Measuring size distribution and bulk density of wood chips

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Problem definition and approach

Particle size distribution has often been identified as a key quality parameter for an undisturbed biofuel conversion. However, the determination of this parameter is still quite uncommon, as the provision of reproducible and comparable data on physical biofuel properties is a difficult task. This is not only due to irregular international test standards but also caused by a high variability of measuring devices. Additionally, there are several procedure-based sources of deviation which largely underestimated. Basic research for solid biofuels is yet scarce. This applies for other fuel parameters, too; bulk density for example, which is mostly regarded as easily determinable, is a highly incomparable parameter due to incompatible determination methods. In view of these uncertainties the here presented research aims at a comprehensive evaluation of existing methods and procedures for determining bulk density and particle size classes of wood chips. The considered citeria are

- reproducibility,
- accuracy (where determinable by using reference material),
- comparability of methods,
- sensitivity to other influencing factors (e.g. moisture content, sample size),
- interactions between the parameters (e.g. size distribution and bulk density).

Procedure

Size classification: Three measuring principles (Figure 1) were used and tested on biofuels. A wide scope of about 20 fuels was applied (fine and coarse chips, chunks, saw dust, chips with high needle content, bark, shavings, pellets). Test fuels were mainly produced from spruce and beech wood. A standard sample from regularly shaped wooden pieces was also applied. In contrast to the before mentioned test fuels the properties of this "artificial" standard material are precisely known; this means that for each particle fraction the "true" results are available for all measurable parameters (e.g. size, length, diameter, shape). The image processing device also gives results for the equivalent diameter, specific surface, sphericity and others. Results were verified by using the standard sample.

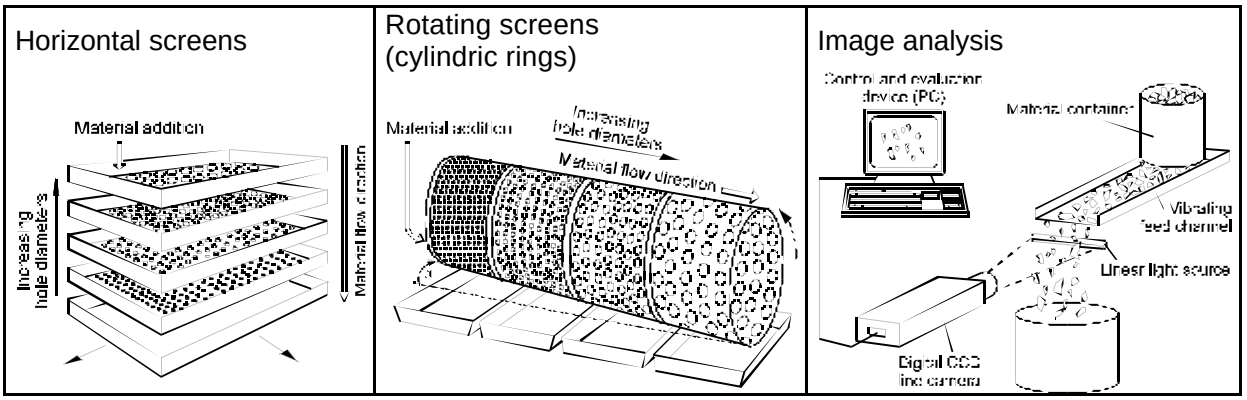

Figure 1. Tested screening methods and optical size classification methods for wood chips

Bulk density determination: Several containers of different shape and size were applied: two cubes of 200 and 50 liters volume and two cylinders of 55.89 liters (following ASAE standard S269.4, 1991) and 14.73 liters. All measurements were conducted both without any shock impact and by dropping 5 times from 150 mm height. Several samples were dried in at least five steps in order to quantify the impact of variable moisture contents.

Results

Size distribution. First results show, that the available measuring devices are largely incompatible. A horizontal screening operation tends to overestimate the share of small particles, where many long and thin particles can pass the smaller holes vertically. This error can be avoided by the image analysis, when larger particles are measured by their Feret's diameter (the maximum vertical extension when falling through the projection area; see Figure 1). As indicated in Figure 2, particle lengths above 100 mm are correctly allocated; however, overlapping projection areas can lead to an exaggerated count in this fraction. The classification by rotating screens shows a remarkable conformity with the equivalent diameter, which is defined as the diameter of a circle whose area is equivalent to the image projection area of the regarded particle. These findings shall be verified by additional results from numerous other trials and by comparing the results from using standard samples. The evaluation is still ongoing.

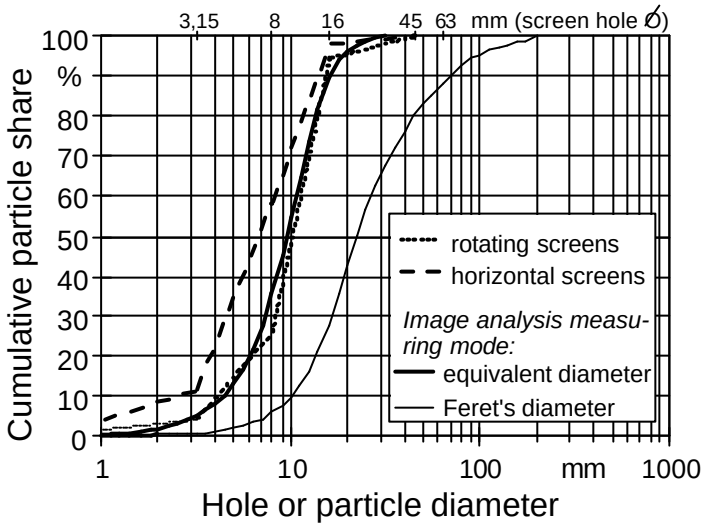

Figure 2. Cumulative particle size distribution, results from several test devices applied on wood chips

Bulk density testing: The results for medium wood chips show, that the accuracy of measurement is primarily influenced by moisture content rather than by container size. For example, bulk density (reported on dry matter basis) increased by more than 10 %, when the sample was atmospherically dried from 50 down to 12 % (wet basis). The influence of a variable container size and shape is however much lower, it ranges in the order of 1 to 3 % deviation. More information shall be available when the evaluation of the full data scope has been completed.

Conclusions

The drafting or revision of international test standards for solid biofuels faces a large variability of testing equipments and influencing factors. Some of the here collected data and results may be helpful in this process. For many aspects, however, further investigation is required.