THE CONTINUOUS MONITORING OF BIOLOGICAL REACTORS

Servomex
LEADERS IN GAS ANALYSIS

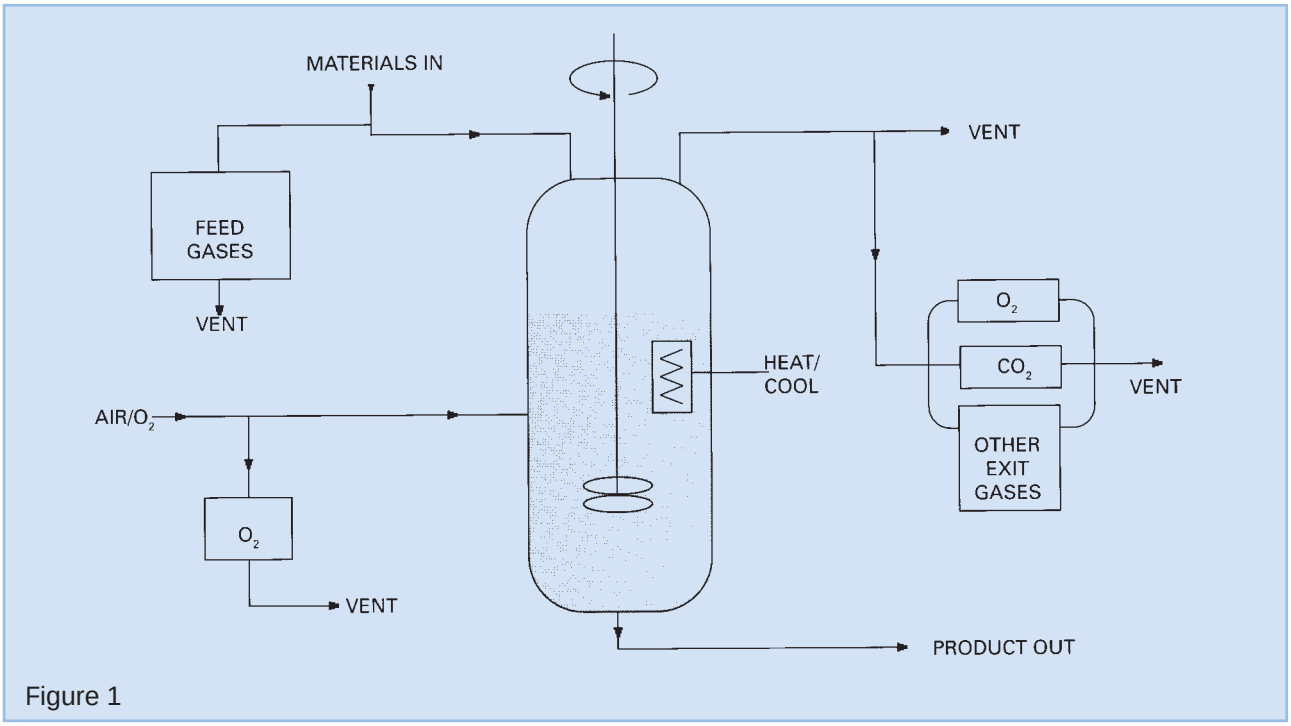

Figure 1

The measurement of oxygen and other gases is often required to ensure the efficient operation and control of fermenters. Servomex can supply paramagnetic and infrared analysers complete with sample conditioning systems to continuously monitor these gases with little operator intervention.

Types of fermenters

Biological reactors generally fall into two main groups: aerobic and anaerobic fermenters.

In anaerobic fermenters, air is excluded from the process as excess oxygen inhibits or poisons the reactions (eg the production of ethanol) whilst aerobic fermenters require oxygen to give “life” to the biological process. The consumption of oxygen can be related to the activity or efficiency of the reaction. The measurement of other gases specifically evolved in the fermentation often provides an indication of the completion of the reaction. Examples include carbon dioxide, ethanol, ammonia and ethylene.

In some processes, such as the biological treatment of effluents, it may be necessary to feed the reaction through the introduction of specific gases such as methane. The measurement of these gases is essential to provide a balanced feedstock.

The manufacture of antibiotics is a typical example of an aerobic fermentation process. The fermenter broth contains a mixture of proteins, sugars and enzymes to produce the desired antibiotic. When the reaction is in progress, oxygen is consumed and carbon dioxide levels increase correspondingly. The monitoring of oxygen consumption gives an indication of enzyme activity while the measurement of carbon dioxide can be used to confirm enzyme performance.

