Laser spectroscopy microleak detection systems enhance aerosol production efficiency and product safety

Real-world results showcase successful aerosol microleak detection system deployments that ensure process safety, product quality, and regulatory compliance, while reducing testing pain points and cost. By Graeme Walker & Jason Mitchell, Emerson

Since the introduction of "bug bombs" in the 1940s, aerosols have come a long way, experiencing a vast expansion of applications, and a corresponding increase in manufacturing volume. According to a Grand View Research study, the industry was valued at $78.7 billion (€70.7bn) globally in 2022, and it is expected to grow an average of 6.7% per year from 2023 to 2030.

To meet market demands and handle such volume, assembly lines must accommodate unprecedented levels of package varieties, while ensuring quality, safety and regulatory compliance. Leakage can occur in aerosol products due to defective components and manufacturing issues, including split gaskets in valves, pinholes in cans, moulding flash on valve components, clinch or crimp failures, and others.

Detecting and eliminating these sorts of defects before product reaches the market is critical for upholding consumer safety and the manufacturer's reputation, so companies must closely monitor finished goods, and use findings to improve their manufacturing processes.

Machine in action

Microleak detection methodology

Historically, hot water baths were used to test for aerosol can deformations and leaks that could lead to dangerous bursts. In the early days, operators on the line observed each can passing through the bath, looking for bubbles that indicated leakage, but as line speeds increased, manual detection became unfeasible.

Even with automated monitoring systems in place, water baths have several drawbacks, requiring:

- high expenses to buy and install, about $250,000+ (€224.8k+).
- a large footprint in space-constrained facilities.
- significant energy investment to maintain continuous water heating above 50°C/122°F.
- frequent maintenance and expensive chemicals to avoid corrosion and keep the bath clean.

An alternative methodology is preferred, but it must still meet an equivalent level of safety as supplied by water baths. This requirement is critical because failure to identify leaking aerosol cans can result in the release of flammable or explosive gases or liquids, risking product recalls, brand reputation damage and, worst of all, safety incidents.

The following sections will explore real results achieved by aerosol product manufacturers that deployed a modern alternative to ensure quality and safety, while simultaneously reducing testing time and cost.

Lubricant manufacturer moves packaging and testing in-house

A lubricant manufacturer designs, formulates, tests, blends, packages, and distributes synthetic and semi-synthetic solutions in a

Figure 1. Emerson's Rosemount Aerosol Microleak Detection System uses QCL technology to assess up to 600 aerosol cans per minute for defects, depending on product specifications and operating conditions

> **This solution empowered the company to meet aerosol quality regulations, while ensuring the safety and integrity of its products**

variety of industrial and automotive markets worldwide. The manufacturer previously partnered with an aerosol filling company to package its R134A refrigerant propellant, but high defect rates were resulting in 2.5 to 5% product loss. This prompted the manufacturer to move its filling process in-house, which required design and procurement of appropriate packaging equipment.

With a limited production floor footprint, the company was particularly motivated to determine an approved alternative to hot water baths for microleak detection and pressure testing. To meet requirements, the manufacturer purchased Emerson's Rosemount™ Aerosol Microleak Detection System, a laser spectroscopy system based on quantum cascade laser (QCL) technology (Figure 1).

This system is capable of detecting, identifying, and rejecting faulty cans at very fast line speeds, 300 cans per minute in the case of the refrigerant packaging system. It does this by drawing in the air around an aerosol can while it passes through the sample arch, directing the air through a measurement cell, and focusing a laser beam through the sample gas, which is reflected to a detector (Figure 2). Variations in light intensity are measured, and the leak rate is then calculated using infrared spectroscopy. If the leak rate is above specification, the product is automatically rejected.

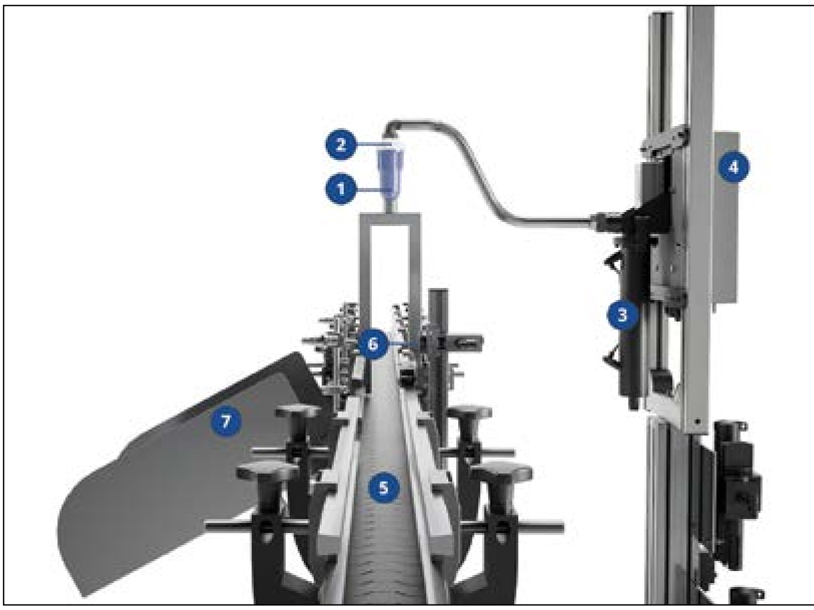
This solution empowered the company to meet aerosol quality regulations, while ensuring the safety and integrity of its products, without the ongoing space, cost and maintenance drawbacks of water bath systems.

