Al-Farabi Kazakh National University

Aeration and Agitation

Lecture 9

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The majority of fermentation processes are aerobic and, therefore, require the provision of oxygen. If the stoichiometry of respiration is considered, then the oxidation of glucose may be represented as:

$$C6H12O6 + 6O2 = 6H2O + 6CO2$$

Thus, 192 g of oxygen are required for the complete oxidation of 180 g of glucose.

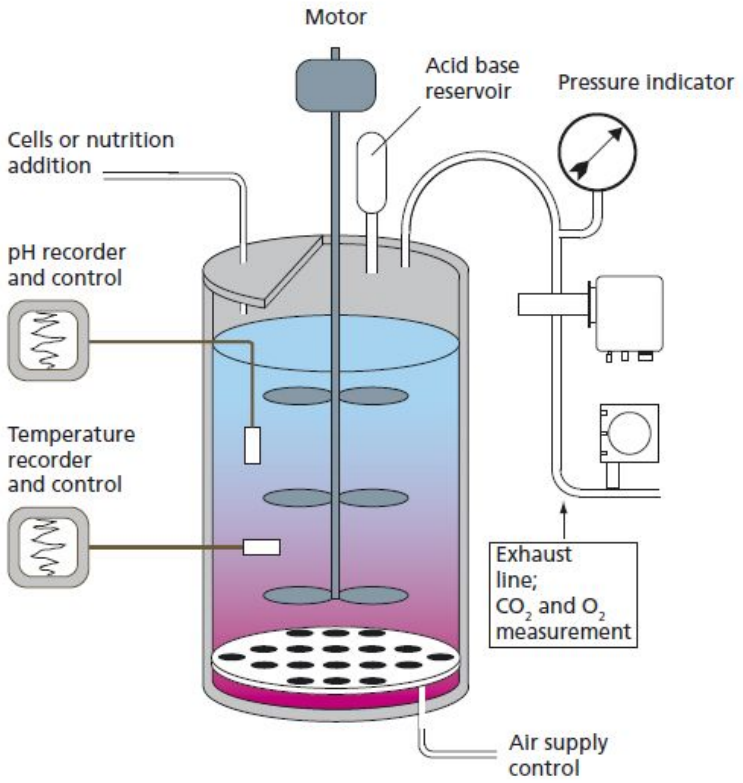
Aeration and Agitation

Important factor in a fermenters
Provision for adequate mixing of its contents

Mixing in fermentation

- to disperse the air bubbles
- to suspend the cells
- to enhance heat and mass transfer in the medium

All relate to Gas-liquid mass transfer



https://www.vaisala.com/en/case/co2-measurements-fermentation

Aeration refers to the process of introducing air to increase oxygen concentration in liquids.

Aeration may be performed by bubbling air through the liquid, spraying the liquid into the air or agitation of the liquid to increase surface absorption.

Agitation – uniform suspension of microbial cells in homogeneous nutrient medium.

The aeration system (sparger)

A sparger is a device that introduces air into the liquid medium in a fermenter.

There are three main types of fermenter used in industrial-scale bioreactors such as:

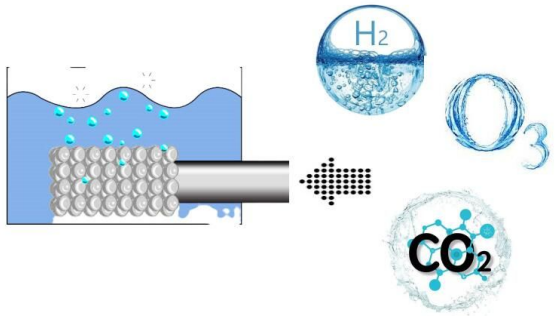
- *Porous Sparger*
- *Orifice Sparger*
- *Nozzle Sparger*

Porous Sparger

It is made up of sintered glass, ceramics or metals' and are mostly used in laboratory-scale bioreactors.

As it introduces air inside a liquid medium, bubbles are formed. These bubbles are always 10 to 100 times larger than the pore size of the aerator.

The air pressure is generally low in these devices and a major disadvantage of using porous sparger is that microbial growth may occur on the pores which hamper the airflow.

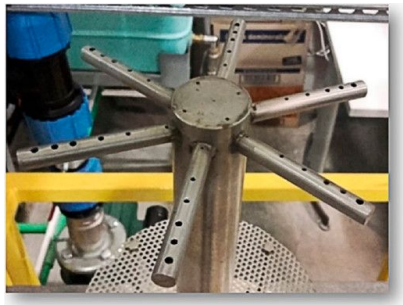


Orifice Sparger

These are used in small stirred fermenters where perforated pipes are used and attached below the impeller in the form of a ring.

The air holes are mostly drilled under the surface of the tubes.

