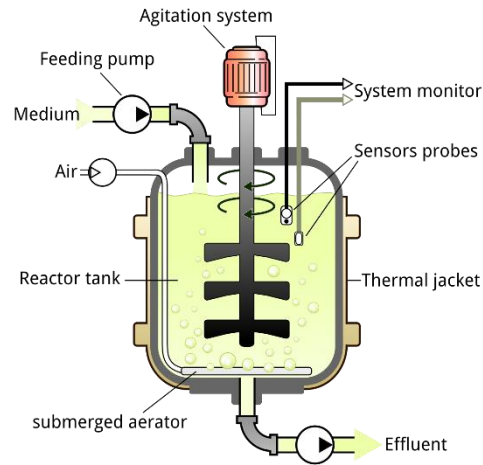


FDE 330

FOOD BIOTECHNOLOGY

Fermenters (Bioreactors)



Fermenters (Bioreactors)

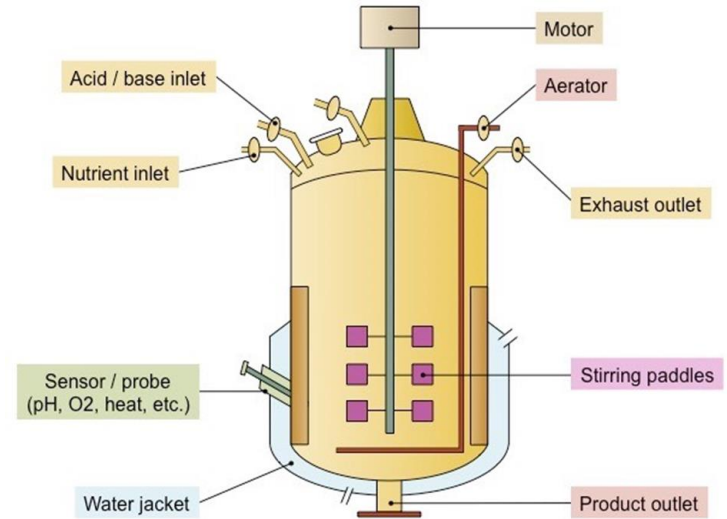
- ▶ Definition 1: Reactors in which biochemical reactions take place, catalyzed by enzymes or cells, are called **bioreactors** or **fermenters**.
- ▶ Definition 2: The biotechnological process is carried out in a specially designed container where the correct environment for optimisation of growth and metabolic activity can be possible to produce the commercial product. That container is called **fermenter**.
- ▶ In simple words, the fermenter is a container where fermentation is carried out.
- ▶ The main function of a fermenter is to provide a suitable environment in which an organism can efficiently produce a target product that may be cell biomass, a metabolite or bioconversion product.
- ▶ Therefore, the bioreactor is the heart of any biochemical process as it provides a meticulous environment for microorganisms to achieve optimal growth and produce metabolites.

Fermenters (Bioreactors)

- ▶ **A fermentor (or fermenter)** is a vessel for the growth of microorganisms which, while not permitting contamination, enables the provision of conditions necessary for the maximal production of the desired products.
- ▶ In other words, the **fermentor** ideally should make it possible to provide the organism growing within it with optimal pH, temperature, oxygen, and other environmental conditions.
- ▶ In the chemical industry, vessels in which reactions take place are called reactors. **Fermentors** are therefore also known as **bioreactors**.

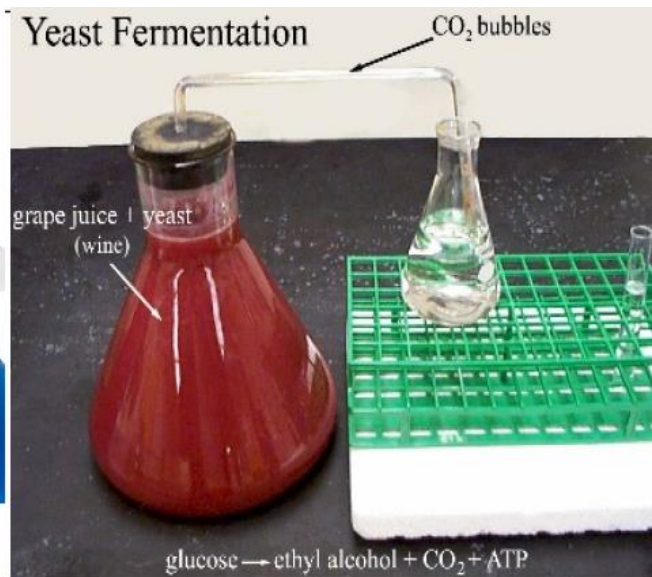
Fermenters (Bioreactors)

- ▶ Bioreactors must have the conditions (optimum pH, sufficient O_2 , salt and substrate supply etc.) to ensure cell growth and proliferation, and thus metabolite production.





