SMC

Expertise
Passion
Automation

# Be fast, accurate and efficient

# 01

# Positive prognosis for analysers

Analysers are an important technology segment within industrial instrumentation and process control. According to strategic market insight specialist **Precedence Research**, the global market size for automated analysers was $7.51 billion in 2022, while expectations suggest it will more than double by 2032 to around $15.19 billion. This dramatic increase represents a CAGR (compound annual growth rate) of 7.3 % from 2023 to 2032. Key market drivers include:

- Increasing demand for advanced diagnostic tools
- Growing calls for point-of-care testing
- Rising investment in healthcare infrastructure
- More need for personalised medicine
- The advent of new laboratory automation technologies, including artificial intelligence and robotics

The adoption of laboratory automation, in particular, is rising fast in the analyser segment as it delivers many notable advantages, such as greater efficiency, enhanced accuracy, better repeatability, fewer errors, lower labour costs and higher throughput.

## Landmark decisions

Achieving the core objectives of successful **analyser development demands astute decision-making at the design phase**. Systems involving sample handling and temperature control, for example, are complex and require input from a motion control technology partner adept at turning concepts into reality. Key to the performance and effectiveness of any analyser is its sample handling, preparation, mixing, measurement and analysis capabilities. These tasks break down into many sub-roles that include:

- Dispensing and pipetting
- Identification
- Incubation
- Centrifuging
- Transport and storage.

Depending on the specific application, key components for analysers could encompass anything from actuators, valves, manifolds and sensors to pumps, step-motor controllers, air preparation equipment, robot hands, grippers, vacuum solutions, static control products, dryers and temperature control solutions (including chillers). With these components, analyser users gain access to several important advantages, such as:

- **Precise, fast and quiet motion for high quality and productive performance**
- **More efficient testing**
- **A safer operating environment**
- **Fewer experimental errors**
- **Greater data accuracy and reliability.**

Many components for analysers need communication capabilities to facilitate the data requirements for machine learning (ML) and artificial intelligence (AI). Only this way is it possible to automate laboratory workflows, including sample preparation, analysis and data management. These functions are vital regardless of whether the analyser is for blood analysis, genetic testing, urine diagnosis, microbiology or pathology, for example.

Demand is also high for industrial and scientific analysers (sometimes called process analysers). Applications here include spectroscopy, chromatography, water analysis and gas monitoring, to list but a few. According to global market research firm **MarketsandMarkets**, the worldwide process analyser market will see growth from $7.8 billion (in 2023) to around $9.3 billion by 2028, representing a CAGR of 3.6 %. Again, a key factor driving these gains is rising demand for automation.

# Accelerate development cycles

This white paper sets out to help analyser design and development engineers make the optimal decisions for their project. It spans a number of automation-critical areas.

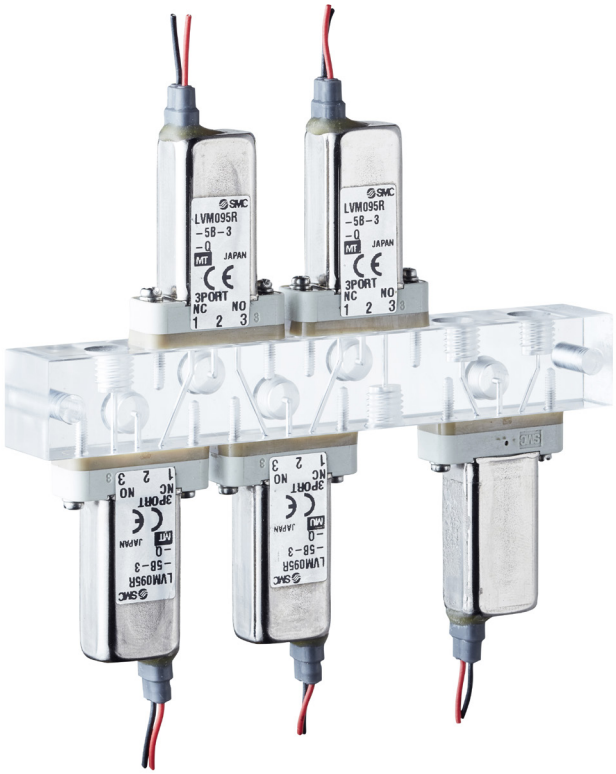
Among major sub-assemblies is the **fluid/gas sample handling** system, which can benefit from components such as micro-dispensing solenoid pumps and miniature valve solutions, for example. A solenoid diaphragm pump provides a single measured micro-shot of liquid each time the solenoid energises, making it ideal for dosing or mixing, particularly with its maintenance-free design and high durability. Indeed, SMC has many specific product advantages in this area, including components that work at high pressure, offer low internal dead volume and provide low-leak performance. As a point of note, **SMC has extensive cross-fluidic experience, both liquid and gas**.