Orifice spargers were used to a limited extent in yeast manufacture, effluent treatment and production of single-cell proteins.



(a) Spider sparger (view from top)

(b) Needle sparger (top plate)

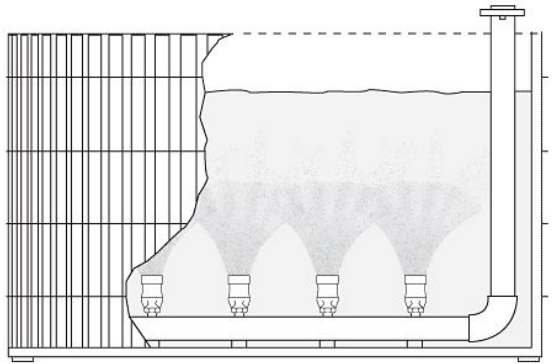
https://pubs.acs.org/doi/10.1021/acs.iecr.1c00609

Nozzle Sparger

This is used in industrial-scale fermenters.

The main characteristic of this kind of sparger is that it contains a single open or partially closed pipe as an air outlet.

The pipe needs to be positioned below the impeller. The design helps to overcome troubles related to sparger blockage.



https://www.s-k.com/steam-jet-heaters/sparger-nozzles.cfm

Agitator (Impeller)

The objectives of the impeller used in fermenters are bulk fluid and gas mixing, air dispersion, heat transfer, oxygen transfer, suspension of solid particles, maintain the uniform environment inside the vessel, etc.

Air bubbles often cause problems inside the fermenter.

Impellers involved in breaking the air bubbles produced in a liquid medium.

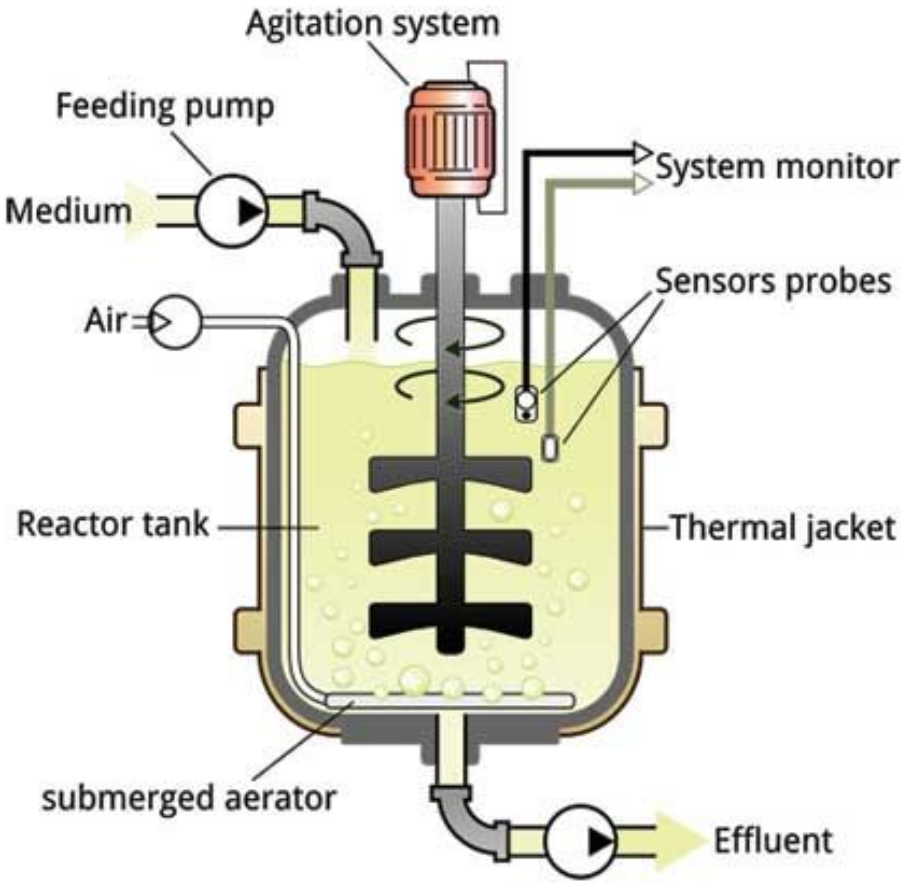
There are mainly three types of agitators used in industrial-scale bioreactors

- ***Disc Turbine*:** It consists of a disc with a series of rectangular vanes connected in a vertical plane around the disc

- ***Vaned disc*:** In this case, the rectangular vanes are attached vertically to the underside of a disc.

- ***Variable Pitch open turbine*:** This type of agitator lacks disc and the vanes are directly connected to a center shaft.

https://www.caframolabsolutions.com/application/dissolving/7-factors-select-impeller/



https://thebiologynotes.com/design-of-a-fermenter/