Frequently Asked Questions :

1. Define fermentor?

Ans : A fermentor 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.

2. Explain the basic functions of a fermentor?

Ans : The basic functions of the fermentors are

- It should permit aseptic fermentation for a number of days reliably and dependably, and meet the requirements of containment regulations. Containment involves prevention of escape of viable cells from a fermenter or downstream processing equipment into the environment. These two points are perhaps the most important of all.
- It should provide a controlled environment for optimum biomass/product yields.
- It should provide adequate mixing and aeration for optimum growth and production, without damaging the microorganisms/cells.
- The power consumption should be minimum.
- It should provide easy and dependable temperature control.
- Facility for sampling should be provided.
- It should have a system for monitoring and regulating pH of the fermentation broth.
- Evaporation losses should be as low as possible.
- It should require a minimum of labour in maintenance, cleaning, operating and harvesting operations.
- It should be suitable for a range of fermentation processes. But this range may often be restricted by the containment regulations.
- It should have smooth internal surfaces, and joints should be welded wherever possible.

- The pilot scale and production stage fermenters should have similar geometry to facilitate scale-up.
- It should be contrasted using the cheapest materials that afford satisfactory results.
- There should be adequate service provisions for individual plants.

3. What should be the basic points of consideration while designing a fermentor?

Ans : Basic points of consideration while designing a fermentor are

- Productivity and yield
- Fermenter operability and reliability
- Product purification
- Water management
- Energy requirements
- Waste treatment

4. Mention the types of agitators used in the fermentor.

Ans : Agitators are of several different types, e.g., (i) disc turbines, (ii) vaned discs, (iii) open turbines of variable pitch and (iv) propellers. Agitators achieve the following objectives; (a) bulk fluid and gas-phase mixing, (b) air dispersion, (c) oxygen transfer, (d) heat transfer, (e) suspension of solid particles, and (f) maintenance of a uniform environment throughout the vessel.

5. Mention the four basic types of seal assembly used in the fermentor.

Ans : Four basic types of seal assembly have been used in fermenters:

(1) the stuffing box (packed- gland seal),

(2) the simple bush seal,

(3) the mechanical seal and

(4) the magnetic drive. Most modern fermenters use mechanical seals; these seals are more expensive, but they are more durable and less prone to leakage or contaminant entry.

6. **What are baffles?**

Ans : Baffles are metal strips roughly one-tenth of the vessel diameter and attached radially to the fermenter wall. They are normally used in fermenters having agitators to prevent vortex formation and to improve aeration efficiency. Usually, four baffles are used, but larger fermenters may have 6 or 8 baffles. Extra cooling coils may be attached to baffles to improve cooling.

7. **Define sparger and mention its basic types.**

The device used to introduce air into the fermenter broth is called sparger. Spargers are of the following three basic types: (1) porous spargers, (2) orifice spargers and (3) nozzle spargers.

8. **Discuss the temperature regulation process in fermentors.**

Ans : The fermenter must have an adequate provision for temperature control. Both microbial activity and agitation will generate heat. If this heat generates a temperature that is optimum for the fermentation process, then heat removal or addition may not be required. But in most cases, this may not be the case; in all such cases, either additional heating or removal of the excess heat would be required. Temperature control may be considered at laboratory scale, and pilot and production scales.

In laboratory scale fermentations, normally little heat is generated. Therefore, heat has to be added to the system; this can be achieved in the following ways: (a) the fermenter may be placed in thermostatically controlled bath, (b) internal heating coils may be used, (c) water may be circulated through a heating jacket, or (d) a silicone healing jacket may be used.

In case of larger fermenters beyond a certain size, excess heat is generated, and the fermenter surface becomes inadequate for heat removal. The size at which fermenter surface becomes inadequate for heat removal will depend on the fermentation process and the ambient temperature at which fermentation is being carried out. In such cases, internal coils have to be used to circulate cold water through them for removing the excess heat.

9. Mention some important antifoaming agents used in industrial fermention process.

Ans : Several compounds have been used as antifoaming agents, and have been found to be suitable for different fermentation processes; these compounds are as follows: alcohols, esters, fatty acids and their derivatives (especially, triglycerides like cottonseed oil, linseed oil, soybean oil, sunflower oil, etc.), silicones, sulphonates, and miscellaneous compounds like oxaline and polypropylene glycol. Antifoams are generally added when foaming occurs during fermentation.

10. Briefly explain the different types of fermentors.

Ans : A variety of fermentors have been described in the literature, but few of them have proved satisfactory for large scale fermentations. Several types of fermentors are known and they may be grouped in several ways: shape or configuration, whether aerated or anaerobic and whether they are batch or continuous. The most commonly used type of fermentor is the Aerated Stirred Tank Batch Fermentor. So widely used is this type that unless specifically qualified, the word fermentor usually refers to the Aerated Stirred Tank Batch Fermentor.