The expertise of SMC can prove a key differentiator in achieving core project objectives. Far more than just a supplier of components, involvement of the company at every project stage will result in the optimal analyser design. Among key options here is the custom development of a multi-layer integrated acrylic manifold, which encases multiple fluid/gas circuits into one solid, leak-free, transparent solution to ensure the introduction of sample and reagent in the right proportion. This innovative solution provides:

- **Minimal dead volume**
- **Optimised and smooth fluid channels, without corners**
- **Visualisation of fluid movement**
- **The optional integration of threaded inserts for mounting purposes**
- **Possible integration of volume (chambers)**
- **The potential to handle mixed fluids: gas and liquid**
- **A fully integrated solution**
- **Precise control of diagnostics and results.**

## Top tip:

Whereas many companies outsource their acrylic manifold manufacture, SMC produces these products in-house. SMC can therefore demonstrate its knowledge in producing and developing the optimal acrylic manifold in the most cost-effective way, while simultaneously simplifying the supply chain and warranty.




Another focus area of this white paper is the **temperature control system**. Again, a reputable automation specialist such as SMC can advise on selecting the right cooling technology, typically a choice between Peltier or refrigeration-type chillers. Imperative again here is the need to appoint a partner that can provide both technologies and, therefore, offer impartial advice. If opting for a refrigerant chiller there are numerous regulatory requirements, both existing and new, to consider.

**Efficiency** forms the topic of another chapter. Aside from energy efficiency, this metric encompasses factors such as productivity, reagent savings, space savings, noise reductions and maintenance efficiencies. Also included is a chapter on **laboratory automation**. The design of SMC solutions involves a special weight and dimension optimisation concept. This approach allows robotic arms to move faster by reducing inertia loads, driving more productivity through shorter cycle times.

# Save time and cost

Those reading this white paper will deduce a number of common threads throughout its chapters. Prominent among them: design engineers save both time and cost if opting to partner with SMC as their technology partner. **Enjoy the read.**

# 02

# Fluid handling

## Conveying the advantages of fluid handling

**A core element of developing analysers for medical or industrial applications is the mechanism and components required for handling the fluid sample prior to actual analysis.** With development times for analysers often more than three years, the need for an expert technology partner and proven components are paramount to avoid the prospect of mid-project requalification, a process that can cause significant delays.

**Top tip:**

Partner with a technology specialist that can offer involvement at every step of the process, providing consultation and advice alongside a complete portfolio of component solutions. This ensures the development of a high-performance and reliable fluid handling system that does not exceed budgetary limits.

## Put to the test

The most common type of analyser is the medical analyser, of which there are three principal types.

- Clinical laboratory testing analyser
- Near-patient testing analyser (POC - point of care)
- Self-testing analyser.

Regardless of the testing technology deployed - be it clinical chemistry, haematology, immunoassay urinalysis, DNA, biology, molecular - the handling system for the fluid sample (blood, saliva, urine and so on) is vital as it contributes to the analyser's speed, repeatability and accuracy. The fluid handling system must perform many functions, including:

- Handling sample extraction
- Mixing, dosing with reagents
- Introducing the fluid sample into the analyser
- Washing and cleaning the system.

## Get up to speed

Fluid handling (liquid or gas) involves the interaction of many important components and functions in unison. While most development teams set out to perform these tasks at maximum speed, this ambition can create situations where speed actually endangers repeatability. To explain further, speed increases the risk of generating bubbles or turbulence in the fluid handling system, both of which can impact the analyser's repeatability.

By choosing components with little or no dead volume, or with optimal circuit topology, those developing the fluid handling system can minimise these issues. In the case of dead volume, an isolation membrane valve with limited internal volume requires less liquid passing through, which in turn means less potential for contamination and easier flushing. Indeed, less means more in many contexts:

- Less errors
- Less time
- Less cost per test
- More accurate results
- More analyses per day
- More precise results.

# Take control

A diaphragm valve controls the on/off function and flow path direction for different functions, from the fluid sampling circuit to the waste line circuit. This valve also serves another important role: managing the flow of bleach or saline wash solution that cleans the tubing, pipette end probes and pumps between analyses.

The most critical feature of a diaphragm valve is its diaphragm, typically made from EPDM, FKM or FFKM. The rest of the wetted part is manufactured from PEEK, which completely isolates internal parts from the flow path of the analyser to mitigate any risk of fluid contamination. As a point of note, the space between the valve's internal chamber and flow path is of specific construction to minimise dead volume, where trapped chemicals could carry over to the next test's fluid flow when the valve closes and re-energises.

### Top tip:

Seek out diaphragm valves that demonstrate an internal flow path with smooth surfaces, as this attribute prevents the generation of bubbles and other flow concerns. Another desirable characteristic is low power consumption, which helps minimise heat transfer to the fluid.

# Clear benefits of diffusion-bonded manifolds

A custom-manufactured bonded manifold, which encases multiple circuits into one solid, transparent solution, are the equivalent of a printed circuit board, but for fluids. Although typically manufactured from acrylic, other materials like PC, PEI, PSU and PVC are available. These manifolds ensure the introduction of sample and reagent in the right proportion. **The advantages over tube-to-tube connections include:**

- A large reduction in the number of joints
- Less risk of leaks, fewer fitting connections
- No possibility of tampering with tubes
- Better reliability
- Improved repeatability
- A reduction in the overall size and weight of the fluidic assembly
- Less space required
- No use of additional adhesives
- Optimised fluidic channels (no corners/dead volume)
- Simple servicing with the need for less expertise
- Flexible choice of fluids: gas and liquid.

