

Substrate(s) Input and Output

Oxygen

Carbon and
Energy
Sources

Nitrogen
Source

Other requirements
(P, S, Na, K, Mg, etc...)

CELL

Carbon dioxide

Biomass

Metabolite(s)

Water

Heat

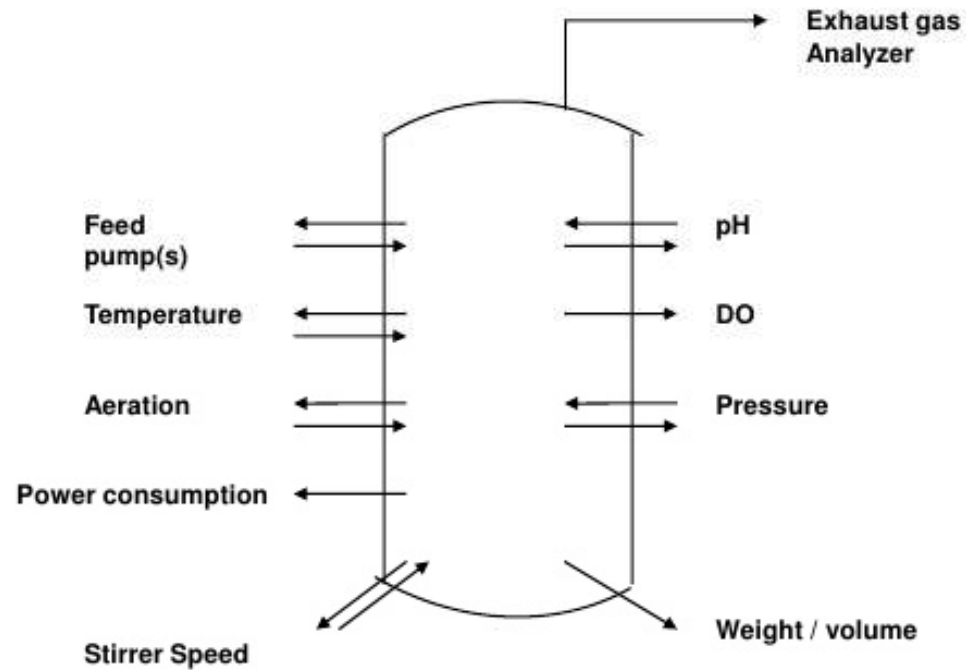
Different Parameters for cultivation system

Physical	Chemical	Biological
<ul style="list-style-type: none"> - Temperature - Bioreactor Pressure (St. St. Bioreactors) - Agitation Speed - Gas Flow rate - Total volume - Feeding rate - Power Input - Foam 	<ul style="list-style-type: none"> - pH - Dissolved oxygen 	<ul style="list-style-type: none"> - Cell Morphology - Cell viability - Optical Density - Cell Dry weight - Cellular composition - Specific growth rate - Specific substrate(s) consumption rates. - Specific production rate
<ul style="list-style-type: none"> - Reactor weight - Feeding tank weight - Culture Viscosity - Gas Hold up - Gas Mixing pattern 	<ul style="list-style-type: none"> - Dissolved carbon dioxide - Redox potential - Out gas analysis (O₂, CO₂, N₂) - Substrate(s) - Product(s) - Enzyme activities - Volatile compounds - Conductivity - Biomass composition (C,H,O,N,P,S) - Metabolite profiling - Mineral Ions 	<ul style="list-style-type: none"> - Oxygen uptake rate - Carbon dioxide production rate - RQ - Growth inhibitors - Protein - DNA / RNA - ATP / ADP / AMP

Main *in situ* sensors used for measuring cultivation parameters

Culture parameters	Sensor	Range	Accuracy
Temperature	Pt-100	0-150°C	0.1°C
Pressure	Piezoresistor	0-2 bar	20 mbar
Gas flow	Thermal mass flow meter	Upto 2 v v ⁻¹ min Based on bioreactor volume	0.1%
pH	pH electrode	2-12	0.02
pO ₂	Polarographic electrode	0-400 mbar	2 mbar
pCO ₂	Membrane covered pH electrode	0-100 mbar	2 mbar

Common measurement and control of bioreactors as generally accepted as routine equipment



← → *Measurement and open or closed loop control*

→ *Measurement only*

Lower ports for *in situ* sterilizable STR

