Optimising chromatograph performance

25 June 2024

Gas and liquid chromatography are indispensable techniques used in the pharmaceutical and clinical fields. They are essential for the separation, identification, and quantification of complex mixtures. These methods offer high sensitivity and precision, making them ideal for analysing a wide range of substances, from small organic compounds to large biomolecules. Creating new pieces of equipment to carry out these tasks requires numerous flow control components and it is important to focus on those that deliver the best results.

Troy Stehr, Industry Account Manager – Lab and Medtech at Bürkert, looks at the challenges of creating chromatographs that deliver the accuracy and repeatability demanded by medical and pharmaceutical applications.

In the pharmaceutical industry, chromatography is crucial for drug development, quality control, and ensuring the purity of active pharmaceutical ingredients (APIs). Clinically, it aids in the diagnosis and monitoring of diseases through the analysis of biomarkers, therapeutic drugs, and metabolites.

Challenges to accuracy

The development of new chromatographic systems, however, presents several challenges. A primary obstacle is the precise control of gas and liquid flow, which is fundamental to achieving accurate and reproducible results. Inconsistent flow rates can lead to poor separation, compromised detection limits, and unreliable quantification, ultimately affecting the integrity of the analytical results.

Ensuring a stable and precise flow rate is essential to ensuring precision and repeatability. Variations in flow can cause peak broadening or tailing, affecting resolution and sensitivity. Using advanced flow control technologies such as electronic pressure control (EPC) in gas chromatographs and precision dosing in liquid chromatographs can maintain consistent flow rates. In addition, real-time monitoring and feedback systems can adjust parameters dynamically to ensure flow stability.

Temperature stability is equally important; fluctuations can affect the viscosity of the mobile phase and the interaction between analytes and the stationary phase, leading to inconsistent retention times. By implementing precise temperature control systems, such as oven temperature programming or thermostat-controlled column compartments, these issues can be mitigated.

Durability and maintenance

Increasing demand for high-throughput analysis and point-of-care testing is driving the need for compact, automated chromatographic systems. Microfluidic technology as well as automated sample preparation and injection systems can reduce sample and reagent consumption, improve throughput, and enable portable applications.

Clearly, for equipment that is used regularly, a robust build quality and simple maintenance procedures are important. Frequent interventions for maintenance caused by system wear and tear can lead to downtime and increased operational costs. Developing durable materials and components, along with automated maintenance protocols, can enhance system longevity and reduce downtime.

The choice of valve can also have a significant effect on maintenance costs and process availability. In a laboratory with an eight-hour working day, valves clocked at 1 Hz, operating for six hours will perform 21,600 switching operations per day.

Using a conventional solution, the valve reaches 10 million operations and can be used for 463 days.

However, selecting a Bürkert solution that can achieve 100 million operations means the equipment can operate for 4,630 days. This equates to a potential saving of 90 million circuits, a service life of more than 4,100 days and seven hours less maintenance, resulting in a more productive solution.

Individual challenges

There are also challenges within the individual fields of liquid chromatography. Analytical work can be affected by vague switching behaviour of the liquid control valves, which leads to imprecise mixing in the mobile phase, leading to an inaccurate gradient. The valves and their control blocks play a vital role in delivering accuracy and cleanliness to the process.

The quality of valve blocks is determined by the design and manufacturing expertise that goes into the complex process of machining as well as the quality of the surface finish. Mass produced valve blocks may not have the optimum level of quality or the best design features for a particular application.

It is better to have a range of options for materials and valves to ensure the most effective design is achieved. For example, incorporating pulse valves enables solvent bottles to be changed during operation, saving time for operators. In the same design, cleaning processes can be automated and valve blocks designed to optimise this activity as well.

Compact reliability

A similar situation exists for gas chromatography as well. Designing and building analysis equipment for laboratories is a complex task, needing to combine a

compact footprint with precision, speed of analysis and reliability. As a manufacturer, sourcing all the various components to create a gas control solution, as well as configuring and installing them can be a painstaking process.

This can be made much simpler by engaging with an expert in the field, such as Bürkert, that has the expertise to design, specify, source, assemble and test all the required components. The result is a task-specific device, optimised for performance and reliability, that delivers stable measurement results with excellent repeatability.

Furthermore, the gas control system can be designed with simple integration interfaces to match both the mechanical and electronic/communication protocols. More complex systems can include multi-channel mass flow controllers, bespoke manifolds and integrated control systems, all of which can be developed and supplied by specialists such as Bürkert.

Precision results

Chromatographs offer clinical and pharmaceutical laboratories the means to conduct vital research and development work. The precise control of gas and liquid flow in chromatography is paramount to obtaining reliable analytical results. Overcoming the challenges in developing new chromatographs requires a multifaceted approach, incorporating advanced technologies and innovative solutions.

By addressing these topics with the support of experts such as Bürkert, the pharmaceutical and clinical sectors can continue to rely on chromatography for critical analyses, ensuring the safety and efficacy of drugs as well as the accuracy of clinical diagnostics.

Image captions:

Image 1: Chromatography plays an important role in clinical and pharmaceutical fields.

About Bürkert

Bürkert Fluid Control Systems is one of the leading manufacturers of control and measuring systems for fluids and gases. The products have a wide variety of applications and are used by breweries and laboratories as well as in medical engineering and space technology. The company employs over 2,200 people and has a comprehensive network of branches in 35 countries world-wide.

Press contact:
Bürkert Fluid Control Systems
Kirsty Miller
Marketing Manager
Tel.: +44 (0)1285 648761
kirsty.miller@burkert.com

PR agency:
DMA Europa
Philip Howe
Progress House, Great Western Avenue, Worcester,
WR5 1AQ, UK
Tel.: +44 (0) 1905 917477
philip.howe@dmaeuropa.com
news.dmaeuropa.com