Validation Solutions

Application Note • Pharmaceutical
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Qualification of Dry Heat Sterilizers and Validation of Depyrogenation processes

Background

The use of dry heat for sterilization is less common than steam due to the reduced efficiency of the micro-organism destruction rate. However, for some materials that are sensitive to the presence of moisture, dry heat is a suitable alternative. In addition to sterilization, dry heat can also be used to destroy pyrogens, this however, means that the required temperatures are much higher. This process is called depyrogenation.

A dry heat sterilizer can either be designed as an oven or a heat tunnel. In both cases filtered, hot air is circulated around or blow vertically down onto the objects that are being sterilized. The dry heat ovens vary in size but can easily be over several m^3 in volume. For heat tunnels, the hot section is usually much larger (several meters long) and a conveyor belt moves the articles through the heating and cooling zones at a defined speed, making it a continuous process.

The temperature and exposure time are critical parameters. In general, dry heat cycles will typically be executed at 160 to 190°C with corresponding exposure times that range from 30 to 120 minutes. For depyrogenation cycles, the minimum temperature is 200°C for at least one hour when operating in ovens. As depyrogenation tunnels are operated at much higher temperatures, typically 325°C or even 400°C, the holding times are typically only a few minutes.

Regular calibration to ensure the most accurate data as possible

To ensure that the sensors provide the most accurate data possible, calibration of the temperature sensors is required prior to use and for post verification. For dry heat sterilizers, sensors must have an accuracy of ±0.5°C, while for depyrogenation ovens and tunnels, an accuracy of ±1°C is considered appropriate. Some systems also use vacuum and therefore require pressure measurements.

Challenges

All dry heat sterilizers undergo qualification to verify specifications as a regulatory requirement. This includes temperature and the holding time performance. Due to the relative high temperatures in the process, one must be aware of the temperature influence on the measuring system. Surface materials and even embedded electronic components need to be resistant to heat exposure.
The moving parts found in tunnels and the distances however, might prove to be a challenge for cable-based systems.

In addition to maintaining the minimum and maximum temperatures for set time periods, there are several other critical factors. These include the spread of temperature across the belt during the sterilization period and the deviation of individual temperature sensors over the sterilization period.

Continuous calibration of the sensors

Another challenge when validating heat tunnel and oven processes is the continuous calibration of measurement sensors. It is essential that users can document that the sensors are within an acceptable accuracy when they were used. This means calibrating shortly before the validation run (Pre-Calibration) and then checking the accuracy afterwards to ensure that they are still within the predefined tolerances (Post Calibration). If the post calibration check reveals that the accuracy is outside the required limits, the validation study is invalidated.

For more information on TrackSense and E-Val Pro or to find the right solution for your needs:

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Suitable Solutions from Ellab

As mentioned before, the temperatures being used highly depend on whether the goal is dry heat sterilization or depyrogenation, but levels are in both cases relatively high.

Ellab offers two different solutions, a wired and a wireless system; whether to choose the E-Val™ Pro thermocouple system or TrackSense® Pro wireless data loggers depends on the exact conditions. In the past, wired thermocouple systems such as the E-Val Pro were used for dry heat sterilization and depyrogenation, providing the accuracy and large number of channels that is required for validating sterilizers. However, the use of multiple cables can be a problem when introducing them through the door seal or along the tunnel conveyer belt. Further to that the type of cable is critical, as they must be flexible and able to withstand high temperatures, which is why that only the mineral insulated cables or Kapton cables are suitable.

When specifically discussing depyrogenation tunnels, adding in the fact that moving parts are present in the tunnels, there is an additional challenge for cable-based systems. Due to this, we recommend using TrackSense wireless data loggers as they present considerable advantages over wired systems.

Data logger advantages

- Loggers are easy to place within applications, thereby highly reducing the set-up time
- As loggers are placed directly in applications, they follow the conveyor belt movements
- Through the use of a thermal barrier around the logger/battery, loggers are provided with enough protection to enable them to be used at temperatures of up to 400°C. It is critical to note the heat period's duration as well as the maximum temperature in the tunnel in order to ensure that the barrier provides enough protection for the logger. If a logger is exposed to too high temperatures, it can cause irreparable damage to the equipment

Ellab calibration equipment and software

The two validation solutions that Ellab offers are slightly different in regard to measuring technology. The TrackSense wireless logger system offers increased stability and accuracy by using Pt-1000 based wireless sensors as opposed to the E-Val Pro thermocouple sensors.

This additional accuracy and long-term stability consequently mean less frequent calibrations, due to lower drift over time. As mentioned before, for calibrating dry heat sterilizes, an accuracy of ± 0.5°C is required and for depyrogenation, an accuracy of ±1°C is acceptable. This is easily verified by using Ellab calibration equipment in the shape of various dry block calibrators, operated directly by the ValSuite™ software, storing the offset values in a database.

For traceability, all wireless loggers/sensors and thermocouples have a unique serial number that is embedded in the firmware and engraved on the body. This ensures that the ValSuite software, which is used to handle both the E-Val Pro and TrackSense Pro, can perform the required statistical analysis and Fh calculations for validation studies. These results can then be printed or presented as PDF reports, providing a large amount of flexibility when it comes to meeting the necessary requirements.

Benefits of choosing Ellab for qualifying dry heat sterilizers and validating depyrogenation processes

- ✓ Choose between wireless data loggers or wired thermocouple system that are operated in the same software
- ✓ High measuring accuracy for the entire temperature range
- ✓ FDA 21 CFR part 11 compliance
- ✓ Reports for full documentation, including Fh calculations
- ✓ Calibration facility embedded in software

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