43-45). Detailed fundamental research was then carried out by Dr. Kubáň in the field of continual flow extraction in the liquid/liquid system (46-51), frequently with subsequent AAS determination (52, 53).

Use of semipermeable membranes for separation and concentration of gaseous components from mixtures rendered it possible to carry out highly selective and sensitive determinations of hydrogen sulfide and hydrogen cyanide (54, 55) and the use of discriminated transport through solid membranes made it possible to apply spectrophotometric detection for the determination of sulfides (56) and ammonia (57).

Flow - injection analysis technique has been successfully employed in a number of cases where the quantitation by classical methods is not feasible, such as utilisation of hydroxylaminolysis in the flow-through system for the determination of penicillins (58), or fluorimetric detection for the determination of ergot alkaloids (59).

In the development of new methods of determination there is an obvious effort of authors to simplify the sample manipulation, i. e. the original sample is applied into the analyser and its further processing takes place only in the flow-through system (60, 61).

It is very laborious and time-consuming to find the optimum conditions of determination for more complex systems with the use of univariant optimisation. A method of the experiment planning utilising the PC programme with a modified simplex for effective multiparameter optimisation has been developed (62).

The original aims of the individual laboratories are reflected also in the practical applications of FIA technique: analysis of environmental samples - waste water, gases

(55, 56, 63, 64), application in technological processes as, e.g., in the production of lanthanoids (65-67), determination of a floatation reagent (68), moisture content (69) or sulfur dioxide (70).

FIA finds versatile possibilities of application also in the field of pharmaceutical analysis and bioanalysis as shown by determinations of drugs in substances and dosage forms (58, 59, 62, 71-73), and the components of body fluids. FIA as a simple automated technique is recently used for evaluating content uniformity in pharmaceutical dosage forms with a low content of the active component (59, 77).

What are the trends of future development ?

FIA has been widely used in various fields - in control laboratories, in the control of technological processes as well as in research - especially thanks to its simplicity, convenient sample processing directly in the flow-through system and possible full automation. That is why, according to the present authors' viewpoint, its further development is expected in the modifications resulting particularly in an increase in the selectivity and sensitivity of analyses and in multi-component analysis using the original samples, i.e. integration of separation techniques into the FIA system, involving also the utilisation of biosensors (78).

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