



Evaluation of Pellet Physical Quality

Purpose: The purpose of this publication is to describe the techniques used to assess the physical quality of fuel pellets.

Physical Properties

Properties in the fuel quality grade specifications for wood pellets include fines, bulk density, diameter, length, pellet durability index, moisture content, ash content and chloride. Physical characteristics are the primary basis for evaluating wood pellet quality in North America. There currently are no standards for non-wood biomass pellets in the USA.

Percent Fines

Fines are important because they increase the chances for dust explosion or spontaneous combustion for pellets stored in bulk silos. Fines also can negatively impact combustion. Percent fines are determined "at the mill gate", and must be $\leq 0.5\%$ for Premium wood pellets.

Fines are the percentage of fuel that pass through a screen, and screen size is stated by the specific standard method, it may vary with pellet diameter. For standard wood pellets this is a 1/8 inch wire screen sieve. The screen is tilted side-to-side 10 times to separate fines from pellets.



Fig. 1. Screen for determining percent fines.

Bulk Density

Bulk density is the fuel mass per unit volume of fuel, a uniform density ensures steady combustion behavior. A cylindrical container 15" in diameter and 19.5" tall is used.

The container is filled with pellets and dropped 5 times from a 6" height to allow for settling. The pellets are struck off level with the top surface. Divide the net mass in pounds by 2 ft³, to obtain bulk density in lbs/ft³. The density should be corrected to a dry matter basis.



Fig. 2. Container for determining bulk density.

Pellet Durability

Pellet durability index (PDI) is a measure of the ability of fuels to resist degradation due to shipping and handling. Of the available standardized pellet tumbling devices, the one with the most accuracy and precision was the tumbler described by ASAE S269.4. Pellet durability can be evaluated immediately after pelleting (green strength) or after pellets have cured (cured strength). The tumbler duplicates the amount of breakage that normally occurs between pellet formation and pellet use. Mechanical durability of pellets does not necessarily relate to bulk density.

The pellet durability tester consists of 4 dust tight boxes, with a baffle fixed diagonally in each box to facilitate mixing. Each chamber is 5.5" W x 12" D x 12" L. The boxes are mounted on a shaft attached to a motor. 500 g of screened sample are weighed into each chamber, and tumbled for 10 minutes. Each sample is then re-screened and weighed. Pellet Durability (percent) is determined by dividing the post-tumbled weight by the pre-tumbled weight, and multiplying by 100.



Fig. 3. Pellet Durability Tester.

Table 1. Pellet Fuels Institute Fuel Grade Requirements for 'Premium' vs. 'Utility' Pellets.

Fuel Property	Premium	Utility
Bulk Density, lb/ft ³	40-46	38-46
Diameter, inches	0.23-0.29	0.23-0.29
Length, % > 1.5 inches	≤1.0	≤1.0
Pellet Durability Index	≥96.5	≥96.5
Fines, %	≤0.5	≤1.0
Ash, %	≤1.0	≤6.0
Moisture, %	≤8.0	≤10.0
Chloride, ppm	≤300	≤300

Non-Woody Pellet Standards

The PFI fuel grade standards refer to woody pellets only and non-industrial use only. Non-woody pellet standards have yet to be established in North America. European non-woody standards (CEN, 2012) for non-industrial use include all the properties listed in Table 1, but also include BTU, N, and S. It will be challenging to maintain physical standards when dealing with grass pellets. Chemical composition parameters, particularly Si, N, K, and Cl, will likely be required for grass fuels.

Summary

The goal of biomass densification is to produce a strong and durable product that will resist breakdown during handling, transportation and storage. Consistent physical properties are necessary to optimize handling and storage systems. Consistent physical properties are also required for optimal combustion. Physical characteristics are the primary basis for wood pellet standards. Maintaining consistent physical standards will be considerably more difficult with non-woody biomass feedstocks, compared to wood fuels.

Additional Resources

ASAE. 1991. Cubes, Pellets, and Crumbles—Definitions and Methods for Determining Density, Durability, and Moisture Content. ASAE S269.4. St. Joseph: American Society of Agricultural and Biological Engineers.

CEN. 2012. EN 14961-6. Solid biofuels – Fuel specifications and classes – Part 6: Non-woody pellets for non-industrial use. Brussels: European Committee for Standardization.

Cherney, J.H. and V.K. Verma. 2013. Grass Pellet Quality Index: A Tool to Evaluate Suitability of Grass Pellets for Small Scale Combustion Systems. Applied Energy 103:679-684.

Obernberger I. and G. Thek 2004. Physical characterization and chemical composition of densified biomass fuels with regard to their combustion behaviour. Biomass Bioenergy 27:653–669.

PFI. 2010. Standard specification for residential/commercial densified fuel. 25 Oct. 2010. www.pelletheat.org. Arlington: Pellet Fuels Institute.

For more information



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