Cutting-edge sample preparation tools help laboratories to stay ahead of the curve

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Laboratories worldwide are in the midst of a robotics revolution, with complex automation platforms making quick work of even the most intricate workflows. Until recently, analytical chemistry labs have largely missed out on this transformation, due to the numerous sample preparation steps – often requiring precise transfers of minuscule volumes – involved in common workflows. This has prompted some facilities to search for novel solutions to remove bottlenecks and improve efficiencies, as well as to put their highly skilled personnel to better use. This article describes how a fully automated, end-to-end platform for chromatography sample preparation is helping to boost productivity and cost-effectiveness for a multinational topical pharmaceutical company.

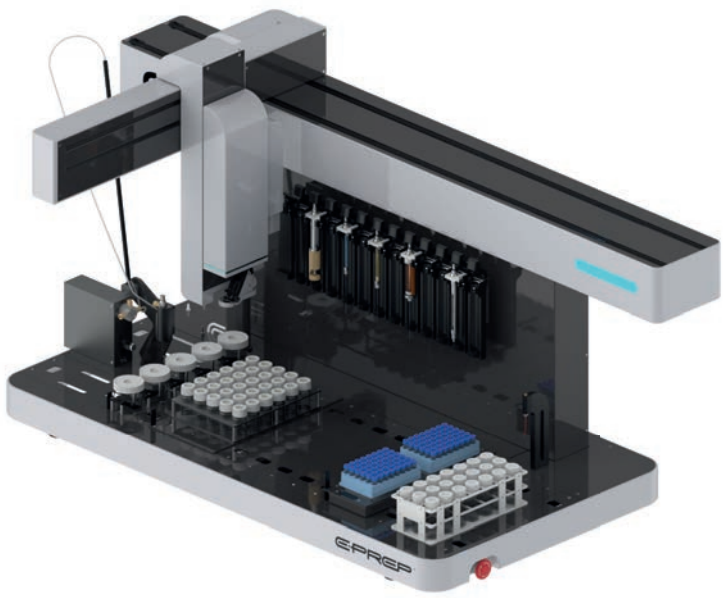
Introduction

Chromatography plays an essential role in the analytical chemistry laboratory, with applications including separation and analysis of complex compound mixtures, biomolecule purification, and quantification of target substances. In the highly regulated pharmaceutical sector, precision and reproducibility of these processes is critical. However, chromatography sample preparation is widely recognised as a complex and labour-intensive process that is often susceptible to errors when performed manually, due to the numerous liquid handling steps and minute sample volumes involved. Even slight inaccuracies in aliquoting, pipetting, dilution or mixing can compromise the integrity of results. Human factors – such as fatigue, distraction, or inconsistent technique – can further exacerbate these errors, leading to variations between samples.

Errors in sample preparation can result in numerous challenges, including reduced column lifespans, instrument downtime, compromised separation efficiency, and inconsistent reproducibility of results. More critically, inaccurate results may adversely affect downstream processes, causing delays, rework, or even product recalls. There is therefore a clear need for innovative solutions to streamline chromatography sample preparation, especially as analytical laboratories face mounting pressures due to increasing workloads and challenges in recruiting and retaining skilled personnel.

State-of-the-art solutions

There are a limited number of laboratory automation platforms that are designed to handle a wide range of chromatography sample preparation tasks with high precision and flexibility. These systems need to perform a wide variety of operations, including sample aliquoting, addition of diluents and reagents, serial dilutions, syringe mixing, liquid transfers, solid-phase extraction (SPE), microSPE and liquid-liquid extraction. Many instruments also feature intuitive user interfaces that allow for rapid set-up and programming of workflows – often using drag-and-drop functionality – and use technologies such as radio-frequency identification (RFID) and proximity sensors to automatically detect components like syringes, vials and racks, which minimises the risk of errors. The efficiency and adaptability offered by automation enable chromatography laboratories to efficiently process batch sizes ranging from a few samples to several hundred, automatically transferring completed samples to autosampler racks ready for analysis. Purpose-built platforms can improve the precision and accuracy of existing laboratory workflows, leading to high-quality results for every sample batch.



Automated chromatography sample preparation platforms provide an end-to-end solution to help increase the efficiency and accuracy of workflows.

Embracing automation

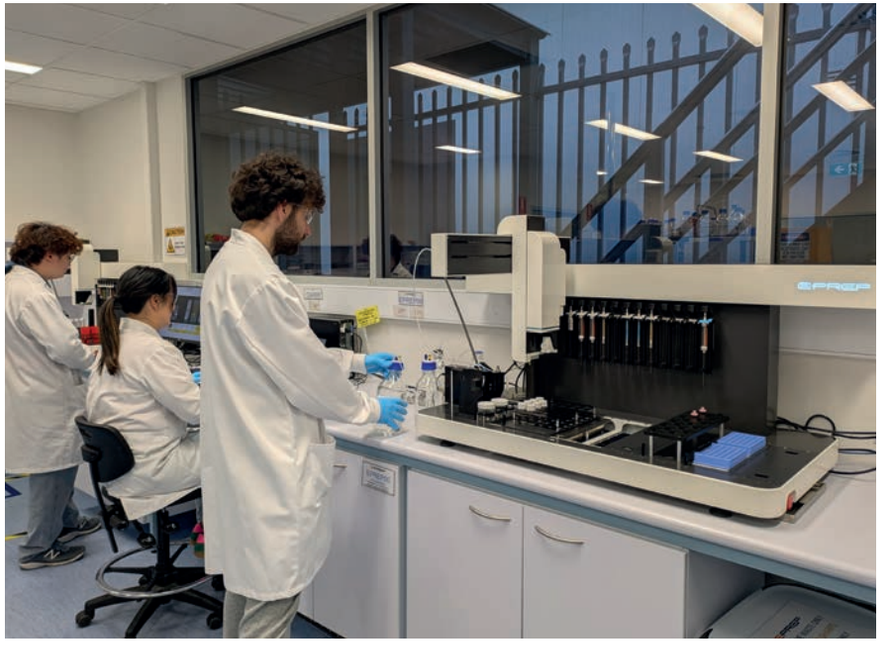
One company that has recognised the need to streamline processes in its analytical laboratories is Ego Pharmaceuticals. Founded in 1953 by a young chemist and his wife, the company is renowned for pioneering one of the first cosmetically acceptable sunscreens. Still family-owned, Ego Pharmaceuticals has grown into a global leader in dermatological care, supplying millions of people with a comprehensive range of skincare products. The company's rapid expansion brought increased complexity and volume to its manufacturing and quality control operations, creating significant pressure to enhance efficiency while maintaining rigorous testing standards to comply with European and USA pharmacopeia methods. To meet these demands, Ego Pharmaceuticals sought to modernise its analytical sample preparation processes, ensuring that the quality control laboratory could keep pace with production while upholding the company's commitment to quality and innovation.