The transparent manifolds also provide immediate visual inspection so that technicians can check fluid channels/paths for contamination and observe any colour changes in projects that involve fluid flow or mixing.

The successful manufacture of acrylic manifolds relies on process expertise in machining the basic layers according to the exact fluidic path configuration agreed with customers, followed by diffusion bonding of the layers under pressure and heat (compensating for shrinkage accordingly).

Each manifold needs to meet the demands of specific applications in terms of the circuit, the mounting components, space constraints, optical clarity, chemical compatibility and the flow speed path. Concerning the latter, acrylic manifolds allow for plenty of design creativity.

### Top tip:

A reputable expert in the design and manufacture of acrylic manifolds will be able to incorporate curved flow paths (which help to minimise dead volumes), different chamber types and various flow path diameters according to requirements.

As an integrated and reliable fluidic control solution, acrylic manifolds can accommodate a variety of essential circuit components, including:

- **Pressure and flow sensors**
- **Pressure switches**
- **Check valves**
- **Pressure regulators**
- **Solenoid valves**
- **Vacuum ejectors**
- **Proportional valves**
- **Silencers**
- **Throttle valves**
- **Diaphragm valves**
- **Air/liquid reservoirs.**

## Top tip:

Ask the technology provider to build a proof of concept (POC) model from a schematic design of the required circuit. This POC should allow the development team to perform full functional testing as a ready to plug-and-play solution.

Few suppliers claiming to offer solutions for the fluid handling systems of analysers have the in-house capability or expertise to produce acrylic manifolds. Many use a third-party specialist. For this reason, opting for a technology partner with demonstrable knowledge in this area leads to better performance, quality and cost metrics.

In terms of the technical specification and layout, acrylic manifolds manufactured by SMC for fluid handling circuits offer:

- **Pressure range: -100 kPa to 0.7 MPa**
- **Environmental operating temperature: -5 to 50 °C**
- **Media temperature: 0 to 40 °C**
- **Maximum layer size: 2,000 x 1,000 mm**
- **Channel size up 0.1 mm.**

Other technical requirements, please ask SMC.

## Top tip:

SMC provides close support for customers in the project-critical task of optimising the layout of an acrylic manifold.

# Pinpointing accuracy

The precision micro-dispensing of fluids ensures the flow and measurement of liquid/gas samples, reagents and wash solutions. Here, a well-specified solenoid diaphragm pump can supply a single measured shot of liquid whenever energising the solenoid. The following characteristics make for a good choice of self-priming miniature solenoid pump:

- **An adjustable pump volume, from 5 µl to 200 µl per stroke**
- **High precision with repeatability in the realm of ±1 %**
- **A maintenance-free design for easy and long-lasting use**
- **A compact housing to save space and simplify integration into complex systems**
- **A selection of different chemically resistant materials ensures a wide range of possible uses, optimised for the application.**

# Pneumatic or electric control?

When it comes to the automation of fluid handling operations such as sample management and loading, opening the reagent chamber doors, washing circuits, and ejecting used cuvettes into the waste stream, the development team can choose from air- or electric-based solutions.

**Top tip:**

While an increasing industry trend for analysers is to not integrate a compressed air source due to noise, vibration, space, maintenance or leaks issues, it remains good practice to work with technology providers that offer a full range of both electric and pneumatic solutions.

Electric automation solutions can include, for example, electric rotary tables that provide continuous 360° rotation, making them ideal for indexing wheels on sample and reaction trays. In addition, compact and lightweight electric grippers with adjustable closing force are suitable for handling a variety of vials and tubes. A combination of rotating and gripping movements is often also required in a compact electrical design.

However, the major differentiator in delivering the optimal fluid handling system for the specific analyser, is **expertise**: expertise in developing, or better said, co-developing custom designs with the OEM.

If the preferred solution is air-based, using a membrane air dryer is a good way to ensure moisture removal. Even a small amount of compressed air moisture can be problematic for a fluid handling system, compromising the lifetime of components and the functionality of products.

# Keep cool

Controlling the temperature of reagents might also be necessary, especially for large-scale analysers that perform hundreds of tests per hour and carry various reagents. The typical shelf life of an unrefrigerated reagent can be just two days, whereas chilled reagents can offer shelf life of 35 days. Many analysers feature integrated chillers or thermal control units in their reagent chambers to preserve the shelf life of reagents. Partnering with a technology expert that can provide adapted solutions is sure to pay dividends.

As a final point, more analyser manufacturers are looking at digitalisation to improve operational efficiency and provide real-time insight based on patient data. Analysers featuring IoT sensors can deliver information on device usage, which is particularly relevant for diagnostic labs that need to optimise the capacity of their capital investments. Likewise, IoT data can track the usage, expiry and consumption of reagents for each test, supporting the efficient management of lab inventory and utilisation. IoT expertise is therefore another factor in choosing the right technology partner.

Ultimately, building the correct mix of components within the analyser's fluid handling system supports the speed, repeatability and overall accuracy of test diagnostics. However, success rests on engaging a technology partner at concept stage.

