

Flow Chemistry and Flow Analysis

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www.flowinjectiontutorial.com

These two branches of chemistry thrive independently in splendid isolation, although they have much in common, besides the underlying theme of study and exploitation of chemical reactions in a flow system. Interestingly, scientists who work in these disciplines do not attend the same conferences, and do not publish in the same Journals. Therefore I am grateful to the Editors of this Journal to be invited to present here the *2015 Edition of Tutorial on Flow Injection Analysis*, because some of its content may inspire the readers, and might help to close the gap within this interdisciplinary space. (<http://www.flowinjectiontutorial.com/>)

The goals of Flow Chemistry (FC) and Flow Analysis (FA) are mirror images: in reagent based assays (FA) a product is synthesized in a flow channel, and subsequently monitored, in order to quantify an analyte. In contrast, research in FC aims at exploration and optimizing the yield of a synthesis of a desired product in a flow stream. Thus, while the ultimate goals are different, methods and instrumentation have similarities. And this is why information on the methodology and instrumentation of FA might become useful to practitioners of FC.

The Introduction of the Tutorial (1.1–1.10) reviews the development of FA, starting in 1955, when Skeggs invented the AutoAnalyzer, the concept of which was based on the homogenous mixing of a sample with reagents in a continuously flowing air segmented stream. Next, in 1975 Flow Injection Analysis (FIA) brought about a revolutionary change, by introducing the concept of forming precisely defined concentration gradients, when sample is injected into a continuously flowing, not segmented stream of reagents. With the advent of computerization and precise pumping, continuous flow has been replaced by flow programming and by miniaturization, as embodied in Sequential Injection (SI) and its subdivision Bead Injection (BI). At this time the literature on these FIA techniques comprises over 22,000 papers and 20 monographs. The *Introduction* also emphasizes the role of flow programming, discusses the limits of downscaling and offers the critique of the lab-on-chip design.

The Chapter on Theory (0) will not be of much use to those who mastered the theory of *Chemical Reactions Engineering*, yet the part discussing the *purpose* of Reynolds work may be surprising.

The Chapter on FIA (1) may be helpful in understanding the principles of this technology, which relies on the repeatability of the concentration gradient formed, when the analyte merges, and disperses within the stream of reagent – a concept opposite to homogenous mixing of reactants as used in Skegg's AutoAnalyzer and in many FC applications.

The Chapter on SI (2) documents the undisputable advantages of flow programming, and of the appropriate downscaling of the flow path, integrated with the flow through detector in the lab-on-valve manifold. The feasibility of using SI technique and instrument for FC can be judged by examining the ammonia assay <http://www.flowinjectiontutorial.com/Methods%202.2.36%20Ammonia%20Assay.html> since it is based on four step synthesis of indophenol blue, the formation rate of which is monitored at different temperatures, along with formation of undesirable decomposition products (which form a blank).

The Chapter on BI (3) is focused on single step (catch and release) separations in the programmable flow format. What is unusual here is that the solid phase forming the column can be hydro-dynamically assembled – and removed – whenever needed. The sorption and desorption of analytes (antibodies, DNA, antigens or other species) can be monitored either on the sorbent or after elution.

The Database, authored by E.H. Hansen, is easily searchable by topic or by authors, giving the user an opportunity to review the range of materials processed and monitored by FIA techniques, including inorganic, organic and biochemical compounds, but also live cells and suspensions.

Finally, **the FIA STORY** is a colorful quilt of tales, written by leaders in the field who generously share their views and experiences of exploring this exciting field of research and business opportunities.

It is my hope that the Tutorial will serve as inspiration to those who are working to advance the field of Flow Chemistry.

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