Plastic Lined Trickle Bed: Low-Cost, Low-Capital Biofuels Production Bioreactor

Salvador Barri, Nymul Khan, W.R. Curtis, Chemical Engineering, Penn State.

Background: A plastic lined trickle bed provides a low cost, easy to scale-up bioreactor that allows for a high mass transfer as shown in the figure. Compared to other kinds of gas-liquid contacting reactors, the trickle bed can be operated at very low operating cost and is easily scaled. Operation in 'dead end' mode where 100% of the gas is consumed as as a stoichiometrically balanced mixture is particularly favorable for a trickle bed since the gas continuous phase is not limited by residence time as it rises through a liquid.

Another advantage of the trickle bed is that it can be implemented in an extremely inexpensive format, requiring little more than a mechanical support. The selective environment of autotrophic growth conditions greatly reduces requirements for sterilization, and a plastic tank is two orders of magnitude cheaper than an autoclave of the same volume.

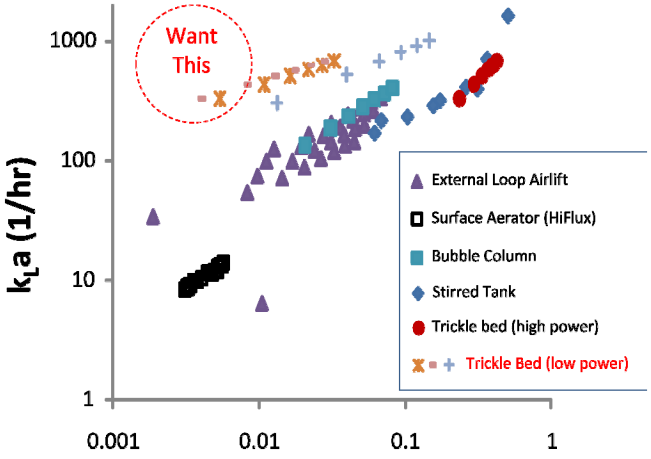

Figure 1: Assessment of Mass transfer capacity (K_La) indicating trickle-bed bioreactors have scaleup.

Description: A trickle bed is simply a bed of packing with a liquid distributor at the top. The liquid trickles down over the packing to provide dissolved nutrients. In this application fuel will accumulate in the liquid for recovery of these C_{34} hydrocarbons, which are liquid at ambient temperatures due to methyl-groups. For an autotrophic organism, a mixture of gas (H_2, CO_2, and O_2) is introduced with very little pressure drop as it transfers throughout the reactor into the liquid phase. Our patent is a plastic bag bioreactor system with a headplate on top to facilitate penetrations for gas and media addition.

Figure 2: Demonstration Plastic bag Trickle bed.

Patents:

Curtis, W.R., Growing cells in a reservoir formed of a flexible sterile plastic liner, U.S. Patent # 6,709,862, March 23, 2004.

Curtis, W.R., Method and apparatus for aseptic growth or processing of biomass, U.S. Patent # 6,245,555, June 12, 2001.

References:

Curtis, W.R., "Achieving economic feasibility for moderate-value food and flavor additives: A perspective on productivity and proposal for production technology cost reduction", In: Plant Cell and Tissue Culture for the Production of Food Ingredients (Fu, T.-J.; Singh, G.; Curtis, W.R., eds.) Kluwer Academic / Plenum Publishing, New York, NY, pp. 225-236, 1999.

Hsiao, T.Y.; Bacani, F.T.; Carvalho, E.B.; Curtis, W.R., Development of a low capital investment reactor system: Application for plant cell suspension culture, Biotechnology Progress, 15(1): 114-122, 1999.