Cell culture fermenter



Shake flask fermenter



laboratory fermenter



Pilot fermenter



Plant fermenter

- ▶ The performance of any fermenter depends on many factors, but the key physical and chemical parameters that must be controlled are;
 - **Agitation rate**
 - **Oxygen transfer**
 - **pH**
 - **Temperature**
 - **Foam production**

Parts of the Fermenter

- ▶ **Fermenter Body:**
 - Fermenter body is usually cylindrical.
 - It is externally surrounded by heat exchangers (heating/cooling jacket).
 - The fermenter body may be made of stainless steel or glass.
 - Curved top and bottom parts provide increased resistance to pressure.
 - The fermenter body and cover form a closed vessel which must be able to resist any pressure likely to be applied to it.
- ▶ **The Fermenter Cover:** It will serve to fill the medium and is necessary for the cleaning of the inside of the fermenter body. The cover is closed before the sterilization of the substrate and is not opened until the end of production.

- ▶ Traditionally, fermenters have been open cylindrical or rectangular vessels made from wood or stone. Some of these are still used, particularly for certain food and beverage fermentations. However, most fermentations are now performed in closed vessels designed to exclude microbial contamination. These fermenters must withstand repeated sterilization and cleaning, and should be constructed from non-toxic, corrosion-resistant materials.
- ▶ Many breweries, particularly those making top-fermented beers for many years had open fermentors. Serious contamination is restricted because of the acidity of the medium usually used. However, for fermentations with strict sterility requirements and closely controlled environmental needs, such as in the antibiotic industry, a material which can withstand regular steam sterilization is necessary. Furthermore, the hydrostatic pressure of a large volume of liquid can be enormous. Stainless steel is therefore normally used for pilot and production fermentors. Laboratory scale fermentors are usually made of Pyrex glass to enable autoclaving.
- ▶ Where a highly corrosive material is fermented, e.g. citric acid, the fermentor should definitely be made of stainless steel.
- ▶ If aseptic operation is required, all associated pipelines transporting air, inoculum and nutrients for the fermentation need to be sterilizable, usually by steam. Normally, fermenters up to 1000 L capacity have an external jacket, and larger vessels have internal coils. Both provide a mechanism for vessel sterilization and temperature control during the fermentation.

Parts of the fermenter

Stirred tank reactor

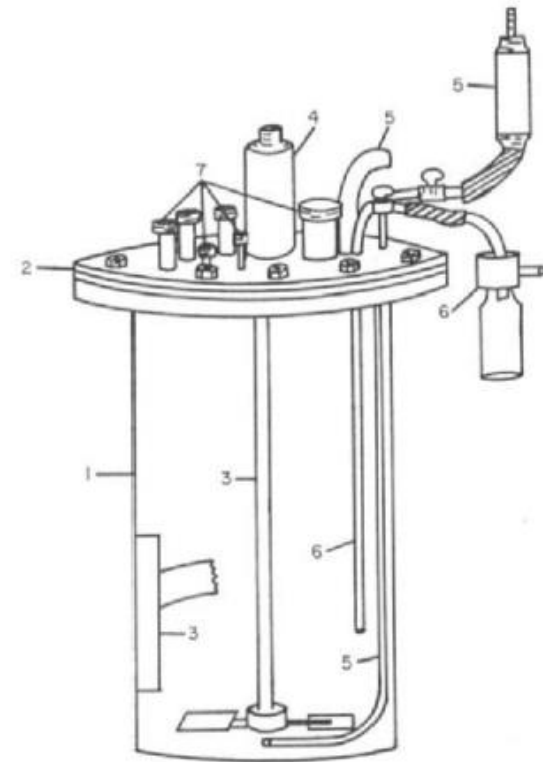
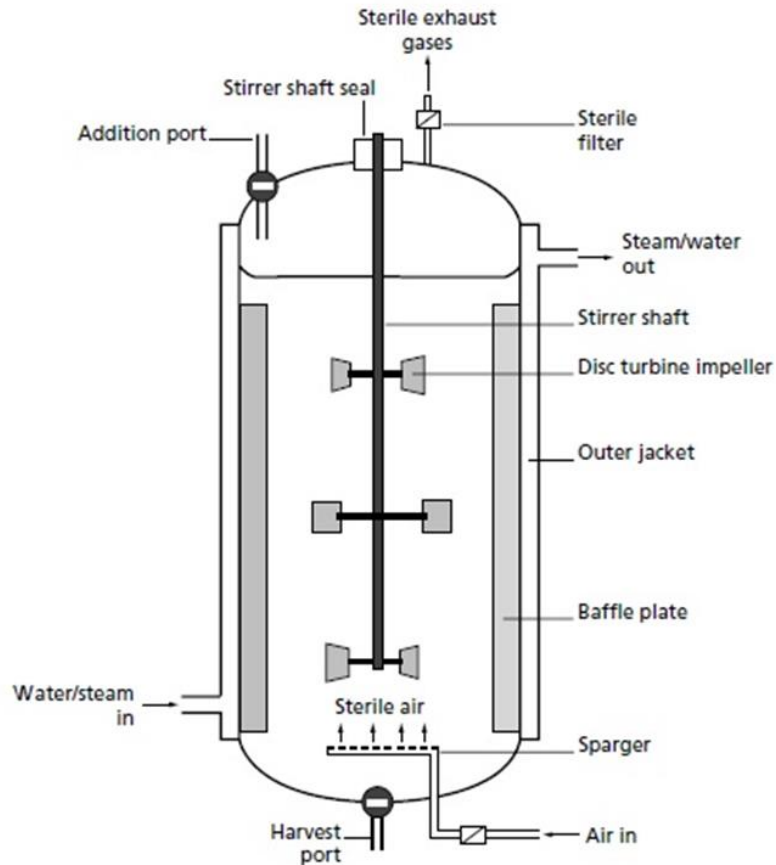


FIG. 5. Typical stirred fermenter. 1. Fermenter body, 2. fermenter cover, 3. agitator and baffles, 4. bearings, gland and drive, 5. air supply, inlet and outlet, 6. sample line, 7. entry points to fermenter.

Agitation and Aeration

- ▶ **Agitations** aim to ensure similar distribution of microorganisms and the nutrients in the broth.
- ▶ **Aeration** is to provide microorganisms growing in submerged culture with adequate oxygen supply.
- ▶ **The following components of the fermenter which is required for aeration and agitation:**
 - Agitator (impellers)
 - Stirrer glands and bearings
 - Baffles
 - Sparger (the Aeration system)

Sr.	Parts of fermenter	Function
1	Impellor (agitator)	To stir the media continuously and hence prevent cells from settling down, and distribute oxygen throughout the medium
2	Sparger (Aerator)	Introduce sterile oxygen to the media in case of aerobic fermentation process
3	Baffles (vortex breaker)	Disrupt vortex and provide better mixing
4	Inlet Air filter	Filter air before it enter the fermenter
5	Exhaust Air filter	Trap and prevent contaminants from escaping
6	Rotameter	Measure flow rate of Air or liquid
7	Pressure gauge	Measure pressure inside the fermenter
8	Temperature probe	Measure and monitor change in temperature of the medium during the process
9	Cooling Jacket	To maintain the temperature of the medium throughout the process
10	pH probe	Measure and monitor pH of the medium
11	Dissolve Oxygen Probe	Measure dissolve oxygen in the fermenter
12	Level probe	Measure the level of medium
13	Foam probe	Detect the presence of the foam
14	Acid	Maintain the required pH of the medium by neutralizing the basic environment
15	Base	Maintain the required pH of the medium by neutralizing the acidic environment
16	Antifoam	Breakdown and prevent foams
17	Sampling pint	To obtain samples during the process
18	Valves	Regulation and control the flow liquids and gases
19	Control panel	Monitor over all parameters

Different Types of Fermentors/ Bioreactors

The six types of bioreactors used in bioprocess technology:

- (1) Continuous Stirred Tank Bioreactors**
- (2) Bubble Column Bioreactors**
- (3) Airlift Bioreactors**
- (4) Fluidized Bed Bioreactors**
- (5) Packed Bed Bioreactors**
- (6) Photo-Bioreactors**

Production Methods

- ▶ **Surface Culture Method**
- ▶ **Submerged Culture Method**

Microbial fermentations in liquid media can be carried out under different operating conditions;

- ▶ **Batch cultivation**
- ▶ **Fed-batch cultivation**
- ▶ **Continuous cultivation**