02-02: Pellets for heating in larger buildings…

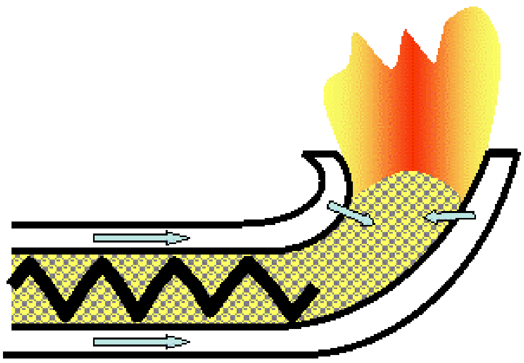
Two main technologies
In the domestic scale, pellets for heating may be burned either in air-heating stoves or in burners mounted in boilers. For scales exceeding approximately 10 kW thermal load, different types of burners are the main alternative, in the higher segment (above approximately 100 kW) complemented by grate-firing.

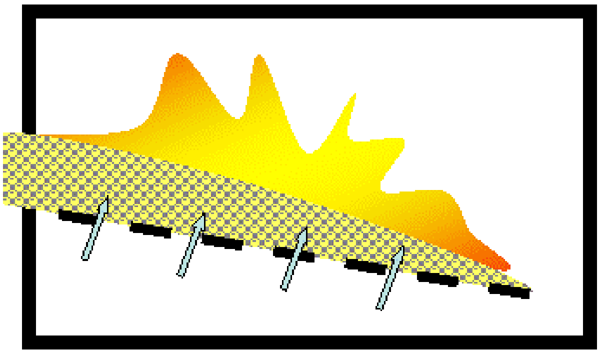
Pellet burners aimed for domestic applications (typically less than 25 kW) may basically be of two different kinds, namely forward-burning with a horizontal flame or upwards-burning with a vertical flame.

As the thermal power and the burners grow larger, the air velocity through the burner will be increased and forward-burning burners will run into problems simply because pellets will start to roll and blow out of the burner because of the high gas velocity. Hence, pellet burners for thermal output larger than about 50 kW will typically be upwards-burning. Pellets are then fed to the burner from below, using a screw feeder, and enter into a burner-cup where they are combusted. The ash is successively pushed up by the pellets and fall out of the cup over its rim. Combustion air is introduced through holes and slots in the double-mantled burner cup.

As the burners grow large, there becomes a problem to acquire a reasonably uniform pellet bed across the cross-section of the burner cup and it also becomes difficult to make the combustion air penetrate the pellet bed from the outer edge towards the centre. Hence, as the scale (the thermal load) increases, another technology tends to be preferred. The pellets are then pushed onto a perforated grid, a grate, through which air is supplied from underneath. This is called grate-firing as is a technology employed from thermal powers about 50 kW and all the way up to 20-30, in coal applications well above 50 MW.

The schematic blow illustrates the two main concepts:





Since the burner is fed from below, using a screw, and the screw feed must be designed so as to prevent back-firing (i.e. that the flames creep backwards through the screw) the feed will be dimensioned as narrow as possible. Hence, the fuel feed will not allow larger or more porous particles to pass and a pellet burner becomes fuel inflexible.

With grate-firing, the fuel feed may be accomplished using screws or pushers and the fuel feed may be constructed so as to facilitate briquettes feeding or even wood chips feeding. Hence, a grate-fired system may be designed for greater fuel flexibility.

Time constants and control characteristics
With grate firing – and generally speaking with higher demands on the thermal output – will there be more and more fuel inside the combustion chamber at any given instant. In large boilers there can be several tons, parts of which is still cold and not yet ignited, parts of which is burning, parts that are glowing at the final stages of burn-out and parts that are completely burnt and has become ash.

To control the combustion intensity – and hence to exercise a modulating control to this amount of fuel – the main parameter is to control the air flow from below, through the grate.

The fuel feed rate is only the second control parameter, exhibiting longer time constant than the primary control exercised by the air supply.

It will be simple to accept that such large amounts of fuel will not react instantaneously to a change in air flow but that the sheer mass of the fuel bed will represent a time delay and a thermal inertia. In some cases – such as if the water circulation through the boiler stops – this might lead to overheating and boiling. The risks associated with this become bigger and bigger as the boiler size increases and in the applications dealt with in this chapter, these risks may not be neglected. What has been said above is applicable also to large pellet burners, the largest ones being about 5-600 kW, though they will have quite a different design.

Though the boilers and systems treated in this chapter will typically run under a modulating control system, there is still a need of a sufficiently large water volume as a buffer to supply sudden demands of hot water. Depending on the purpose of the building and of the behaviour of the occupants, this demand may be bigger or smaller, but again this has to be taken into due account during the dimensioning process.

Considerations concerning storage
Wood pellets are an upgraded fuel with a bulk density typically in the range of 600 – 750 kg/m^3 and with moisture contents well below 15 %. Hence, the heating value of wood pellets is about 4.5 kWh/kg and the energy density becomes about 2.7 – 3.4 MWh/m^3 storage volume.

For briquettes, the bulk density is lower, about 500-600 kg/m^3 and so is the energy density: dimensioning values in the range about 2.2 – 2.7 MWh/m^3.

Briquettes – as well as pellets – may both be considered biologically inert.

In contrast, wood chips may exhibit most any moisture content ranging from 10-15 % in the case of saw-mill residues and all the way up to 55 % in the case of felling residues. This affects both the heating value and the density and to further complicate the picture, the degree of close packing with irregular particles like chips is also vary much variable. Generally speaking, though, is the energy intensity in chips storage very low – typically less than 1.5 MWh/m^3 bulk volume – sometimes as low as 0.5.

Wood chips are also a biologically active material and the establishment of mould and in the worst case rot fungi may provide a local problem not only for the working environment but also in the close vicinity of the storage.