**SMC has been co-operating with analyser manufacturers around the world for many decades, helping them save costs and reduce development times for fluid handling systems.**

# 03

# Refrigeration

## Keep cool under pressure: Choose a single-source solution

The design and development of an analyser for medical or industrial purposes is a lengthy process comprising several validation steps. Getting it right from the outset can make a big difference in both time and cost. When it comes to an important sub-assembly such as the refrigeration system, there are many advantages to relying upon **a single supplier** for all application demands, including:

- The temperature control system: Peltier or refrigerant type ‘chillers’
- The refrigerant circuit piping
- The flow control components.

It is important that design engineers specify the optimal temperature control solution from the beginning of an analyser development project in order to avoid changes that could necessitate re-validation and potentially add lengthy delays.

According to the system specification and type of application, **SMC can provide a complete customised solution recommendation based on key attributes that include performance, reliability and efficiency**. SMC customers also benefit from:

- Long-standing thermal management experience and knowledge
- Proven potential to customise
- Comprehensive pre and aftersales support.

# Peltier or refrigerant chiller?

To make this key decision, designers must first understand the fundamental differences between how Peltier and refrigerant-type chillers achieve cooling. While the latter uses compressed refrigerant gas that the system releases into coils, Peltier chillers take advantage of a solid-state device to cool the analyser interior.

## Peltier chillers

Chillers based on the Peltier effect offer impressive temperature stability, low noise output, low vibration and compact dimensions.

Definition:

**The Peltier effect is the cooling of one junction and the heating of the other when maintaining electric current (DC) in a material circuit comprising alternate layers of dissimilar semiconductors. These semiconductors sit between ceramic layers that serve as thermal insulators, creating a Peltier cell (also known as a thermoelectric device).**

The amount of cooling generated by a Peltier-type chiller is directly proportional to the voltage difference applied between the positive and negative power supply wires. With a Peltier-type chiller (thermoelectric device), analyser developers can control temperature to a narrow tolerance band **(±0.01 to ±0.03 °C)** due to its rapid response time.

Of course, in cooling applications there is a clear need to remove heat from the warm side of the Peltier cell, which means all chiller solutions of this type require heatsinks and fans. However, the noise of the fans in a Peltier cell is lower than that produced by other existing heat-transfer technologies, ensuring their suitability for use in laboratory environments. The vibration of Peltier-based chiller systems is also low because there are no moving parts (except the fans and pumps employed in fluid transfer tasks).

Here is a summary of the benefits that Peltier-type chillers provide:

- **Precise temperature stability**
- **Solid-state design for silent operation and low vibration**
- **No refrigerant for better sustainability credentials**
- **Compact, low profile and lightweight design**
- **High reliability**
- **Low maintenance**
- **Long lifetime**
- **Possible refurbishment.**

Of course, there are some performance attributes that lag behind those provided by refrigerant-type chillers. Energy efficiency is slightly lower, for instance.

### Top tip:

While Peltier-type chillers are more accurate, they tend to be more suitable for small power applications.

## Refrigerant chillers

Refrigerant chillers perform the same function as Peltier-type chillers but there are a number of key differences. The mode of operation, for example, necessitates the compression of refrigerant gas to create cold air. Specific benefits of this type of system include:

- Slightly better energy efficiency than Peltier-type chillers
- The ability to provide very low temperatures
- Slightly faster cooling than Peltier-type chillers.

Like any type of refrigerant-based system there is a little noise and vibration. The biggest issue, however, is the use of refrigerant itself, which is not necessary in Peltier-type systems. With refrigerant gases there naturally comes stringent regulations and standards. Although there is a way forward.

# Refrigerant: The way forward

The seemingly continuous arrival of new legislation regarding refrigerants makes it impossible to ignore cooling in the development and certification cycle of an analyser, which can range from 5-10 years. Such legislation is necessary because **cooling currently accounts for more than 7 % of global greenhouse gas (GHG) emissions** and is rising fast. Indeed, not only do cooling systems use a considerable amount of energy, but refrigerant gases such as hydrochlorofluorocarbon (HCFC) and chlorofluorocarbon (CFC) are also very harmful for the ozone. This is where the Global Warming Potential (GWP) index comes in useful.

Definition:

**Global Warming Potential (GWP) is an index to measure how much infrared thermal radiation a greenhouse gas would absorb over a given timeframe after emission to the atmosphere. The GWP makes different greenhouse gases comparable with regard to their effectiveness in causing radiative forcing. It is expressed as a multiple of the radiation that would be absorbed by the same mass of added carbon dioxide ($CO_2$), which is taken as a reference gas. The GWP value of $CO_2$ is therefore 1.**

Each type of refrigerant has its own GWP. As an example, R410A refrigerant, until recently a common gas in chiller applications, has a GWP of 2,088. This translates into an equivalent of 2,088 tonne of $CO_2$. The following is a list of typical refrigerants:

- R410A: GWP 2,088
- R134a: GWP 1,430
- R407C: GWP 1,774
- R404A: GWP 3,920.

## Raising the standards

All of the refrigerant gases listed are far above the limits proposed by new regulations. So what do the forthcoming standards say? Although some of regulations have yet to set their stipulations in stone, the typical analyser development cycle of 3-5 years makes it necessary to study the details.