A general description of the following types of fermentor is given in the following sections: (1) stirred tank reactor, (2) airlift fermentor, (3) tower fermentor and (4) bubble up fermentor, (5) single use or disposable fermentor.

11. Write an account on an air lift fermentor?

Ans : An airlift fermenter consists of a gas light baffled riser tube or draught tube (broth rises through this tube) connected to a down-comer tube (broth flows down through this

tube). The riser tube may be placed within the down-comer tube or it may be externally located and connected to the latter . Air/gas mixture is introduced into the base of the riser tube by a sparger. The aerated medium/broth of the riser tube has a lower density, while that in the down-flow tube it is relatively much less aerated and, as a consequence, has a higher density. This density difference drives the circulation of broth. The oxygen is continuously consumed by the cells and carbon dioxide is generated by respiration.

12. Give an account on bubble up fermentor?

Ans : Bubble up fermentor is a bubble column fermenter that is fitted with an internal cooling coil. Air is introduced from the bottom of the column. In this vessel, the cooling coil effectively separates the column into an inner riser/draught tube and the outer down-flow tube. The cooling coil assembly functions as a leaky draught tube. The culture broth rises in the compartment enclosed by the cooling coils and it moves down in the compartment outside the coil, although back- mixing also occurs through the coils. The region above the cooling coil shows good mixing, and there were no poorly oxygenated zones in the vessel.

13. What are the advantages of the Single use or disposable fermentor?

Ans : Recently available Single use or disposable fermentor having good productivity compare to classical multiple use bioreactors. Having following advantages.

- Pre sterilized bag, no cleaning or sterilization is needed.
- Powerful and flexible control system.
- All bag contact parts are single use, class 4 tested and ready to use.
- Simplifies validation process.
- 50 to 1000 L working volumes.
- Scalable technology to support increasing volume demand.
- Minimizes investments and maximizes returns.
- Computer assisted programming systems

14. Briefly explain the criteria used to design medium for fermentors.

Ans : On a large scale one must normally use sources of nutrients to create a medium which will meet as many as possible of the following criteria:

- It will produce the maximum yield of product or biomass per gram of substrate used.
- It will produce the maximum concentration of product or biomass.
- It will permit the maximum rate of product formation.
- There will be the minimum yield of undesired products.
- It will be of a consistent quality and be readily available throughout the year.
- It will cause minimal problems during media making and sterilization.
- It will cause minimal problems in other aspects of the production process particularly aeration and agitation, extraction, purification and waste treatment.

A typical fermentation media should contain carbon and nitrogen sources, water, precursors, inducers, elicitors, minerals, growth factors and vitamins.

15. Discuss the commonly used media for the fermentation process.

Ans : Commonly used media are as follows:

Molasses: Pure glucose and sucrose are rarely used for industrial scale fermentations, primarily due to cost. Molasses, a by product of cane and beet sugar production, is a cheaper and more usual source of sucrose. This material is the residue remaining after most of the sucrose has been crystallized from the plant extract. It is a dark coloured viscous syrup containing 50–60% (w/v) carbohydrates, primarily sucrose, with 2% (w/v) nitrogenous substances, along with some vitamins and minerals.

Starch and dextrins: These polysaccharides are not as readily utilized as monosaccharides and disaccharides, but can be directly metabolized by amylase-

producing microorganisms, particularly filamentous fungi. To allow use in a wider range of fermentations, the starch is usually converted into sugar syrup, containing mostly glucose.

Sulphite waste liquor: Sugar containing wastes derived from the paper pulping industry are primarily used for the cultivation of yeasts. Waste liquors from coniferous trees contain 2–3% (w/v) sugar, which is a mixture of hexoses (80%) and pentoses (20%). Hexoses include glucose, mannose and galactose, whereas the pentose sugars are mostly xylose and arabinose.

Whey: Whey is an aqueous by product of the dairy industry. The annual worldwide production is over 80 million tonnes, containing over 1 million tonnes of lactose and 0.2 million tonnes of milk protein. This material is expensive to store and transport. Therefore, lactose concentrates are often prepared for later fermentation by evaporation of the whey, following removal of milk proteins for use as food supplements.

Fats and oils: Hard animal fats that are mostly composed of glycerides of palmitic and stearic acids are rarely used in fermentations. However, plant oils (primarily from cotton seed, linseed, maize, olive, palm, rape seed and soya) and occasionally fish oil, may be used as the primary or supplementary carbon source, especially in antibiotic production.

Corn steep liquor: Corn steep liquor is a by product of starch extraction from maize and its first use in fermentations was for penicillin production in the 1940s.

However, the use of cane molasses, beet molasses, cereal grains, starch, glucose, sucrose and lactose as carbon sources, and ammonium salts, urea, nitrates, corn steep liquor, soya bean meal, slaughter-house waste and fermentation residues as nitrogen sources, have tended to meet most of the above criteria for production media because they are cheap substrates.

However, other more expensive pure substrates may be chosen if the overall cost of the complete process can be reduced because it is possible to use simpler procedures