

Manufacturing Fuel Pellets from Biomass

Introduction

Wood pellets have increased tremendously in popularity as a heating fuel during recent years, with many homeowners and commercial facilities choosing pellet stoves or boilers over traditional wood-fired equipment due to their relative ease of use. As a result, the demand for fuel pellets has also grown quickly. However, wood is not the only suitable feedstock for manufacturing pellet fuel. A wide array of biomass materials can be used to manufacture pellets, most notably perennial grasses such as switchgrass or miscanthus. Not only that, but the necessary equipment for making pellets is available at a variety of sizes and scales, which allows for everything from the smallest scale (single homeowners manufacturing for their personal use only) to the largest commercial plants producing more than 500 million tons of pellets per year.

Properties of Biomass Pellets

Biomass pellets are generally a superior fuel when compared to their raw feedstock. Not only are the pellets more energy dense, they are also easier to handle and use in automated feed systems. These advantages, when combined with the sustainable and ecologically sound properties of the fuel, make it very attractive for use.

The standard shape of a fuel pellet is cylindrical, with a diameter of 6 to 8 millimeters and a length of no more than 38 millimeters. Larger pellets are also occasionally manufactured; if they are more than 25 millimeters in diameter, they are usually referred to as “briquettes.”



A high-quality pellet is dry, hard, and durable, with low amounts of ash remaining after combustion. According to the Pellet Fuels Institute, “premium” pellets (which are the most common pellets currently on the market) must have an ash content of less than 1 percent, whereas “standard” pellets may have as much as 2 percent ash. All pellets should have chloride levels of less than 300 parts per million and no more than 0.5 percent of fines (dust). Many biomass feedstocks have a higher ash content than the standard allows. In addition, some grasses and other materials generate ash that tends to form clumps and deposits at high temperatures. Because of this, most wood pellet stoves are not suitable for burning fuel pellets made from materials other than wood. Instead, “biomass pellet” stoves, which are designed especially for those fuels, should be used.

Table 1. Typical properties of biomass pellets from different sources.

| Feedstock | Bulk density (kg/m ³) | Energy content (MJ kg ⁻¹) | Ash content (%) | Reference |
|-------------------|-----------------------------------|---------------------------------------|-----------------|-----------|
| Sawdust | 606 | 20.1 | 0.45 | 2 |
| Bark | 676 | 20.1 | 3.7 | 2 |
| Logging leftovers | 552 | 20.8 | 2.6 | 2 |
| Switchgrass | 445 | 19.2 | 4.5 | 3, 7 |
| Wheat straw | 475 | 16 | 6.7 | 3, 9 |
| Barley straw | 430 | 17.6 | 4.9 | 3, 8 |
| Corn stover | 550 | 17.8 | 3.7 | 3, 1 |

Note: to convert from MJ kg⁻¹ to btu/lb, multiply by 430. To convert from kg/m³ to lb/ft³, multiply by 0.0624279.

A Description of the Pelleting Process

The process of manufacturing fuel pellets involves placing ground biomass under high pressure and forcing it through a round opening called a “die.” When exposed to the appropriate conditions, the biomass “fuses” together, forming a solid mass. This process is known as “extrusion.” Some biomass (primarily wood) naturally forms high-quality fuel pellets, while other types of biomass may need additives to serve as a “binder” that holds the pellet together.

However, the creation of the pellets is only a small step in the overall process of manufacturing fuel pellets. These steps involve feedstock grinding, moisture control, extrusion, cooling, and packaging. Each step must be carried out with care if the final product is to be of acceptable quality.

Feedstock Grinding

Standard-sized pellet mills generally require biomass that is ground to particles that are no more than 3 millimeters in size. Several types of equipment are available to carry out this task. If the biomass is quite large and dense (e.g., wood), the material is first run through a “chipper,” and then run through a hammer mill or similar device to reduce the particles to the required size. Smaller and softer biomass (e.g., straw) can be fed directly into the hammer mill without first being chipped.

Moisture Control

Maintaining an appropriate moisture level in your feedstock is vital for overall quality of the final pellets. For wood, the required moisture level of the feedstock is at or near 15 percent. Other types of biomass have other requirements—you may need to experiment a bit. Moisture can be removed from the feedstock by oven-drying or by blowing hot air over or through the particles. If the feedstock is too dry, moisture can be added by injecting steam or water into the feedstock.

Extrusion

The pellet is actually created in this step. A roller is used to compress the biomass against a heated metal plate called a “die.” The die includes several small holes drilled through it, which allow the biomass to be squeezed through under high temperature and pressure conditions. If the conditions are right, the biomass particles will fuse into a solid mass, thus turning into a pellet. A blade is typically used to slice the pellet to a predefined length as it exits the die.