Some of the strictest regulations are in Europe. Indeed, a new standard on fluorinated greenhouse gases specifies a **GWP of 150 or less as defined by Regulation 2024/573 of the European Parliament/ Council**, which amends EU Directive 2019/1937 and repeals EU Regulation 517/2014. This is lower than US regulations.

Legislation of this type is driving the industry towards lower-GWP gases via a wider acceptance of flammable refrigerants, but that is not really a solution for analysers. Additionally, many other refrigerants are toxic/harmful to health and cannot travel by aircraft, presenting a genuine problem for analyser manufacturers.

Despite the issues, many suppliers of chiller technology are adopting these refrigerants. R-32 is a common example, which is often described as a ‘balanced’ refrigerant in terms of sustainability, safety and energy efficiency. However, its GWP of 675 falls foul of new regulations. R-32 is also flammable.

So, are there any zero GWP options? The answer is yes, with R717 a typical consideration. Although R717 is refrigerant-grade ammonia (NH3) with zero GWP, it is a colourless, pungent, highly toxic gas, so needs handling with extreme care.

## Low GWP, non-flammable, non-toxic

SMC can put forward a trio of solutions with the potential to negate all of these issues. The first is the aforementioned Peltier-type chiller, which uses no refrigerant whatsoever. As a second option, the company can also offer water-cooled refrigeration solutions. Water is low cost, completely non-toxic, easily accessible and environmentally friendly. There are, however, some drawbacks to choosing this type of solution:

- Ambient environmental temperatures can affect cooling efficiency
- Water can cause corrosion, damaging refrigerant components and driving up maintenance costs.

The third option, which SMC suggests is likely the optimal solution for temperature control in many forthcoming analyser development projects, is $CO_2$. With its GWP of 1, $CO_2$ is also non-flammable and non-toxic, and therefore not subject to air transport restrictions. There are operational advantages too:

- A more compact footprint, around 20 % smaller
- Users can refill circulating fluid from the front
- No F-gas management required
- Eliminates the need for periodic inspections
- No F-gas recovery or disposal costs.

SMC already has refrigeration solutions available based on the use of $CO_2$ gas, putting the company at the forefront of analyser development technology.

# Other factors

There are a number of further factor that influence the decision of design engineers when it comes to refrigeration, including:

- **Compactness**
- **Energy efficiency**
- **Ease of maintenance**
- **Size versus cooling capacity.**

## Compactness

The amount space by volume consumed by analysers is of course a vital factor in today's laboratories. SMC is committed to reducing the size of all components, not just for the easiest implementation in the smallest possible space, but also to reduce the global footprint of its products.

A good example is the company's **HEF series** Peltier-type chiller, which replaces the HEC002 range with a **volume reduction of 88 % without any compromise in performance**. The HEF series also scores with its rapid temperature control: it only needs 41 seconds to reduce the temperature by 10 °C, which is 86 % less time than the previous model.

## Energy efficiency

The biggest influencer of TCO (total cost of ownership) is running costs, which makes energy efficiency an important consideration for design engineers keen to make their analysers attractive to end users.

**SMC focuses on energy-efficient performance for its entire chiller range**. However, a number of recent developments have pushed this metric to new levels. A case in point is the HRSH refrigerant-type chiller with its triple inverter technology.

### Technology insight:

Triple inverter technology provides demand-based rotation control for the chiller's compressor, pump and fan (air cooled models), offering substantial energy savings.

Depending on the HRSH model selected, users can expect to see 33-53 % less power consumption (without any compromise in performance) compared with a chiller that does not feature this technology. Both the coolant and refrigeration circuits are included in a compact and lightweight package, making it ideal for analyser applications.

Of course, while Peltier-type chillers such as the updated SMC HEF series may consume a little more energy, they offset this through the absence of refrigerant.

## Maintenance

Another huge factor in the TCO equation is maintenance. Despite the presence of many maintenance-free components, like the seal-less immersion pump in SMC's HRSH refrigerant-type chiller, such is the criticality of temperature control in analysers that preventative maintenance becomes a vital strategy for users of these important devices. Just like a car benefits enormously from correct and timely maintenance, so does a thermo-chiller.

With this thought in mind, SMC has devised a separate preventative maintenance standard for each chiller series in its portfolio, bringing complete peace of mind regarding temperature control and avoiding any potential for drift. At the same time, this approach makes for low TCO as it prevents any costly unplanned downtime or process errors from unexpected equipment failure.

The preventative maintenance standards created for each SMC thermo-chiller series are a recommendation for the lifecycle of the unit, setting out the daily, monthly, three-monthly, six-monthly and yearly inspection schedules. The standards also provide a list of parts that benefit from periodic replacement. Depending on the model, these components might include:

- The pump
- Pump seal
- Fan(s)
- Expansion valves
- Compressor.

**SMC has made life extremely easy for owners of its thermo-chillers**. An alarm activates when the dedicated hour counter for a specific part reaches the predetermined maintenance time.

All preventative maintenance strategies receive support from SMC's worldwide service teams, so using the company's chillers ensures reliability and business continuity. SMC has a presence in over 80 countries worldwide, where professional repair teams guarantee the comprehensive and high-quality servicing of all SMC thermo-chillers. The company boasts close-to-zero incidents of chillers returning to the company's factories for repair.

