Fuel Pellets from Wheat Straw: The Effect of Lignin Glass Transition and Surface Waxes on Pelletizing Properties

The utilization of wheat straw as a renewable energy resource is limited due to its low bulk density. Pelletizing wheat straw into fuel pellets of high density increases its handling properties but is more challenging compared to pelletizing woody biomass. Straw has a lower lignin content and a high concentration of hydrophobic waxes on its outer surface that may limit the pellet strength. The present work studies the impact of the lignin glass transition on the pelletizing properties of wheat straw. Furthermore, the effect of surface waxes on the pelletizing process and pellet strength are investigated by comparing wheat straw before and after organic solvent extraction. The lignin glass transition temperature for wheat straw and extracted wheat straw is determined by dynamic mechanical thermal analysis. At a moisture content of 8%, transitions are identified at 53°C and 63°C, respectively. Pellets are pressed from wheat straw and straw where the waxes have been extracted from. Two pelletizing temperatures were chosen—one below and one above the glass transition temperature of lignin. The pellets compression strength, density, and fracture surface were compared to each other. Pellets pressed at 30°C have a lower density and compression strength and a tendency to expand in length after the pelletizing process compared to pellets pressed at 100°C. At low temperatures, surface extractives have a lubricating effect and reduce the friction in the press channel of a pellet mill while no such effect is observed at elevated temperatures. Fuel pellets made from extracted wheat straw have a slightly higher compression strength which might be explained by a better interparticle adhesion in the absence of hydrophobic surface waxes.