Abstract
Mass transfer limitation is a major problem especially I aerobic processes with cells immobilized by entrapping in polymer gel beads. Many mathematical models have been used to demonstrate that immobilizing the cells in micro gel beads can substantially reduce the mass transfer problem. However, most processes are still done with cells immobilized in large diametergel beads and there are relatively very few detailed experimental studies to demonstrate the usefulness of immobilizing the cells in micro gel beads. Various methods of immobilizing cells in micro gel beads have been reported but whether or not such methods can be used for industrial application would depend on their simplicity, costs and scale up potentials. Furthermore, the immobilization condition must be mild to avoid excessive stress on the cells. Atomisation by rotating disk is mild because high pressure is not used. The stress exerted on the cell is similar to that of centrifugation. Thus, most microbial cells can be immobilized by rotating disk atomization without significant decrease in cell viability. Also, the diameters of the beads do not depend on the diameter of the feed nozzles. This means that the polymer-cell mixture can be pumped through a large diameter nozzle to the top of the rotating disk and thus avoid the problem of nozzle plugging even when high viscous polymers are used. The power requirement is also comparably low and the process is flexible. In other words, gel beads of the same diameters can be produced from polymers of various physical characteristics by adjusting the volumetric flow rate of the polymer-cell mixture, the disk diameter and/or the rotation speed of the disk. The rotating disk atomization system described in this section is very simple and a laboratory scale system that can produce up to 3L of micro gel beads per hour is already commercially available. By controlling the atomization conditions, uniform gel beads of say desired sizes ranging from 200 to 1200 μm can easily be produced. Furthermore, it can be scaled up easily by increasing the sizes and number of the disks, and enlarging the diameter of the vessel. To use cells immobilized in micro gel beads for industrial processes, there is a need for development of suitable bioreactors with appropriate fluid dynamics. Aside from the low mass transfer efficiency in packed or expanded bed systems, the inter bead void volume in beds of micro gel beads is very small. Thus they are easily pluged, leading to nutrient channeling with consequent decrease in mass transfer and productivity. However, since micro gel beads can tolerate higher hydrodynamic stress than the conventional large diameter gel beads, long time process stability in fluidized bed reactors can be achieved. However, there is still a need to practically demonstrate this by more detailed case by case optimization of processes with cells immobilized in micro gel beads. In this regard, more detailed studies on reactor designs, fluid dynamics, bubble column vs, airlift systems, gel bead loading ratios etc, are required before micro gel beads can be widely used for industrial processes.