00-07: Properties of wood pellets…

Wood pellets consist mainly of stem wood either from conifer trees or from deciduous trees, with or without bark. The difference between fresh wood and pellets is only the physical properties – not the chemical properties or the composition and not the energy content.

The heating value for stem softwood in northern Europe – mainly pine and spruce – is typically about 20 MJ/kg_{DAF} (Dry, Ash-Free) substance while the heating value for hardwood trees is about 5 % lower, around 19 MJ/kg. In the stem wood, the ash content is low, generally less than 1 % by weight and the ash also has a high melting point. If bark is mixed into the pellets the actual ash content may be significantly higher and also may the ash melting point be lowered.

Since wood pellets are an upgraded and dry fuel is the combustion temperature high, theoretically above 1600 ºC, and low ash-melting point may result in slagging and fouling problems in the combustion chamber.

The quality of the pellet – its mechanical durability and its density – are mainly determined by the sieving of the milled material prior to pressing, the moisture content and by the pressure obtained in the press matrix:

- Too wide a particle size span will result in weak pellets as will too narrow a span or too small mean particle size.
- The water content in the solid feed material prior to the press may not exceed 15 % and should preferably not be below 10 %. Too much water may result in the pellets exploding after the dice while too low a water content will tend to increase the wear of the dice.
- Too low a pressure in the compression process will lower the bulk density and the durability while too high pressures increase the wear of the matrix.

High quality pellets will be tough to break by hand and will withstand mechanical wear so that – when delivered to the end user – the fraction of fines produced through attrition during the handling process is less than 5 % by weight.

High quality pellets will also exhibit a particle density exceeding 1100 kg/m^3, giving a bulk density for storage and through transport exceeding 650 kg/m^3. The higher the bulk density the smaller volume is required to store a specific amount of energy and hence a high bulk density is advantageous to the end user.

From a transport point of view – though – is a higher bulk density not an advantage. The limiting value is set by the load capacity of the vehicle divided by the load volume, and that is about 4-500 kg/m^3 for railroad cars as well as for lorries and trucks. Hence, any density above this limit will hit the *weight* limit for the carrier before it hits the *volume* limit and it makes no difference for the carrier how high the density becomes as long as it exceeds approximately 500 kg/m^3.

The actual heat content of wood fuels (ΔH) – as of any fuel – can be calculated if the heating value for the dry, ash-free substance (ΔH_{DAF}), the fraction of ash in the dry substance ($f_{ASH,DRY}$) and the moisture content (f_{WATER}) are known. The equation is

$$\Delta H = \Delta H_{DAF} \cdot (1 - f_{ASH,DRY}) \cdot (1 - f_{WATER}) - f_{WATER} \cdot 2.45 \quad \text{MJ/kg}$$

As an example, let's calculate the energy content in pine pellets (ΔH_{DAF}=20.2 MJ/kg) with an ash content in the dry substance of 0.7 % ($f_{ASH,DRY}$=0.007) and 12 % water (f_{WATER}=0.12):

$$\Delta H = 20.2 \cdot (1 - 0.007) \cdot (1 - 0.12) - 0.12 \cdot 2.45 =$$
$$= 20.2 \cdot 0.993 \cdot 0.88 - 0.12 \cdot 2.45 = 17.652 - 0.294 = 17.36 \text{ MJ/kg or } 4.82 \text{ kWh/kg.}$$

(*to obtain kWh from MJ, divide by 3.6*)

Briquettes
Another distribution form for dry saw mill residues is briquettes. As opposed to pellets, which are produced using a pressure about 700 bar in rotating presses are briquettes typically produced in excenter presses at pressures no higher than about 200 bar.

Hence, briquettes become much more brittle than pellets and can not withstand mechanical wear. The bulk density with briquettes scarcely exceeds 500 kg/m^3 but is still significantly higher that the bulk density for the saw dust and cutter shavings that are typically the raw material. Hence, briquetting may significantly lower the cost to transport the residual fuel fractions (*saw dust and shavings*) from carpentry to an energy plant.

The combustion equipment for briquettes, though, must be flexible enough to handle saw dust and shavings since the briquettes will most probably break before they actually enter into the combustion chamber.

The moisture content in briquettes is similar to that of pellets and hence the heating value is also similar.