

Measuring and Monitoring CO₂ in incubators

One of the most important devices in producing and researching biopharmaceuticals is the CO₂ incubator. Incubators are used for cell culture processes in many applications, including antibody production, tissue engineering, viral vaccine research, reproductive technologies, cell and gene therapies, and toxicity studies. To be effective, incubators mimic the environmental conditions of cells in a living body (in vivo) to enable successful cell growth in media within the chamber (in vitro). Culturing cells requires not only ideal conditions in the media used, but also in the incubator chamber. Further, if batches are not cultivated under controlled conditions, results may not be reproducible.



Modern incubators as complex systems

In cases where a cell culture has failed to proliferate, there are several avenues of troubleshooting to consider. However, the first point-of-failure in cell cultivation is often conditions within the incubator. While modern incubators can automatically adjust conditions based upon measurements from sensors within the incubator itself, those measurements may not be accurate.

Unless a CO₂ incubator is newly installed and validated, or recently serviced and re-qualified — and presuming the service included a calibration and adjustment of the integrated sensors — relying solely on the incubator's measurement capabilities is risky. There are several systems that could fail in any incubator. The

costs associated with any one parameter being out of tolerance are high; losing samples is only one possibility.

Making in vitro match in vivo

Different processes require different culture conditions. For most human cells, incubators typically maintain a temperature of 37 °C, with carbon dioxide at 5 % CO₂ and relative humidity (RH) at 95% RH. Stress testing can require higher or lower temperatures, and sometimes gases other than CO₂ are maintained at a given concentration. External sensors can be added for different parameters, but also to provide redundant monitoring with devices that are easier to calibrate and able to send alarms for out-of-tolerance conditions.

Accurate measurements mean repeatable processes

For incubator applications, Vaisala offers several sensors to measure and monitor conditions. For carbon dioxide within incubators, the GMP251 CO₂ probe is an ideal solution. The probe is based on Vaisala's CARBOCAP® technology that ensures measurement stability. The CARBOCAP® sensor features a new type of infrared (IR) light source, instead of the traditional incandescent light. This advance significantly extends the expected lifetime of the probe. The GMP251 probe also compensates for temperature and pressure, which is important with any gas measurement. In addition, the sensor head is heated to prevent condensation and maintain accuracy.

Wireless monitoring simplify installations

In the latest adaptation of GMP251 probe technology, the probe is connected to Vaisala's wireless RFL100 data logger to provide easier installation and send real-time and historical data to Vaisala's viewLinc Continuous Monitoring System. As the software component of this system, viewLinc provides alarming, real-time trend data, and reports for compliance with GxP regulations. viewLinc monitors multiple parameters, including temperature, relative humidity, CO₂, differential pressure, level, door switches, etc. and sends remote alarms via text, email, or phone dial-out.



The RFL100 data logger uses Vaisala's proprietary wireless technology VaiNet to achieve wired-equivalent connectivity and superior signal strength to 100 m (330 ft.). The VaiNet RFL100 carbon dioxide data logger can measure CO₂ percentage, or CO₂ percentage with temperature, humidity, or both. Designed for incubators, the

RFL100 includes probe-mounting options that allow for secure and flexible sensor placement within an incubator. Optional heat-resistant cables simplify heat sterilization processes because only the probe needs to be removed. Easy removal of the GMP251 smart probe also allows for easy calibration of the probe independent of the data logger.



As the need for incubator applications increases — caused by growth in markets that include reproductive technologies, cell and gene therapies, infectious disease and vaccine research — accurate measurements that allow for reproducible processes needs to be a defining feature in biotechnology research and production. With advances in wireless technologies like the RFL100, and development of smart probes like the GMP251, installation, deployment, calibration, data integrity, and compliance with GxP regulations can provide researchers and manufacturers with a competitive advantage.



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