The efficiency of the process is often measured by comparing the oxygen in the head space of the reactor with that in the feed gas.

A typical biological reactor and its monitoring points is shown in Figure 1.

Analysis conditions

The gases entering the reactor are generally dry and pressurised. In this case, measurement is simple as it is only necessary to match the pressure of the process gas with that acceptable to the analyser.

However, the gases leaving the reactor are saturated with the solvent system used in the reactor (water, isopropanol, etc.) and at elevated temperatures

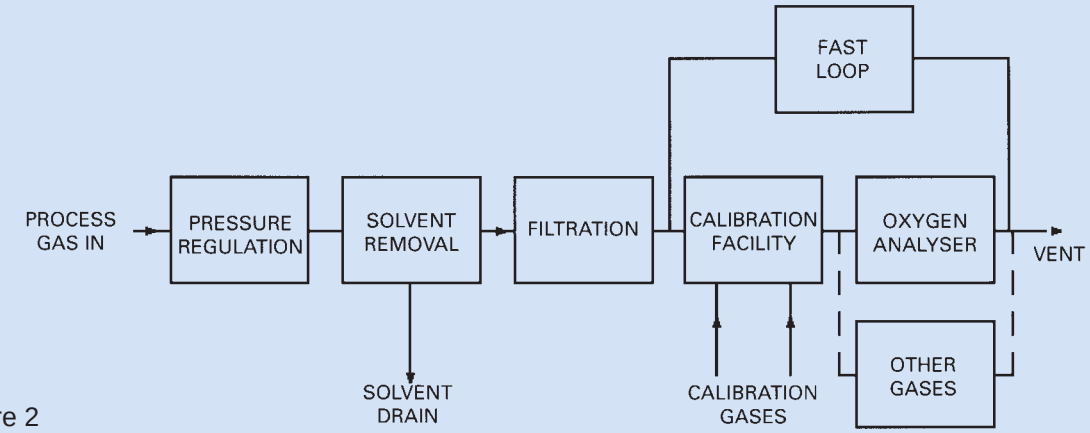

Figure 2

and varying pressures. It is necessary to prepare or condition the process gas into a state acceptable for the analyser. A typical sample conditioning scheme is shown in Figure 2.

The removal of the solvent modifies the composition of the gases slightly and the concentration of the measured component will increase. In the operation of most reactors the error is small, quantifiable and therefore acceptable. When the error is not acceptable, an alternative analysis technique may be used where the gas is kept above its dew point using steam or electric heating through the sample conditioning procedure and in the analyser.

Analysers available

There are two instruments primarily used for the monitoring of gases associated with biological reactors: the Servomex 1100A series paramagnetic analyser to measure the oxygen: and the Servomex Xendos 2500 series infrared analyser which may be configured to monitor a variety of gases. Table 1 shows the typical analysis ranges for commonly encountered gases.

The paramagnetic analyser is based on a well-proven design which is fast and accurate and virtually unaffected by other gases in the sample. Since this is a physical measurement technique, there are no chemicals or electrolyte to replace and maintenance requirements are low.

The Servomex 2500 infrared analyser employs a single beam, dual wavelength measurement technique which gives increased measurement sensitivity and a high degree of stability. Contamination on the sample cell windows has little effect on the measurement and the cells can be easily changed or cleaned.

Both these analysers are rugged instruments, designed for unattended operation on process sites with infrequent calibration, and may be operated in safe or hazardous areas. They are available in various configurations with both sensing and output display at the point of measurement or with the display electronics mounted in a control room some distance away from the measurement cell.

Systems

As well as providing the analysers for these measurements, Servomex can design and manufacture a complete analytical package, consisting of the probes, conditioning system, analysers and recorder. A typical requirement is for one or more analysers to measure sequentially the composition of gases from multiple reactors. Servomex will be pleased to offer advice on the correct system to use.

Measurement:	Typical Analysis Range*
O_2	0-25%
CO_2	0-10%
Ethanol	0-200vpm
Methane	0-5%
Isopropanol	0-500vpm
Acetone	0-1000vpm

*NB Not the minimum range that can be measured.

Table 1

Servomex has a policy of constant product improvement and therefore reserves the right to change specifications without notice.

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