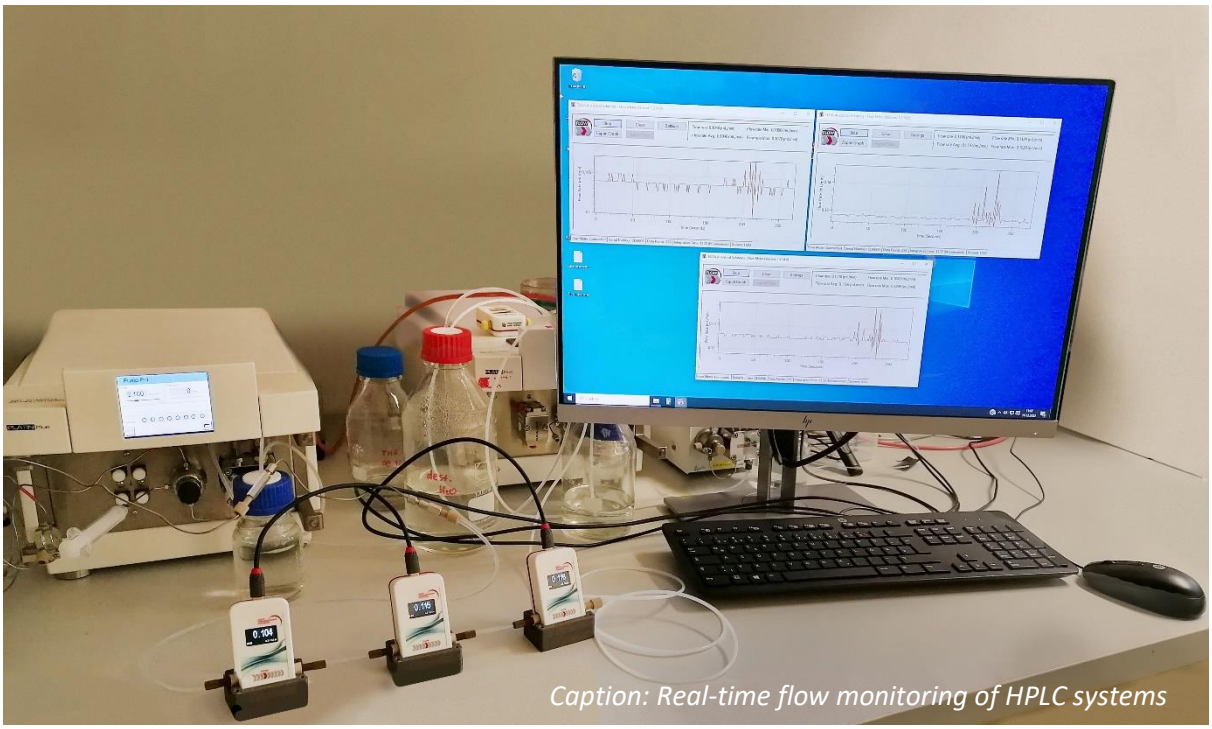
Laboratory 4.0 & **Liquid Chromatography**



Caption: Real-time flow monitoring of HPLC systems

In the world of analytical chemistry, liquid chromatography stands as a cornerstone technique, enabling scientists to separate, identify, and quantify components with unparalleled precision. As technology continues to advance, so too does the field of liquid chromatography, ushering in new capabilities and possibilities. To shed light on the latest innovations and emerging trends in this dynamic field, we had interaction with Carlo Dessy, Managing Director of Testa Analytical Solutions eK, a respected developer of liquid chromatographic instruments, related detectors and software.

Please tell our readers about the concept of Laboratory 4.0.

We are in the early stages of an exciting workplace transformation where digital technologies connect automated processes and equipment, monitor, and control supply chains, and work alongside automated systems programmed to leverage artificial intelligence (AI). This transformation, known as 'digitalization,' enables you to use digital technology to collect data, establish trends, automate processes, and make better business decisions. In scientific labs the application of these principles is often referred to as Laboratory or Lab 4.0.

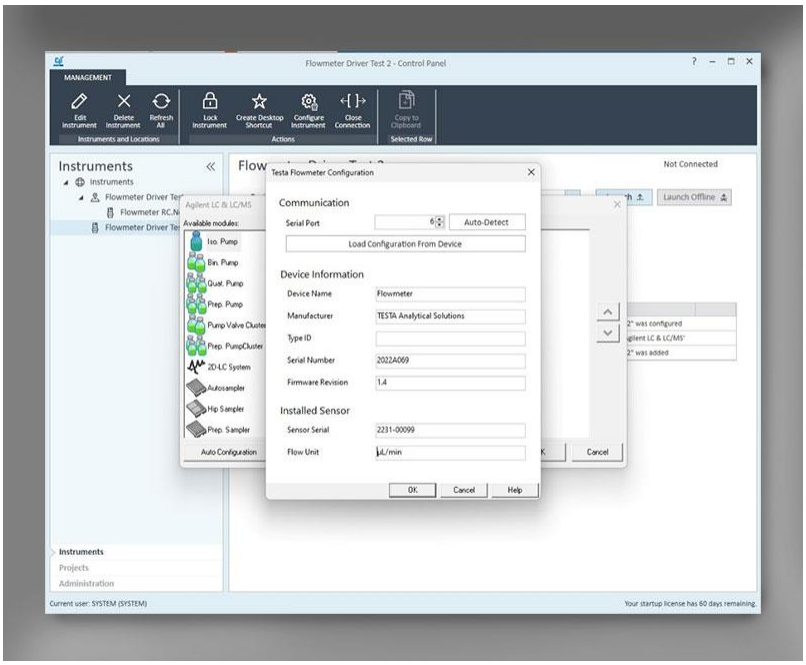
What are the driving forces for this next generation of smarter, networkable lab equipment and automated workflow tools?