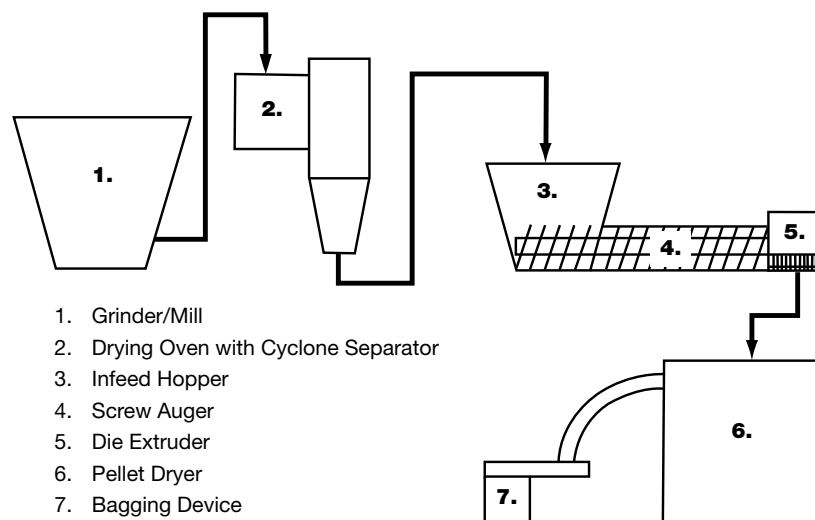
Some biomass tends to fuse together better than other biomass. Sawdust is an especially suitable feedstock for pelleting because the lignin that is naturally present in the wood acts as a glue to hold the pellet together. Grasses tend to not fuse nearly as well, and the resulting pellets are less dense and more easily broken. The proper combination of input material properties and pelleting equipment operation may minimize or eliminate this problem. It is also possible to add a “binder” material to the biomass to help it stick together, or to mix a fraction of sawdust, with similar results. Distillers Dry Grains (a product of the corn ethanol industry) are reported to improve the binding properties of some biomass.

Cooling

Pellets, as they leave the die, are quite hot (~150°C) and fairly soft. Therefore, they must be cooled and dried before they are ready for use. This is usually achieved by blowing air through the pellets as they sit in a metal bin. The final moisture content of the pellets should be no higher than 8 percent.

Packaging

Pellets are typically sold in 18-kilogram bags, which can be easily filled using an overhead hopper and conveyor belt arrangement. The bags should be clearly labeled with the type of pellet, their grade (i.e., premium or standard), and their heat content.



Energy Requirements for Pellet Manufacture

Pellet manufacture requires quite a bit of energy, both for drying damp feedstock and for running the various pieces of machinery. Large plants typically burn a portion of their feedstock to provide heat for drying, whereas smaller facilities often use other means. As a rule of thumb, a pelletizer requires between 50 and 100 kilowatts of electrical demand for every ton per hour of production capacity. In addition, electricity is usually needed to operate any chopping, grinding, drying, cooling, and bagging equipment that is in use. If a reliable source of electricity is not available, gasoline or diesel-based equipment is available.

Economic Considerations

The cost of setting up a pellet plant is not cheap; as a rule of thumb, expect to pay \$70,000 to \$250,000 per ton-per-hour capacity. The wide variation in costs is a function of the size, quality, and availability of the equipment. Larger capacity equipment is often more expensive on a per-ton basis because of the greater durability of the equipment and (usually) higher quality of the resulting pellets. Be cautious about selecting the cheapest available equipment—you may regret it later if the equipment ends up being of poor quality. Another important factor to consider when selecting equipment is the availability of spare parts and repair professionals. In general, about half of the purchase cost of equipment will be for the pellet machine, and half for the other devices.

Operating costs will include the cost of feedstock, energy, labor, and maintenance of the equipment. Typically, pellet dies will need to be replaced after every 1,000 to 1,500 hours of operation.

Other Important Factors to Consider

Two other important factors to consider when deciding whether to manufacture pellets are the availability of feedstock and the availability of a market. If you are producing pellets for your own personal use from biomass grown on your own farm, this is relatively easy to assess. However, if you are considering pellet making as a business, it is vitally important to identify and secure a steady supply of biomass for your needs. Sawdust and other waste products are no longer easy to obtain, and in some areas are simply not available at all. The market for fuel pellets is also an important consideration. Not only will you need to find a customer for your product, you must also take into account that most users of fuel pellets only need supply during the winter months. However, it is valuable to note that your investment in pellet equipment will be more likely to pay off if you are able to operate the facility for a large fraction of the year. Constant operation may be necessary if you are to recoup your investment in equipment and operate in a financially viable manner.

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