Fuel Pellets from Biomass. Processing, Bonding, Raw Materials

The depletion of fossil fuels and the need to reduce greenhouse gas emissions has resulted in a strong growth of biomass utilization for heat and power production. Attempts to overcome the poor handling properties of biomass, i.e., its low bulk density and inhomogeneous structure, have resulted in an increasing interest in biomass densification technologies, such as pelletization and briquetting. The global pellet market has developed quickly, and strong growth is to be expected for the coming years. Due to an increasing demand for biomass, the traditionally used wood residues from sawmills and pulp and paper industry are not sufficient to meet future needs. Therefore, new types and sources of biomass will be used more commonly in the future. Although wood pellet production has been an established process for more than 100 years, little research has been conducted about pellet production; it has mainly been about process optimization. The present study investigates several important aspects of biomass pelletization. Seven individual studies have been conducted and linked together, in order to push forward the research frontier of biomass pelletization processes. The first study was to investigate influence of the different processing parameters on the pressure built up in the press channel of a pellet mill. It showed that the major factor was the press channel length as well as temperature, moisture content, particle size and extractive content. Furthermore, extractive migration to the pellet surface at an elevated temperature played an important role. The second study presented a method of how key processing parameters can be estimated, based on a pellet model and a small number of fast and simple laboratory trials using a single pellet press. The third study investigated the bonding mechanisms within a biomass pellet, which indicate that different mechanisms are involved depending on biomass type and pelletizing conditions. Interpenetration of polymer chains and close intermolecular distance resulting in better secondary bonding were assumed to be the key factors for high mechanical properties of the formed pellets. The outcome of this study resulted in study four and five investigating the role of lignin glass transition for biomass pelletization. It was demonstrated that the softening temperature of lignin was dependent on species and moisture content. In typical processing conditions and at 8% (wt) moisture content, transitions were identified to be at approximately 53-63 °C for wheat straw and about 91 °C for spruce lignin. Furthermore, the effects of wheat straw extractives on the pelletizing properties and pellet stability were investigated. The sixth and seventh study applied the developed methodology to test the pelletizing properties of thermally pre-treated (torrefied) biomass from spruce and wheat straw. The results indicated that high torrefaction temperatures above 275 °C resulted in severe degradation of biomass polymers, thus reducing the ability to form strong inter-particle bonds and resulting in poor mechanical properties of the manufactured pellets. The results can be used to give an indication for finding the right compromise of high energy density, improved grindability, and sufficient pellet stability.