Lab 4.0 has the potential to accelerate innovation by streamlining and automating processes and enabling more insightful data analysis. Successful digitalization within a laboratory requires connecting as many processes, instruments, people, systems, and consumables as possible. Using this connected laboratory framework, you can build automated end-to-end workflows that accelerate science and improve productivity.

Connected technologies can reduce or even eliminate some of the repetitive, manual work that scientists and technicians need to carry out. If scientists conduct experiments using connected instruments, data can be instantly fed into a laboratory information management system (LIMS). This removes the need for manual data input or transfer, and reduces the risk of transcription errors, improving data quality.

With connected technologies you can access, manage, and report data in real-time throughout laboratory workflows, rather than just at the end.

This can be particularly important in highly regulated environments, where every process must comply with good manufacturing practice (GMP).



Caption: Next generation flowmeter software driver for HPLC systems

By connecting everything to a LIMS it becomes possible to manage, track and report on samples, tests, and test results at every step, from raw material analysis through to finished product, supporting auditing requirements and making it easier to demonstrate compliance.

Finally, the improved data quality and integrity achieved through connectivity provides a robust foundation for more advanced analytics.

What technologies do you think will have the largest influence on these developments?

Any kind of machine intelligence requires reliable input signals or information in order to operate correctly. These inputs must fulfil by themselves a set of requirements in terms of reliability, function, and self-diagnostics in order to deliver useful information. A new generation of intelligent sensors capable of supplying information which can be directly used without any further processing will be an integral part of achieving the benefits of Lab 4.0 systems.

Are current generation liquid chromatography systems equipped to master this evolution?

Real-time monitoring of solvent flow, detection of air bubbles, and even auto identification of the solvents used are fundamental parameters that any liquid chromatography system which targets to fit in the lab 4.0 philosophy should ideally deliver. In my opinion, no commercial liquid chromatography system is currently fully equipped for this challenge.

I have recently noticed small steps in the right direction for manufacturers of the next generation of HPLC, UHPLC and GPC/SEC systems to have more intelligence built in.

What experience does TESTA Analytical have in developing next generation Laboratory 4.0 automation tools?

Most manufacturers still rely on a simple measurement of pressure for assessment of presence of flow in their HPLC systems. Unfortunately, this gives you only a limited view of what is really going on. A few years ago, TESTA Analytical started an R&D program to create intelligent sensors for monitoring and validating in real-time the performance of liquid chromatography systems.

The first intelligent sensors we produced were simple sensors capable of detecting critical levels of solvent in a reservoir or waste bottle. We then moved onto the more challenging task of non-invasive measurement of flow rate of any solvent commonly used in HPLC. This development resulted in a family of real-time flowmeters capable of covering the range from micro flow to preparative flow rates. More recently we launched a powerful, yet easy-to-use software tool capable of integrating data generated by our flowmeters into chromatography data systems from several different manufacturers.

This data integration represents an important step into Lab 4.0 as it allows validation of each single chromatogram produced by your HPLC system and documentation of flow data alongside the data obtained by the detectors of the system.

TESTA ANALYTICAL SOLUTIONS

Please describe a typical custom product development by TESTA.

Our custom product development business arose from instrument companies enquiring about TESTA's willingness and ability to rapidly develop and deliver optimized versions of our GPC/SEC and HPLC detectors for their particular application challenges. What is our product development process is a question we are asked frequently and typically discuss at length? For the context of this interview, I will try to condense my answer to a few sentences. We always start by asking the customer the goal of their planned product development. This might sound very simplistic but product definition by itself is complex as it involves multiple considerations ranging from technical, administrative, and financial to market and competitors. We therefore take great care to discuss all these matters with our clients to ensure the best possible target product definition. Once the product is defined, we then can check our detector module portfolio to see whether components we already have in repertoire might be adapted. This has a number of advantages in technical, financial and time terms.

If we have an existing detector module that can be adapted - we then work to produce a prototype that demonstrates proof of function.

Once proof of function is demonstrated we work to shape the prototype into a reliable product backed by the necessary technical and service documentation. Ultimately the success of our client's new product is our success.

This is our motivation. This is why we want to supply customers with the best possible solution for their application or process, using the most advanced technology, designed for reliable long operation at a price that enables the product to be competitive. We never take shortcuts or make compromises in our custom product developments as ultimately this is a path to an unhappy customer.

About Author:

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