Fundamentals of Biomass pellet production

Pelletizing experiments along with modelling of the pelletizing process have been carried out with the aim of understanding the fundamental physico-chemical mechanisms that control the quality and durability of biomass pellets. A small-scale California pellet mill (25 kg/h) located with the Biomass Gasification Group at MEK-DTU has been installed for experiments with different types of wood, straw, waste materials and additives such as adhesives and inorganic compounds. A series of pelletizing tests has been performed using a ring die with a compression ratio of 6.5. Pine shavings and beech wood dust has been tested individually and combined. Pine dust is relatively easy to pelletize while beech dust is almost impossible to pelletize with the present pellet mill conditions. Additionally, the inorganic part of the beech wood was rich in corrosive alkali chloride salts. With the die used it was possible to pelletize a 60% (wt) pine + 40% (wt) beech mixture but not a 40% (wt) pine + 60% (wt) beech mixture. Addition of 3% (wt) rape oil or 3% (wt) Wafolin did not facilitate the pelletizing process of beech. However, it was found that the addition of polymer-rich compounds such as brewers spent grains to the beech dust significantly facilitated the pelletizing process and increased the pellet quality. Furthermore it was found that additivation with inorganic calcium phosphorous compounds into the pellets could be easily made using realistic and necessary amounts in order to decrease the corrosiveness and the sintering ability of the ash residues. It had earlier been observed that straw could be pelletized, but that the pellet quality in general did not appear to be very high. Similar results have been obtained in the present study. The pellets were not as durable as the pine/beech pellets. Even though further tests are needed, it appears that the addition of small amounts of brewers spent grains increases the quality of the pellets. A model is presented which describes the pelletizing pressure variation along the press channels of the die. Equations based on differential control volumes are set up to describe the forces acting on the pellet in the die. Important model parameters are the sliding friction coefficient, the ratio of compression and the material specific parameters such as the elastic moduli and the Poisson's ratio. Model calculations show how variation in the characteristic parameters significantly changes the necessary pelletizing pressure. By using typical material parameters of the hardwood beech and the softwood pine it is illustrated why beech, in accordance with the experimental test results, is more difficult to pelletize than pine.

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