# In summary

Thermo-chillers serve a key function in analyser performance, where correct product temperature is vital to process precision and reliability. Of course, every analyser development programme is different, which means it may have different temperature control requirements. The good news is that **SMC has the experience and product options available to help design engineers meet all of their application goals.**

04

# Efficient solutions


## Proficiency in efficiency

Besides the automation of sample analysis, there are many ways that SMC can support analyser design engineers in making their products more efficient for end users. For instance, end users can:

- Get a **productivity boost** through one or all of the following: ultra-fast SMC on-off valves that reduce cycle times; SMC valves with zero dead volume that reduce cleaning times; and advanced SMC automation solutions that avoid any potential for manual mistakes
- Make **reagent savings** (use only what is necessary) via process optimisations involving SMC fluid control, pressure control and precision solutions
- Avoid the transfer of heat to the sample or reagent through SMC temperature control solutions, and thus **improve energy efficiency**. This factor receives a further improvement through the use of energy-efficient SMC automation components and optimised processes.
- **Save space** with compact SMC components. Modern laboratories demand small-footprint solutions.
- **Reduce noise emissions** with more silent SMC solutions, new materials, electric solutions, leakage monitoring and reduction systems, and/or solutions that work with low pressure
- **Drive maintenance efficiencies** by partnering with SMC. Maintenance teams at SMC work in accordance with international standards to ensure business continuity across the supply chain.

# Get clever with AI

New industry developments such as artificial intelligence (AI) offer another excellent way to make key efficiency improvements in analyser process applications. SMC offers a wide range of fully digital products that supply all relevant data in support of AI implementation. With AI-based diagnostics it becomes possible to overcome many long-standing laboratory issues, such as:

- **Inaccurate and inconsistent results**
  By deploying algorithms to evaluate data and identify patterns that humans cannot easily recognise, AI can reduce mistakes and variability in laboratory test results.
- **Large volumes of data**
  It is incredibly challenging for lab technicians to analyse and interpret vast quantities of data. AI in healthcare and medical applications can accelerate and improve the processing and analysis of large data sets.
- **Time-consuming tasks**
  Laboratory tasks like manual counting or interpreting images consume precious time. AI is able to automate these tasks, reduce the time needed for analysis and increase productivity.
- **Limited expertise**
  A shortage of skilled laboratory professionals may restrict the capacity of laboratories to interpret complex data. AI can offer expertise and assistance, particularly in pathology and image analysis, by automating the interpretation of complex data sets.
- **Cost and resource constraints**
  Labs frequently have to manage constraints such as budget restrictions and limited resources. By automating tasks and increasing productivity, AI is able to lower costs and help labs deploy better resource management strategies.


# Global opportunities

By tapping into the experience and expertise of SMC and its involvement in the life science sector, analyser developers looking for more efficient solutions in turn receive the assurance of alignment with international industry standards. As a result, analyser OEMs get peace-of-mind that their products are suitable for use anywhere in the world. A vital competitive advantage.

Depending on the application, analyser manufacturers might be seeking automation components that are compliant with:

- FDA (Food and Drug Administration)
- RoHS (Restriction of Hazardous Substances)
- REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals)
- GMP (Good Manufacturing Practice)
- IVDR (In Vitro Diagnostic Regulation)
- MDR (Medical Device Regulation)
- PFAS (organic fluorinated substances restrictions).

Whatever the requirement, SMC has accreditation-compliant products to help analyser developers achieve their project objectives, including maximum product and process efficiency.

# 05

# Laboratory automation

## The science of laboratory automation

With laboratory workloads increasing around the world, many labs cannot keep on top of current orders without either drastically increasing their headcount or adopting automation. While hiring more labour might initially sound cheaper, in the long-term automation represents a far more cost-effective option.

But the choice in favour of automation is far more than financial. Automation reduces repetitive manual labour, allowing lab technicians to take up more value-added activities such as quality assurance. Automation also reduces errors, improves time management and boosts lab performance in an increasingly competitive arena. It can even lead to faster availability of more reliable results. Partnering with an automation technology specialist such as **SMC is paramount for any lab equipment OEM or laboratory looking to automate a process**.

Many labs are already embarking on automation projects. Grand View Research estimated **the value of the global lab automation market** at $6.87 billion in 2022 and expects it to grow at a compound annual growth rate (CAGR) of 6.64 % from 2023 to 2030. This is perhaps unsurprising given the benefits that automation provides:

- Increasing the number of processed samples (and thus productivity)
- Reducing the required processing time per sample
- Negating issues with the lack of skilled technicians
- Protecting technicians from hazardous process steps and handling toxic or biohazardous materials.

Some of these advantages support direct cost savings. Automated systems are able to process a far larger quantity of samples, for instance, lowering the costs per sample considerably.

### Top tip:

Automation systems do not always execute the process steps faster than a human operator. Higher throughput often results from processing samples in parallel or running 24/7, for example.

Better traceability of the samples is another key advantage. Accreditations and certifications require a high level of process standardisation, typically in accordance with standard operating procedures (SOPs). Here, automated systems offer considerable advantages, eliminating the discrepancies that different operators may inadvertently introduce. In a similar way, variance between individual samples also reduces.

