Abstract
A circulating loop bioreactor (CLB) with cells immobilized in loofa sponge was constructed for simultaneous aerobic and anaerobic processes. The CLB consists of an aerated riser and a non-aerated downcomer column connected at the top and bottom by cylindrical pipes. Ethanol production from raw cassava starch was investigated in the CLB. Aspergillus awamori IAM 2389 and Saccharomyces cerevisiae IR2 immobilized on loofa sponge were placed, respectively, in the aerated riser column and non-aerated downcomer column. Both alpha-amylase and glucoamylase activities increased as the aeration rate was increased. Ethanol yield and productivity increased with an increase in the aeration rate up to 0.5 vvm, but decreased at higher aeration rates. The CLB was operated at an aeration rate of 0.5 vvm for more than 600 h, resulting in an average ethanol productivity and yield from raw cassava starch of 0.5 g-ethanol l(-1) x h(-1) and 0.45 g ethanol/g starch, respectively. In order to increase ethanol productivity, it was necessary to increase the dissolved oxygen (DO) concentration in the riser column and decrease the DO concentration in the downcomer column. However, increasing the aeration rate resulted in increases in the DO concentration in both the riser and the downcomer columns. At high aeration rate, there was no significant difference in the DO concentration in the riser and downcomer columns. The aeration rate was therefore uncoupled from the liquid circulation by attaching a time-controlled valve in the upper connecting pipe. By optimizing the time and frequency of valve opening, and operation at high aeration rate, it was possible to maintain a very high DO concentration in the riser column and a low DO concentration in the downcomer column. Under these conditions, ethanol productivity increased by more than 100%, to 1.17 g l(-1) x h(-1).