Understanding Pasteurization and Sterilization processes

By: Douglas Wright, President

While the current growth of the Microbrewery and unpasteurized beers results in some amazing beers there is the point for any beverage producer where increased volumes and demand for consistent products will result in the need to pasteurize some or all of your beverages. This involves heating products at high temperatures (above those sustained by normal electronics) in order to destroy any harmful bacteria present.

A good pasteurization tunnel is the first step you do need to be sure your bottles and cans are being pasteurized without over cooking them and reducing flavour. Therefore Pasteurization becomes an art form and must be continually checked and modified. Since Pasteurization processes typically involve a scalding spray, a greater water resistance than most dataloggers or electronics can sustain is needed as well.

Ideally the process involves measuring internal bottle/can temperature relative to the external temperature of the spray and many processes involve recording internal product temperatures as well. (SterilDisk and PasteurDisk) dataloggers inside a dummy can/bottle or an outside probe (SterilCyl, PasteurCyl) inserted through special fittings to record internal temperatures are ideal here.

In canning and bottling, the SterilCyl, PasteurCyl, SterilDisk and PasteurDisk dataloggers are used to measure the temperature for the purpose of validating the sterilization of the products inside the cans and packages. Typically in many pasteurization tunnels the sensors are normally located near the outside wall and in one spot only giving potentially poor representation of the actual product temperatures. Since the SterilCyl, PasteurCyl, SterilDisk and PasteurDisk dataloggers can be placed anywhere in the tunnels and even in the cans or bottles they offer superior results that reflect true readings and not buffered readings. The use of suitable internal probes also improves the accuracy.

In all cases easy to use software is critical to programming and downloading the dataloggers. While many factors are important here, the most important are:

- Easy graphing
- Tables showing graphed data.
- Fields to show load and batch data
- Ability to export to Excel or other programs
- Data that is initially stored in encrypted files for compliance.
- Fo or Pu values

The F or P values: The sterilisation or pasteurisation values

In general, process operators are simply interested in the following information: at what temperature and for how long should the process be carried out?

In sterilisation processes we frequently encounter a specific value of F, known as F0 (F-naught). This is the number of minutes of equivalent sterilisation at 121.11°C (~250°F). If another temperature is used this is normally stated after the symbol F. For example we could have F110 or F135 and so on.

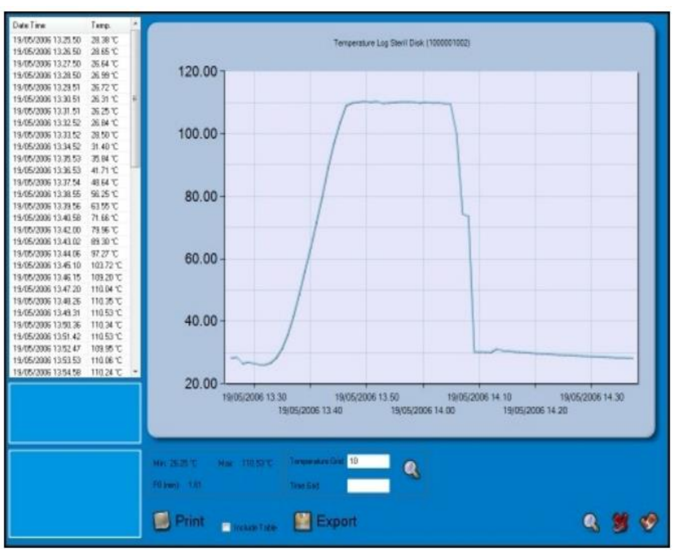
In practice the F-Value is typically set at 12D values (*The D-Value refers to the decimal reduction time, and is defined as the time required, at a given temperature, to reduce the number of micro-organisms to one tenth their initial value (or one decimal place). This means that 90% of the micro-organisms would have been killed*)

For pasteurisation processes, technically one should refer to the P value, however F is commonly used as well. *The F-Value (or P-Value) is therefore the duration (in minutes) of the entire sterilisation or pasteurisation process, at a defined temperature.*

In pasteurisation applications, especially for drinks, one encounters the term Pasteurisation Units – PU. *One PU is defined as exposing a product at 60°C for 1 minute.* In practice, such processes will not be identical to the theoretical ones: in fact the temperature will not rise immediately to the target value; it will not remain perfectly constant over time and will not drop to the ambient temperature in an instant.

Consider the typical diagram shown below and observe how the value F0 (referred to 121.11°C) changes progressively. The process is carried out with Z=10 (*The Z-Value is therefore the temperature change that will bring about a 10-fold change in the D-Value. The Z-Value is measured in °C)*

As can be observed, F0 starts to change when the temperature rises to about 100°C and remains constant after this drops below 100°C. Also note that we get a value for F0 even though the process never actually reaches 121.11 °C. This is possible thanks to the effect of the Z-Value, which allows for the calculation of equivalent thermal processes.



Software programs that automatically analyse data from sterilisation and pasteurisation processes require that a few parameters are set up:

A. The reference temperature T (in general this is 121.11°C for sterilisation and 60°C for pasteurisation)

B. The Z-Value (in °C, that corresponds to the change in temperature required to change the decimal reduction time by a factor of 10) which is necessary to cater for the fact that the process is not carried out at a single constant temperature.

The program will automatically calculate the value for F (or P for pasteurisation) **that has been defined for the temperature T**.

If necessary, one may also introduce a threshold value for temperature below which any contribution to the F (or P) value is ignored.

One may also express the above in terms of sterilisation or pasteurisation units, since one unit is effectively one minute of exposure to a nominal temperature T. Therefore, a value of F0 = 5.5 minutes is equivalent to 5.5 sterilisation units (At 121.11°C), and 20 pasteurisation units are equivalent to exposing the product for 20 minutes at the reference temperature (normally 60°C).

The reference temperature, Z-Value and the process duration parameters (if one wants to use the PU or SU) depend upon the type of micro-organisms one wants to destroy, and are published.

Technical aspects of temperature monitoring

Where measurements should be taken?

In practice, sterilisation and pasteurisation equipment have chambers of a certain size, and the temperature distribution inside these chambers may not be uniform. One needs to map temperatures inside such spaces in order to identify critical zones and tune the process so that it is effective even in the worst case areas. One should not simply rely on the thermometer supplied with the equipment, since although this is normally accurate, its sensing point could be located in a more favourable zone of the chamber.

Furthermore, the measurements should be made at the core of the product, since this area presumably reaches the desired temperature after the rest, and it is the point of interest for the process.

What effect can the type of process have?

The values of F or P will differ according to the environment in which the processes are carried out, mainly because the time it takes for the core of the product to rise to the desired temperature will depend upon the type of process. For example in steam sterilisation the above values, as well as the reference temperature, will not match those for hot-air or microwave processes. Microwave sterilisation, in particular, does not produce an even temperature distribution.

What type of instrument should be used?

Any calibrated instrument will provide a valid measurement. This may be based upon thermocouple, thermistor or RTD sensors. If possible, use miniature data loggers that can be placed inside the product or whose probes can be inserted in the product being monitored. For on-line, or real-time monitoring, where you will be able to view the temperature profile in real time, you will need to employ miniature, wireless data loggers. These will let you view the measurements as they are acquired, rather than after the process is complete.

If you have any other questions please do not hesitate to contact us at any time.

Scigiene

1295 Morningside Ave Units 16, 17, & 18
Toronto ON M1B 4Z4 Canada
Telephone: 416-261-4865 Fax: 416-261-7879
www.scigiene.com