Ego Pharmaceuticals has long recognised the complexity and labour-intensive nature of analytical sample preparation as a potential bottleneck in its production, particularly given the diversity of its product portfolio. With over 120 products manufactured at a single site – all of which require rigorous testing of both raw materials and finished products – the need for adaptable and efficient processes is paramount. Manual methods were proving increasingly inefficient in meeting the demands of such a varied product range. Preparing samples for different types of analytical methods required constant switching between protocols, recalibration of instruments, and handling of multiple types of solvents and reagents. This variability increased the likelihood of human errors and could sometimes lead to inconsistent results, requiring costly and time-consuming reanalysis. Traditional automation systems are often excellent at handling specific workflows, but lack the adaptability to transition between different methods that are necessary. The company therefore needed an automated yet flexible sample preparation solution that could accommodate a wide range of analytical methods while minimising downtime and set-up requirements. The team investigated the various options on the market, and identified the ePrep® ONE as the best solution to meet their requirements.

Enjoying efficiency

The implementation of automated sample preparation has delivered significant benefits to Ego Pharmaceuticals' analytical and microbiology laboratories. The first method selected for redevelopment was quality control and stability testing for one of the

company's legacy products. The conventional procedure required multiple dilution and pipetting steps involving hazardous solvents, making it an ideal candidate for automation. By re-evaluating the existing process with the capabilities of the automated platform in mind – as well as applying green chemistry principles – solvent volumes were reduced from 200 ml to 20 ml, and chlorinated solvents were replaced with safer alternatives. These changes resulted in a 70% reduction in solvent usage, a 90% decrease in solvent costs, and a five-hour saving in operator time per test cycle. The automated system's ability to run independently also allowed laboratory staff to focus on more value-added tasks, further improving overall efficiency.



ePrep ONE in situ

Automation has also reduced the high failure rates associated with manual methods, streamlining workflows and ensuring that testing keeps pace with manufacturing. Encouraged by its early successes, the company has already extended automation to other procedures, including cleaning validations, standard preparations and serial dilutions. Plans are also underway to optimise additional processes, such as switching from high performance liquid chromatography (HPLC) to ultra-high performance liquid chromatography (UHPLC) for several methods, as well as implementing two-phase extraction for raw material analysis. These changes are expected to further enhance efficiency by replacing labour-intensive steps with automated operations.

Growing market pressures

The drive toward automation in chromatography sample preparation is not unique to Ego Pharmaceuticals. Across the pharmaceutical, biotech, and chemical industries, laboratories are increasingly turning to robotics and advanced automation to address similar challenges. The rise in sample screening, personalised medicine and complex biologics has increased the volume and complexity of analytical testing, meaning traditional manual methods can no longer keep up with demand without sacrificing accuracy or efficiency.

Regulatory pressures are also contributing to the adoption of automation. Agencies such as the US Food and Drug Administration (FDA) and the European Medicines Agency (EMA) require strict compliance with data integrity guidelines, which necessitate consistent, reproducible and fully documented processes. Automated systems that are designed to be FDA 21 CFR Part 11 compliant offer an advantage by reducing variability and providing complete traceability from sample preparation to final analysis to meet data integrity requirements. This not only ensures compliance but also reduces the risk of audit failures.

The ongoing skills shortage in analytical sciences is also driving the need for automation. Laboratories are struggling to recruit and retain experienced personnel, making it essential to use automation to streamline routine tasks and allow scientists to focus on more critical aspects of their work. In an industry increasingly influenced by robotics and artificial intelligence, Ego Pharmaceuticals saw the benefits of adopting technologies that improve productivity, accuracy and staff satisfaction early. Since many graduates now entering the workforce are trained with these advanced tools, making them available in the laboratory is critical for attracting and retaining talent. Automated sample preparation helps to ensure that skilled personnel are deployed where their expertise is most valuable, focussing on identifying targets, working on improvement projects, and spending more time reviewing chromatography results – including analysing data and trends.

Conclusion

Integrating innovative sample preparation solutions to automate its workflows has enabled Ego Pharmaceuticals to successfully remove bottlenecks, improve reproducibility and enhance overall laboratory efficiency, while maintaining its commitment to quality and continuous improvement. Ultimately, the adoption of automation in chromatography sample preparation represents more than just a technological upgrade, it's a significant step to future-proofing laboratory operations. As analytical demands grow, automation will be a key differentiator, enabling companies to stay competitive, compliant and innovative in an ever-evolving industry.