Additionally, the solution's onboard diagnostic and data-producing capabilities enabled the manufacturer to optimise its packaging process control with actionable insights, along with visibility into batch quantities and rejection rates. This helped the company increase its use of automation, reduce waste and improve environmental stewardship.

As a result of the in-house packaging and improved testing system, the company saved an estimated $200,000 (€179.9k) in capital costs as compared to a water bath system, with an additional $35,000 (€31.4k) in energy, consumables, and maintenance cost savings each year. These numbers do not even factor valuable space gains on the plant floor into consideration, which provide additional benefits.

Contracted filler increases line efficiency and testing integrity

Some companies in the aerosol industry are not responsible for manufacturing products, but rather specialise in filling and packaging



1. Air extraction arch: draws the air from around the aerosol can into the sample handling system
2. Air filter: used for the removal of air particles and leaked contents of the aerosol cans
3. Sample cell: laser light is directed through the air extracted from around the cans and back into the sensor head.
4. Sensor head: contains the lasers and laser light detector. It is rated ATEX, IECEx and UKEx Category 3 for use in Zone 2, and for use in Class 1, Division 2, Groups A, B, C, & D, T6.
5. Conveyor belt: used to transport the aerosol cans
6. Automated can rejection/pusher mechanism
7. Rejection bin

Figure 2. The Rosemount Aerosol Microleak Detection System automatically identifies and rejects leaking cans inline using an air extraction arch, air filter/regulator, sample cell, sensor head and an automated rejection mechanism

Configuration	Single Laser Aerosol Microleak Detection System	Multi-Laser Aerosol Microleak Detection System
	Sensitivity	
Post Water Bath: 8×10^{-3} mBarL-1	Yes	Yes
Water Bath Alternative: 2×10^{-3} mbarLs^{-1}	Yes	Yes
	Propellant	
Propane	Yes	Yes
Butane	Yes	Yes
DME	Yes	Yes
134a	Yes	Yes
CO_2	Post water bath only	Yes
HFO	Yes	Yes
152a	Yes	Yes
N_2O	Yes	Yes

Table 1. The Rosemount CT2211 Aerosol Microleak Detection System is configurable with a single or multi-laser sensor head, adaptable to user needs

other companies' products into consumable forms for the market. As with companies that package their own products, contract fillers are subject to the same stringent safety and quality requirements to minimise product leakage and flammability risks.

Brand owners often mandate the use of a microleak detection system by their filling contractors. These contractors traditionally used conventional hot water baths to identify faulty cans and seals, but modern laser-based alternative analysis systems are empowering fillers to detect smaller leaks with higher accuracy at faster line speeds. Additionally, these systems have lower maintenance overhead because they have fewer moving parts and do not require calibration.

One such contracted filler installed a Rosemount Aerosol Microleak Detection System in its line to conduct quantifiable test regimes for microleaks, initially downstream of its water baths, but eventually replacing them. This ensured the company was fully compliant with pressure and leak testing requirements and regulations, providing quality assurance over a range of product lines for various manufacturers at line speeds up to 220 cans per minute.

The new system is ATEX zone 2 and Class 1 Division 2 certified for use in hazardous environments. The system is integrated into the company's non-destructive product testing regime, and it is capable of automatically rejecting defective products from the conveyor belt used to transport cans in and out of the microleak detection system. These capabilities enabled the contractor to take on more orders over a multitude of propellants (Table 1), meeting higher production demands without compromising quality or safety.

Additionally, the contractor used batch insights provided by the microleak detection system to collect and analyse performance data previously unavailable with its traditional water bath inspection systems. This information helped it optimise filling and packaging processes by identifying production issues that could lead to faulty or contaminated cans, and it helped the contractor shift from reactive to proactive maintenance practices.

Reduce waste with laser-based leak detection systems

Modern microleak detection systems are not merely quality gates, they can additionally serve as a powerful process performance indicator. For this and other reasons, the road to return on investment is short when leveraging these systems to identify and address developing issues before they turn into mass-scale systemic failures and wasted product.

With a wide range of applications, QCL spectroscopy microleak detection systems are empowering aerosol manufacturers to produce profitably, conduct business reputably, operate sustainably, and adhere to the highest safety and quality standards.

All figures courtesy of Emerson Measurement Solutions

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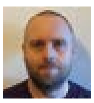

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