Assessment of Potential Life-Cycle Energy and Greenhouse Gas Emission Effects from Using Corn-Based Butanol as a Transportation Fuel

May Wu, Michael Wang, Jiahong Liu, and Hong Huo

In *Biotechnology Progress*, Volume 24: 1204-1214 (2008)

Abstract

Since advances in the ABE (acetone-butanol-ethanol) fermentation process in recent years have led to significant increases in its productivity and yields, the production of butanol and its use in motor vehicles have become an option worth evaluating. This study estimates the potential life-cycle energy and emission effects associated with using bio-butanol as a transportation fuel. It employs a well-to-wheels (WTW) analysis tool: the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model. The estimates of life-cycle energy use and greenhouse gas (GHG) emissions are based on an Aspen PlusVVR simulation for a corn-to-butanol production process, which describes grain processing, fermentation, and product separation. Bio-butanol-related WTW activities include corn farming, corn transportation, butanol production, butanol transportation, and vehicle operation. In this study, we also analyzed the bio-acetone that is coproduced with bio-butanol as an alternative to petroleum-based acetone. We then compared the results for bio-butanol with those of conventional gasoline. Our study shows that driving vehicles fueled with corn-based butanol produced by the current ABE fermentation process could result in substantial fossil energy savings (39%–56%) and avoid large percentage of the GHG emission burden, yielding a 32%–48% reduction relative to using conventional gasoline. On energy basis, a bushel of corn produces less liquid fuel from the ABE process than that from the corn ethanol dry mill process. The coproduction of a significant portion of acetone from the current ABE fermentation presents a challenge. A market analysis of acetone, as well as research and development on robust alternative technologies and processes that minimize acetone while increase the butanol yield, should be conducted.