Demonstration of the Pelletizing Properties and the Heat of Combustion of the Wood of Western Juniper (*Juniperus occidentalis* Hook.)

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Edwin J. Burke
Missoula, Montana

Introduction

The large amounts of woody residue associated with the primary breakdown of juniper logs are caused by highlytapered stems, large knots, decay pockets, bark seams and pockets and other factors. While one commonly identified potential use of the residue is fuel pellets, no information concerning western juniper's pelletizing characteristics or heat values is currently available. This project's goal was the demonstration of this species' pelletizing properties and Heat of Combustion[1] values.

Pelletizing Trial

Raw material was prepared from sawmill residues from is harvested near Klamath Falls, Oregon. After air drying to 12% dry-basis moisture content, comminuting[2] and screening, 75 lbs. of a heartwood and sapwood residue mix of western juniper was to be manufactured into pellets at a western Montana plant. This plant used a ring-type agricultural pellet mill (standard in the industry) equipped with dies having a 2.25" working length.

The 100% western juniper plugged the machine. A mix of 60% western juniper and 40% Douglas-fir, however, worked satisfactorily. The machine operator reported that further reducing the ratio of western juniper to Douglas-fir (<50% western juniper) would most likely allow for better pelletizing, without need to periodically lubricate the dies with kerosene and/or water spray. The operator also suggested that pure juniper might be run, but it would require pelleting dies with shorter working lengths, probably 1” – 1.5”.

The principal problem with using a 100% juniper raw material was the heat generated in the long dies. It appears that the juniper, lacking oleoresin found in Douglas-fir, spruce, pine and larch, did not have adequate lubricating properties required for dies of that length. When kerosene was added to the pure furnish, plugging was avoided, but the pressure rolls still generated enough heat to nearly combust the furnish waiting to enter the dies. The resulting pellets were black in color, with hard, shiny surfaces. The pellets formed from the 60:40 mix were slightly darker than the tan to light brown color of the plant's pine/Douglas-fir pellet. Given the higher heat generated by the long dies and the juniper mix's lack of any appreciable light-colored sapwood to match the pine's color, this darker pellet color should be expected.

[1] Heat of Combustion, also known as Higher Heating Value, is the quantity of heat evolved by the complete combustion of a unit mass of substance. This total energy content of a fuel is measured in the English system as BTU’s/lb. A BTU (British Thermal Unit) is equal to the energy required to raise 1 lb. of water 1°F.

[2] Comminution is the machining into small, either discretely or indiscretely-sized particles. Common processes include hammermilling, grinding, chipping and flaking.

Immediately after manufacture, pellets had a faint kerosene odor. After exposure to the air in open containers for 48 hrs., the odor faded, and the odor of heated or "toasted" wood, such as lumber directly from a dry kiln, was noted. A sample of pellets burned at a local stove shop indicated no significant difference in burning rate or odor when compared to pine/Douglas-fir pellets. The juniper blend pellets were longer than the pine/Douglas-fir pellets, but broke in the feed mechanism of the stove and, therefore, offered no serious feeding problems. Since only a small, 2 lb. sample was burned in the stove, no long-term burning data are available, and information on pellet ash content, moisture exposure behavior, emissions and smoke odor need to be developed.

Heat of Combustion

Wood and bark samples from Klamath Falls trees were prepared by grinding wood and bark (separately) from Klamath Falls area trees. The small, pill-sized samples of wood contained both sapwood and heartwood, while bark samples were pure. Heat content determination was conducted using a Park adiabatic bomb calorimeter. In this process, 1-gram pellets of finely ground (40 mesh) wood are burned in an oxygen saturated water-bathed bomb and the resulting temperature rise of the bath used to calculate the higher heating value. In addition to the energy released by the combustion of the cell wall and extraneous materials, this method also captures the heat of condensation of any water present as moisture in the wood and also as water of constitution (formed and liberated from the pyrolysis reaction).

Since a wood stove would not capture any of the liberated water's heat of condensation (this moisture travels up and out the flue pipe), the Higher Heating Value serves only as a comparative evaluator of relative heat content. The actual heat content of most species will usually be approximately 1,000 BTU/lb. less than the Higher Heating Value. Residue left after combustion is assumed to be the inorganic (mineral) salts found within the cell wall, and is known as "ash". The residue remaining in a wood stove contains more than the inorganic ash of the wood. Ash content of the wood and bark samples was visually estimated.

Results of this evaluation show that western juniper has approximately the same Heat of Combustion as other Pacific Northwest softwood species. As with other species, ash content of the wood will be lower than that of the bark.

Conclusions

Wood Fuel Pellets

1. Western juniper can be pelletized. Some adaptation in equipment and procedures maybe needed to compensate for the lack of oleoresin, and its lubricating properties, of juniper wood.

2. The emission smoke of 60:40 western juniper-Douglas-fir pellets does not have a noticeably different odor than that of Douglas-fir-pine mix pellets.

3. Long-term burning trials need to be conducted in order to determine the optimum furnish composition, moisture content and die length.

Heat of Combustion

1. Preliminary tests show western juniper to have a Higher Heating Value of approximately 8,700 BTU/lb. which is about 109'0 less than resinous woods like pine, but which is approximately equal to other non-resinous woods such as true fir.

2. As might be expected, ash content of the bark is higher than that of the wood.

Implications for Industry

Wood Fuel pellets

1. The operator at the plant where the project's pellets were manufactured suggested pure juniper might be run if the working length of the dies was shorter than 2.25", most likely about l" to 1.25".

2. Dry basis moisture content of the furnish should be between 8 and 12%, the, same for the pelletizing of other softwood species.

3. Pellets that are made from blends of western juniper and other resinous species, especially pine, should be investigated. These pellets would be lighter in color, which preliminary market research indicates is more desirable, and the oleoresin of the other species would provide much-needed lubrication.

4. Pellets burn with little of the noticeable "cedar" odor of the burning solid wood, which fireplace logs may be able to take advantage of this selling point, while utilizing mill and woods residues.

5. The fibrous bark may be difficult to reduce into pieces small enough to make 0.25" diameter pellets. Larger pellet diameters may provide an outlet for bark residues, but ash content and resulting dark pellet color might prove to make the pellets unmarketable. Fireplace logs, however, are often very dark in color, and the dark bark would enhance the desired dark color.

6. The western juniper/Douglas-fir blend pellets performed properly in the feed mechanism of a pellet stove, even though they were slightly longer (1" vs. ½”) than other commercial pellets.

Heat of combustion

1. The Heat of Combustion of the wood of western juniper is about 10% less than resinous woods like pine, but is approximately equal to other non-resinous woods such as true fir.

2. The ash content of western juniper wood and bark appear to be not substantially different from the values for other Pacific Northwest softwood species.