# Analyse without compromise

For many years SMC has been participating in the market value chain for lab automation solutions, with analysers key among the projects. By understanding the engineering requirements of analysers, SMC can offer optimal solutions to OEMs and laboratories. Analysers require special products that include:

- **Robotics**
- **Liquid handling solutions**
- **Dispensing equipment**
- **Sample management technology.**

It is an established fact that automating a process is an effective way to combat rising costs and drastically reduce the impact of skilled technicians. However, labs and designers of lab analysers are often unaware of the latest technologies that can provide a positive impact on research, development and discovery programmes.

**Real-word example:**

A lab engaged SMC for a way to automate the screwing and unscrewing of caps on sample containers. Devising a successful solution would allow lab technicians to apply a much larger percentage of their time on essential trials and development projects. By working in partnership with SMC's product specialist team and utilising the company's latest electric drive technology, it was possible to create a solution that eradicated the need for technicians to perform this repetitive and time-consuming task.

# Automation innovation

Through SMC's experience and dedicated global presence, **the company is contributing to the design, development and manufacture of automated systems for analysers with a complete product portfolio of standard and custom automation solutions**.

For instance, SMC's pneumatic solutions are designed under a weight and dimension optimisation concept, allowing robotic arms to move faster by reducing inertia loads. Products of note include the SMC JMHZ2 series parallel-style pneumatic gripper.

Electric solutions are also a good fit for analyser automation projects. Here, SMC's LEH electric robot hand/gripper provides soft and gentle handling using two or three fingers with strokes from 4 to 80 mm.

An electrical gantry solution (XYZ), compact and lightweight actuators (CQ/JMGP/JCM/JMB series), and five-port solenoid valves (JSY series) also contribute to rapid motion.

Of course, speed without accurate positioning is of little use in many lab automation projects, and analysers are no different. Sample positioning is essential, **where SMC electric actuators and rotary tables (LER series) offer high precision and repeatability**. The company's electric actuators come in slider (LEF series), rod (LEY/LEYD series) and guide rod (LEP/LES series) variants. Further analyser automation solutions available from SMC include:

- **Step/servo motor controllers**
- **Solenoid directional control valves**
- **Serial transmission systems**
- **Field bus communication, including wireless technology**
- **Air/water couplers**
- **Static-removing ionisers**
- **Digital pressure and flow sensors**
- **Pressure and flow controller open and close loop option**
- **Air preparation equipment**
- **Membrane air dryers**
- **Refrigerant and Peltier-type chillers**
- **Solenoid-operated pinch valves.**

With the laboratory arena continuously moving forward, SMC is prepared for the evolution and ready to act as partner for those looking to save time and cost in developing automated solutions. Tomorrow starts today, so now is the time to begin.

# 06

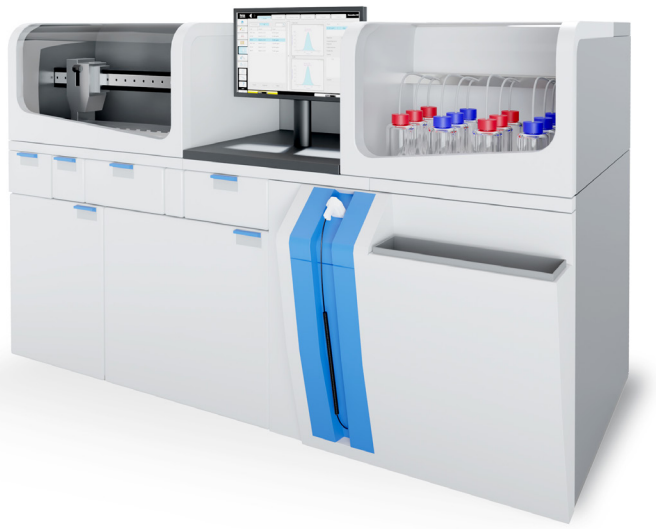
# Industrial analysers (applications)

## Analysers: captains of industry

While many common applications for analysers are typically within the medical and healthcare sector, demand for these innovative systems is also strong across industrial and scientific markets.

According to global market research firm MarketsandMarkets, the so-called process analyser market can expect to see **global growth from $7.8 billion (in 2023) to $9.3 billion by 2028**, representing a CAGR (compound annual growth rate) of 3.6 %. A key factor driving this increase is rising demand for automation from various industries and applications that include:

- Mass spectroscopy analysers
- Atom spectroscopy analysers
  1. Absorption method
  2. Emission method
  3. Reflection method
  4. Fluorescence method.
- Chromatography analysers
  1. High-performance liquid chromatography (HPLC)
  2. Ultra-high performance liquid chromatography (UHPLC)
  3. Gas chromatography (GC).
- Water analysers, including total organic compound (TOC) analysers
- Ion mobility spectrometer (IOM) analysers
- Gas analysers
- Various gas monitoring systems .



