Introduction optimum design operation and scale-up of

Introduction : Minibioreactorsystems allow for parallel cultivation in multiple independent wells.

Low volumeminireactors allow rapid screening of large number of cultures, while largerreactors allow for process control during longer operation. However, all theprevious researches have not assessed the potential of minibioreactors inprocess characterization based on the online measurement of oxygen uptake rate. Which are the mathematical models which govern the oxygentransfer in these bioreactors? How will oxygen tranfer models play role inonline experimental redesign? These are the questions which need to be answered. Oxygen requirements in Fermentations : In aerobic bioprocesses, oxygen is a key substrate; due to its low solubility in broths (aqueoussolutions), a continuous supply is needed. Oxygen supply is a decisive parameterin fermentations. The oxygen transfer rate (OTR) must be known, and if possiblepredicted to achieve an optimum design operation and scale-up of bioreactors. One of the limiting factors in bioreactorcultivation is the mass transfer characteristics of the bioreactor particularlythe volumetric mass transfer coefficient (Kla) for transfer of oxygen from thegas phase into the broth.

Kla determines the maximum achievable biomassconcentration under aerobic batch cultivations. During most aerobic fermentationsthe mass transfer requirements with respect to oxygen, supplied by dispersingair in the culture in form of bubbles, is an important constraint to high celldensity operation. As long as the biomass concentration is low, mass transferdoes not make severe problems. At some critical cell concentration, however, oxygen can no longer be supplied fast enough to meet the oxygen demand.

Thereafter oxygen limits product formation and cell growth. Oxygen transfer is often therate-limiting step in the aerobic bioprocess due to the low solubility ofoxygen in the medium. The correct measurement and/or prediction of thevolumetric mass transfer coefficient, (kLa), is a crucial step in the design, operation and scale-up of bioreactors. Oxygen transfer in stirred tank bioreactors: The dissolved oxygenconcentration in a suspension of aerobic microorganisms depends on the rate ofoxygen transfer from the gas phase to the liquid, on the rate at which oxygenis transported into the cells (where it is consumed), and on the oxygen uptakerate (OUR) by the microorganism for growth, maintenance and production. The gas–liquid masstransfer in a bioprocess is strongly influenced by the hydrodynamic conditionsin the bioreactors.

These conditions are known to be a function of energydissipation that depends on the operational conditions, the physicochemicalproperties of the culture, the geometrical parameters of the bioreactor andalso on the presence of oxygen consuming cells. Stirred tanks bioreactors providehigh values of mass and heat transfer rates and excellent mixing. In thesesystems, a high number of variables affect the mass transfer and mixing, butthe most important among them are stirrer speed, type and number of stirrersand gas flow rate used. The oxygen mass transfer rate andthus kLa are influenced by the power inputthat drives the turbulent two-phase gas-liquid flow in the culture. In aeratedstirred tank bioreactors this flow originates from the agitator and thecompressor used for aerating the culture.

Importantly, the value of kLa is critically dependent of the broth composition, particularly from its surface active components. kLa measurements in model media are difficult toextrapolate to fermentation broths thus measurements during the originalcultures are desirable. Moreover, as the fermentation media change theirproperties significantly across cultivations, online measurements becomenecessary. In the literature the masstransfer rate OTR is usually described by simple law: where kLa, thevolumetric mass transfer coefficient, describes the capability of the aeratedstirred tank bioreactors for mass transfer and (O* ? O)is the driving force, the concentration difference across the liquid-sideboundary layer at the gas-liquid interface.

In literature this is described bysimple correlations that relate it to the global energy dissipation densitiessupplied by the agitator and the gas supply by an air compressor (Cooper et al., 1944; Nienow, 2009; Van’t Riet, 1979): This correlation does not explicitlycontain information about the scale of the tanks, nor do they contain geometricdetails of the equipment or influences of the culture composition. When thereis a dependency of these items, then they are hidden in the free parameters (K, ?,
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oxygen volumetric mass transfer coef? cient, kLa. Themost commonly presented characterization of bioreactor DO transfer is theoxygen volumetric mass transfer coefficient, kLa. Determination of KLa: