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Explosive Decompression Pretreatment in Lignocellulosic Ethanol Production

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Abstract

The pretreatment is essential step prior to the conversion of the lignocellulosic material to ethanol which could be used as a liquid fuel in engines. However most traditional pretreatment methods have low efficiency, use chemicals or vast amount of energy and therefore, these processes might not be economically feasible. A novel biomass pretreatment method will be presented which opens up the biomass structure for more efficient enzymatic hydrolysis. No catalysts or chemicals are used in the process thereby, making it economically and environmentally attractive.

In this method the biomass is exposed to a high pressure using different gases, and temperature where the cells of the lignocellulosic biomass are filled with a solution saturated with dissolved gases. When the pressure is suddenly released, the feedstock is exposed to an explosive decompression and the dissolved gases are released from the solution. Sudden change in the volume breaks the cell walls and opens the biomass structure resulting in increased surface area of the substrate for enzymatic hydrolysis.

In this paper two gases nitrogen and compressed air are utilised for pressure generation where range of different pressures (1–60 bar) and temperatures (25–175°C) were applied to barley straw to evaluate the efficiency of the pretreatment. The pretreatment was followed by enzymatic hydrolysis and fermentation. Resulting glucose and ethanol concentrations were measured to estimate the most suitable set of pretreatment conditions.

Results show that the highest glucose yield was gained when nitrogen gas was used (at 150°C 278 to 338 $g\,kg^{-1}$ depending on the pressure). The results with compressed air were almost the same as those gained in autohydrolysis pretreatment, where no added pressure was used in addition to elevated temperature. The fermentation efficiency was lower at higher temperatures, however, in spite of the decrease in ethanol yield when pretreatment temperature was increased, the highest ethanol yield was gained at 150°C and in 10–30 bars with nitrogen explosion since the high glucose yield at pretreatment temperature 150°C enables to gain high ethanol yields in further process.

Keywords: Bioethanol, biofuels, biomass pretreatment, explosive decompression, lignocellulosic ethanol

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