Title Compaction characteristics of barley, canola, oat and wheat straw

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Citation Biosystems Engineering, Volume 104, Issue 3, November 2009, Pages 335-344

Keywords grain; characteristic

Abstract

Agricultural biomass has the potential to be used as feedstock for biofuel production. However, crop residue after harvest must be gathered, processed and densified in order to facilitate efficient handling, transportation and usage. In this study compacts were prepared by densifying material against a base plate (representing the specific energy required to overcome friction within the straw grinds) as opposed to the process that occurs in a commercial operation where compacts are formed due to back-pressure effect in the die. Densification was measured using four selected biomass samples (barley, canola (oilseed rape), oat and wheat straw) at 10% moisture content (wb) and 1.98 mm grinder screen size using a compaction apparatus which applied four pressure levels of 31.6, 63.2, 94.7 and 138.9 MPa. The specific energy required to extrude the compact was measured; this will closely emulate the specific energy required to overcome the friction between the ground straw and die. The mean densities of barley, canola, oat and wheat straw compacts ranged from 907 ± 31 to 988 ± 26 kg m^{-3}, 823 ± 73 to 1003 ± 21 kg m^{-3}, 849 ± 22 to 1011 ± 54 kg m^{-3} and 813 ± 55 to 924 ± 23 kg m^{-3}, respectively; while the mean total specific energy for compaction of grinds ranged from 3.69 ± 0.28 to 9.29 ± 0.39 MJ t^{-1}, 3.31 ± 0.82 to 9.44 ± 0.33 MJ t^{-1}, 5.25 ± 0.42 to 9.57 ± 0.83 MJ t^{-1} and 3.59 ± 0.44 to 7.16 ± 0.40 MJ t^{-1}, respectively. Best predictor equations having highest coefficient of determination values (R^2) and standard error of estimate or root mean square error were determined for both compact density and total specific energy required to compress the ground straw samples. The resulting R^2 for pellet density from barley, canola, oat and wheat straw were 0.56, 0.79, 0.67 and 0.62, respectively, and for total specific energy the values of R^2 were 0.94, 0.96, 0.90 and 0.92, respectively.