

# Validating EtO Sterilization

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Close control of the EtO sterilization process is required to ensure the safety of medical devices. Requirements for validation and control of EtO sterilization have increased substantially in recent years. The ANSI/AAMI/ISO (American National Standards Institute/Association for the Advancement of Medical Instrumentation/International Organization for Standardization) 11135 standard "Medical devices -- Validation and routine control of ethylene oxide sterilization" was issued in 1994, but due to a grandfather clause, many sterilizers are only now becoming subject to the standard. One of the most significant features of the new standard is a requirement for monitoring humidity during the conditioning stage. Furthermore, independent monitoring of humidity is the preferred, although not the only acceptable method. The standard also specifies specific requirements for the selection of humidity sensors and period during which humidity as well as temperature must be monitored.

Griffith Microscience is a leading EtO sterilization contractor serving the medical device industry. Medical device manufacturers typically ship products such as pharmaceutical vials, disposal needles, surgical gloves, etc. to Griffith's plant where they are sterilized, packaged and then shipped to a distribution center or directly to customers. EtO has historically been one of the most simplest, safest and cost-effective methods of sterilization. It can be used with nearly all medical products and can even be used to re-sterilize many products. Among several competing technologies, EtO currently holds a market-leading 45% share of the medical device sterilization business.

Sterilization is carried out in a vacuum chamber because of the explosive nature of EtO gas. In order to ensure effective sterilization, every batch of product is validated in three "challenge" cycles that are run at one half the normal amount of dwell time. Biological indicators are placed at various locations around the product and, after the cycle is completed, inserted in a culture media designed to promote their growth. If observation in the culture media shows that the indicators have been killed, then the sterilization process is validated. EtO requires elevated levels of temperature and humidity in order to maintain its effectiveness as a sterilization agent. An important part of the validation process is maintaining, monitoring and recording the temperature and humidity throughout the product load.

## **Previous sensor problems**

In the past, Griffith Microscience used thermocouples that were hardwired to a multipoint data recorder to measure temperature inside the sterilization chamber. A trained technician was required to set up these devices. It took a considerable amount of time because of the need to carefully wire thermocouples and set up the data loggers. In spite of the technicians' precautions, sometimes wires or contacts would break when the thermocouples were being positioned in the product load. In other cases, the data recorder would run out of paper or paper would jam in the feed mechanism. These problems were usually discovered after the validation run had been completed. While the validation cycle can usually withstand loss of a single sensor, multiple sensor losses or data recorder problems forced the cycle to be repeated. The technician had to spend extra time at the end of the cycle unwiring the thermocouples so that the product load could be removed.

Recording humidity within the chamber was also a problem. The sensors used in the past didn't stand up well to EtO. When they were first used, they tended to fail during the validation cycle.

Griffith engineers got around this problem running an extra conditioning cycle during which temperature and humidity were closely monitored without inserting EtO into the sterilization chamber. At the end of this cycle, the humidity sensors were removed. Then, the sterilization process was run as a separate cycle. This solved the problem of damage to the sensors but increased the time and cost of the validation.

### **Evaluation of alternatives**

In an effort to overcome these problems, Griffith engineers examined a number of humidity and temperature sensors designed to withstand harsh environments. They exposed each type of sensor that they examined to hundreds of hours of EtO exposure at elevated temperature levels. Nearly all of the products that they tested either failed or showed signs of damage during these tests. Datatrace sensors, from Mesa Laboratories, Inc., Lakewood, Colorado, were only devices tested that met all of the specifications established by the engineers. Griffith engineers made the decision to switch to these sensors for monitoring EtO sterilization. The new hermetically sealed

Datatrace sensors are designed for continuous monitoring under even the most adverse conditions. The fact that these sensors are hermetically sealed eliminates the problem of chemical attack which caused problems with both the thermocouples and the humidity sensors used before. The new devices also provide increased protection against explosive hazards because they are designed based on the concept of intrinsic safety so that, even if the seal is penetrated, neither the device's electrical or thermal energy is sufficient to ignite the gas vapors in a hazardous location.

### **Eliminating wiring**

The internal data logging capabilities of Datatrace sensors eliminate the need to string wires from measuring points to a central data logger. Each sensor records up to 1000 readings for each parameter, temperature and humidity. The small size of the devices make them perfect for placement within the product load. Data can be retrieved from the sensors through a serial port on the devices. A Windows-based software package prompts the user through the functions required both to set up the devices to record at any desired interval or any particular time period. The sensors record up to 1000 measurement points and there is no limit on the length of time over which this data can be sampled. Then, after the measurements are completed, the data can be easily downloaded into the PC for producing reports or further analysis.

Although Datatrace sensors are not medical devices, their accuracy and quality is assured through a rigorous internal campaign by their manufacturer which is also a medical device producer. The FDA has found that Mesa Laboratories operates in compliance with FDA quality system requirements, which Datatrace uses in turn as its quality assurance model. Precision constant temperature silicone oil baths, isothermal dry wells and high precision reference standards are used in calibration. Calibration standards are submitted to independent metrology labs for accuracy and verification and full redundancy calibration procedures are performed.

### **Significant cost reduction**

The new devices have substantially reduced the cost and improved the reliability of the validation process at Griffith Microscience. First of all, the ability of the humidity sensors to withstand EtO has made it possible to combine the conditioning cycle with a validating cycle, eliminating one cycle and reducing validation costs by approximately 25%. Second, the elimination of the need to string wires from the sensors to a multichannel datalogger has substantially reduced setup time. Griffiths engineers estimate that they save two man-hours per validation cycle. The new sensors are so much easier to manage that a technician no longer needs to be present when the validation cycle is loaded, making it considerably easier to schedule cycles during nights and weekends.

An engineer will typically set up the sensors on Friday for a weekend validation run. The setup parameters determine when the sensors will begin collecting data and the length of the sampling interval. The sterilization operator positions the sensors within the product load and starts the sterilization run. The high data storage capacity of the sensors makes it possible to allow sufficient extra data collection time on either side of the scheduled run so that data is still collected even if the schedule changes. When the validation cycles are completed, the operator removes the sensors. When the engineer comes into work on Monday, he downloads the data readings and prepares the appropriate reports.

Since Griffith Microscience began using the new sensors, not a single cycle has had to be run over because of sensor failure. This saves money and helps assure the company's customers that their products will be delivered without any unexpected delays. The elimination of sensor failures also excludes the possibility that a product load might be damaged because it had to be sterilized a second time because of multiple sensor failure. The reliability of the new sensors has been proven on many occasions. Recently, a sensor fell out of a product load, rolled across the floor and was run over by a lift truck. The outer case of the sensor was dented but when an engineer connected a computer to the device he found that all data was intact. Further testing showed that the dented sensor still took measurements within its specified tolerance range.

All in all, the new sensors have helped Griffith Microscience save money and increase customer satisfaction. The ability to combine cycles and the elimination of the need to wire point sensors has reduced validation costs. The fact that a technician no longer needs to be present during product loading and unloading provides further cost reductions and increases scheduling flexibility. Most important of all, the elimination of sensor failures helps insure that Griffith is able to meet customer delivery schedules.