SPECTROCHEM INSTRUMENTS PVT. LTD.

Temperature measurement & control

Instrumentation through innovation

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SPECIAL POINTS OF INTEREST:

Control systems

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A bio-technology news letter

Most of the chemical, bio and bacterial processes are temperature dependent. In many a process either heat is released or absorbed.

Example:

(1) Dilution of sulphuric acid with water
(2) Reaction of NaoH with acid
(3) Glucose when dissolved in water absorb heat from surroundings and in the process cool the container and water.

Similarly in bio-processes temperature plays a critical role . The growth, mixing, activity and finally pH, DO as well as foam generation are all dependent on the temperature of the system. Many a time a close control of the temperature of the system is to be achieved.

The mobility of ionic species, the processes of diffusion, saturation of Oxygen all are influenced by the temperature. Also there is generally a non linear relationship between growth rate of the organism, nutrient conditions and optimum temperature.

Selection and programming of the control instrumentation incase of bio process is some what difficult. This is mainly due to the living organisms and their metabolic processes. The over all process is to be critically evaluated and an algorithm can be created to control. At various stages in the life cycle of the bacteria the requirement of parameters are different . A comprehensive program to cover the process from start to finish is to be evolved, taking all the aspects into consideration.

Resistance temperature detectors (RTDs) are commonly used as temperature sensors for bioprocess engineering. The RTD is a sensor which measures changes by way of resistance. The resistance measurement system is considered to be accurate for ranges between - 75^{0}C and +550^{0}C.

The principle of operation relies on the inherent characteristic of certain metals to change their electrical resistance to current flow when they undergo a change in temperature. The resistance is sensed by a coil of wire. The wire is wound on a silver or copper core and is encased in a protective sheath. The material of the wire is generally platinum. Standard curves and tables which relate the resistance to temperature are available.

The temperature coefficient is the change in resistance of a 1 ohm piece of wire when subjected to a 1^{0}C change in temperature.

The resistivity is the electrical resistance between any two parallel faces of the one unit length cube of the material being measured.

Resistance is equal to the resistivity divided by the conductor area, in comparable units, multiplied by conductor length in the same units. Platinum RTDs are used in laboratory as standards because of their high resistivity good temperature coefficient, acceptable, thermal EMF general corrosion resistance and useful range up to 900^{0}C.

There are a variety of temperature measuring techniques and devices. Spectroscopic and infra Red measurements are non-invasive and dependent on radiation measurement.

Control System:

Temperature control of the bio process is generally achieved by circulation of a thermic fluid in the close vicinity of the reactants. The heat transfer characteristics of the systems are so designed that within an accepted time frame the heat content of the processes materials is modified. Continuous monitoring of the temperature via RTDs the data is used to heat or cool the thermic fluid.

Various algorithms are employed to maintain the temperature

1.Simple on/off set point control
2.Proportional control
3.Reaction logic control

Let us examine each of these and understand what is the use of suited system for bio-processes.

On/off set point control:

In this case a simple relay switches on or switches off the heat source once the set point temperature is attained. Here again there are two conditions. One has to select a tolerance range for the set point. (i.e.) if the set point is 25^0C one has to set a high point and a low point so that the system does not hunt. So a range is set (i.e) 25 $\pm 2^0$C high 27 and low 23. Whenever the set point exceeds 25, the system is switched off and as the system cools down to 23^0C the relay switches on the power. This way of control is generally employed where the system is tolerant to certain temperature excursion. Normally due to the thermal mass, the temperature raises even after the system is switched off. This power is only applied when the system cools to a set lower limit.

PID control:

In case of proportional control the system is programmed to record the difference between the set point and the actual read temperature and apply power(i.e.) change in rate of heat accordingly. In this method of control the system is dynamic and will not allow the over shooting. In other words the control is more closely and precisely followed by a dynamic program. Systems can auto tune themselves or the user has to supply the "P", "I" & "D" values. There are a number of auto tuning algorithms, the most popular being Zieger Nicolas.

Reactive logic control: ™

Just like in proportional control the rate of heating or cooling is dynamically controlled to a better precise limit and two systems a heat source and a cooling source are employed. Wherever necessary at any given time both can be switched on to achieve a very closely set target. The system learns the control dynamics required and completely takes over the total control. This unique control process is our own innovation and a patent is being applied.

In our next issue:
Mass transfer & heat transfer

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