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Research Paper

Effect of microwave–chemical pre-treatment on compression characteristics of biomass grinds

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ABSTRACT

The effect of microwave and microwave–chemical pre-treatments on densification characteristics and physical quality of pellets made from wheat and barley straw grinds were investigated. The ground wheat and barley straw samples were immersed in water, sodium hydroxide or calcium hydroxide solution at different concentrations (1 and 2% w/v) and then exposed to microwave radiation at three power levels (295, 603 and 713 W). Chemical composition and bulk and particle densities of samples were determined after pre-treatments. Pre-treated grinds were compressed in a plunger–die assembly with a force of 4000 N and compression and relaxation test data were recorded. The specific energy required for compression and ejection of pellets produced from untreated and pre-treated wheat and barley straw grinds was calculated. The tensile strength of the pellets was also evaluated to investigate the hardness of the pellets. Chemical composition analysis showed that microwave and chemical pre-treatment was significantly able to disintegrate the lignocellulosic structure of wheat and barley straw grinds. Data analysis also indicated that the pellets made from microwave–chemical pre-treated biomass grinds had a significantly higher density and tensile strength than the untreated or samples pre-treated by microwave and distilled water.

1. Introduction

There is a growing global interest in the development of economically viable bioenergy production systems that can displace the use of fossil fuels. This effort is currently being undertaken in both developed and developing countries to reduce greenhouse gase production and energy costs, and increase the energy self-reliance of nations. Increasing energy security, reduction in greenhouse gas emissions, use of renewable resources and foundation of a carbohydrate-based chemical process industry are the main benefits of using lignocellulosic materials as a stable energy source.

Agricultural residues are one of the main sources of lignocellulosic biomass for energy generation and offer an abundant and inexpensive source of renewable resources. Among the agricultural residues, cereal straw is the largest biomass feedstock in the world (Kim and Dale, 2004). Cereal straw is a valued by-product of cereal production and for many years has been used for livestock feed, bedding, insulation, mushroom cultivation and mulching. However, with the development of science and technology in the recent decades, most societies in the world have become interested in the use of cereal residues for the production of value-added products, especially liquid fuels and chemicals (Bowyer and Stockmann, 2001).

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