## Analyse ideas with the perfect partner

Industrial/scientific applications demand analysers with the same performance, quality and functionality attributes as those designed for use in the medical and healthcare sectors. For engineers working on new or next-generation industrial analysers, a sure-fire way to achieve these objectives is to partner with a proven technology specialist offering the whole plethora of automation solutions required to turn concepts into reality. SMC's range of products in the analyser field includes:

- **Pumps**
- **Actuators, including electric types**
- **Pressure sensors**
- **Flow sensors**
- **Pressure and flow controllers**
- **Temperature control solutions**
- **Static control products**
- **Air preparation equipment**
- **Grippers**
- **Vacuum products**
- **Connectors and fittings, tubings**
- **Manifolds, including multi-layer products**
- **A broad spread of valves.**

Regarding the latter, SMC can provide media-separated fluid control valves with minimal dead space, diaphragm and seat valves for fluids and gases, and valves in miniature formats.

# The SMC difference

With a goal of developing ever more advanced automation, **SMC offers high-quality, exceptionally reliable products that contribute to industrial automation, backed by first-class customer service**. Central to this offer is a comprehensive approach to the design of compact and lightweight products. Smaller, lighter solutions require fewer raw materials for their production and less time to process. In addition, these products use less energy and contribute to lower $CO_2$ emissions. All without any compromise in performance or reliability.

## Appointing SMC as an automation partner for industrial/scientific analyser projects is a tried and tested formula for success, as the following real-world projects highlight.

### Success #1

When a manufacturer of X-ray fluorescence **spectrometers**, mass spectrometers and optical emissions spectrometers (spark spectrometers) wanted to reduce assembly time and cost, it approached SMC for a complete solution that included **valve, fittings and throttle valves**. These were not just any automation components: the quality and performance requirements meant the complete assembly had to demonstrate a leakage rate of ~0 l/min. In addition, all components had to be completely free of grease and oil, with the final tests conducted using argon.

### Success #2

A stand-out feature of a new **water quality measuring system** that detects micropollutants in water processed by both wastewater and drinking water treatment plants, is its remarkably precise temperature control developed in close collaboration with SMC. The system's manufacturer leveraged SMC's expertise to develop a custom solution that could regulate water temperature using a **chiller** with a tolerance of 0.2 °C, for a flow rate of around 1 l/min. SMC performed the modelling and thermal calculations to design plastic prototypes and arrive at a perfectly stable solution. Notably, a system of remote probes indicates the energy required by the chiller. The chiller's robustness proved to be a major asset, guaranteeing consistent, reliable performance.

### Success #3

Whether for petrol or other substances, liquid tank systems should always be leak-tight to avoid the rapid escalation of what could become a dangerous situation. After manufacture, these tanks therefore undergo thorough testing prior to vehicle installation. To this end, a company in Europe developed **a helium leak testing system** that uses high vacuum and mass spectrometers to identify even the smallest leaks in components – and it takes just 60 seconds. Five **high-vacuum angle valves** from SMC's XLA series provide the precision, speed, safety and long service life necessary for this critical task. Furthermore, XLA series angle valves are exceptionally durable, withstanding up to 2 million cycles.

# 07

# Executive summary

## The analyser adviser

Making the correct decisions at an early stage of analyser development is vital because of their long development cycle (5 years or longer in some instances). This intensive process involves key milestones that include prototyping, testing, evaluation, risk assessment, certification and approval. Replacing an analyser component in the middle of this process could mean re-starting some phases and a lengthy, not to mention costly, delay. Analyser developers could suffer extended time-to-market and compromised commercial success.

Among the core advice provided by this white paper is the need to appoint a single-source technology partner that is able to deliver plug and play standard or custom solutions. Taking such a decision provides:

- A collaborative engineering relationship at initial project stage
- An interactive solution approach to improve existing designs
- Extensive knowledge in liquid and gas handling
- Faster time-to-market
- Easy instrument integration
- Components that comply with industry regulations.

SMC pursues total stakeholder involvement in the analyser value chain. In collaborative working partnerships with design and development engineers, SMC can demonstrate its understanding of these advanced devices. Analyser manufacturers can leverage the company's resources and expertise to arrive at the optimal solution.

## Local presence, global support

With the experience of its local teams, its internationally networked life science specialists and the company's comprehensive global presence, SMC supports a complete portfolio of innovative products for analysers. The company can develop and recommend customised specific solutions to help deliver competitive gain. For instance, building the correct mix of components within the analyser's fluid handling system helps to maximise speed, repeatability and overall accuracy during test diagnostics. By directly addressing these objectives, the customer or partner can tap into gains that include:

- Improved cost effectiveness
- Higher individual test value
- Lower maintenance costs
- Safer day-to-day operations.

However, what makes the difference is SMC's expertise in developing, or better said, co-developing custom designs in line with international standards. Local engineers backed by a global network of technical centres results in identifying the best technical solutions for each analyser project.

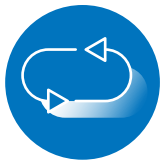
## Fast, accurate and efficient

Design engineers save both time and cost when partnering with SMC as their automation expert. Time-to-market is paramount in the analyser market, where lost time is lost revenue. Working with SMC minimises development time, safe in the knowledge that the company can provide a full range of automation components built on premises that include **quality, precision, reliability, efficiency, compactness, quiet operation and cost-effectiveness**.

**SMC has been co-operating closely with analyser device manufacturers in their development projects for many decades.** The company's experts are on hand and ready to support this vital industry and continue providing a small but important contribution to good health and wellbeing.

**Increase your productivity**

**Guarantee impeccable accuracy**



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