DEM SIMULATION OF WOOD PELLETS DYNAMICS IN A MECHANICALLY FLUIDIZED REACTOR

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The Mechanically Fluidized Reactor (MFR) is a novel technology developed to perform fast pyrolysis of solid biomass with particle size between 4 to 8 mm (1). The MFR has been developed to treat cohesive and thermally sensitive biomass materials. This technology does not require any fluidization gas, therefore the residence time of the vapors is solely controlled by their production rate.

In order to get better process understanding and to optimize the process, the particle dynamics in the MFR has been numerically investigated in this contribution. The cylindrical apparatus with a stirrer consisting of vertical blades has been modeled (Fig. 1a). The simulations have been performed in the in-house developed simulation framework MUSEN (2), which is based on the Discrete Element Method (DEM). All particles in the apparatus (foamed glass beads and wood pellets) have been considered individually and for all particles the Newtonian equations of motion have been solved (Fig. 1b).

To simulate non-spherical wood pellets, the bonded-particle model has been employed. The cylindrical pellets have been reproduced as a set of primary particles connected with elastic solid bonds (Fig. 2a). The restitution coefficient of primary particles, Young's modulus, strength of solid bonds have been estimated based on the experimental results. The experimentally and numerically obtained force-displacement curves and impact characteristics of wood pellets have been compared (Fig. 2b). Such fitting allows not only to reproduce dynamics of food pellets, but also to consider their attrition and breakage behavior.

In this contribution, several simulation case studies were performed to investigate the influence of different parameters, such as stirrer rotation velocity, particle size distribution, pellets shape and strength on particle dynamics in the apparatus. Future work will consider the vapor flow from the wood pellets and investigate the influence of different stirrer geometries.

REFERENCES
Figure 1. Apparatus geometry and simulation results.

Figure 2. Microscale modelling of wood pellets.