Simulation of in situ removal of ethanol from culture broth using microbubbles

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Abstract: Ethanol is a renewable and clean biofuel mostly produced via fermentation process. The productivity of ethanol can be increased when the ethanol was removed from the culture broth to diminish the inhibition effect on growth rate of microorganisms. In this study, the conventional processes and in situ removal processes were modeled based on Polymath and Aspen Plus. During the process of in situ removal, hot air microbubbles (>78°C) was generated and fed to ethanol-water mixture. Ethanol, which is lower boiling point than water, was then evaporated from the mixture into microbubbles. The ethanol in microbubbles was removed when they floated over the mixture. The rate equations and kinetic parameters of the formation of by-products i.e., glycerol and acetaldehyde were formulated using Polymath. Polymath was also used to estimate the kinetic parameters with the rate unit of mol/L·hr. These parameters were then used in Aspen Plus to estimate the increase of productivity and energy consumption. In comparison with the conventional processes, the simulation results showed that the productivity of ethanol from the in situ removal processes increased by 1.5%. The energy removal at the fermenter section increased by 38.83%. However, the overall energy consumption including fermentation and separation sections of the in situ removal processes decreased by 9.73%.

Keywords: Simulation; In situ removal; Ethanol; Microbubbles