01-01: Firewood as a fuel for domestic heating…

Firewood consists mainly of stem wood either from conifer trees or from broadleaf trees, with or without bark. It will have a cross sectional measure about 10 cm and a length adapted to the boiler where it is used, typically 40-80 cm. A single firewood log will then have a dry substance weight about 1 kg and with a moisture content of 20 % will the single log represent approximately 14-15 MJ or about 4 kWh of thermal energy. (*to obtain kWh from MJ, divide by 3.6*)

The single log will also be comparatively big, compared to the internal size of the combustion chamber, that is.

Supposing the boiler has a thermal capacity of 20 kW then means that no more than five wood logs may be burnt during any one hour to avoid overloading the boiler. Overload, as well as too low load, will cause emission of unburned hydrocarbons through the chimney. Hence, with a continuous firing, there is a need to supply one new log to the boiler every 10-15 minutes if the emission of hydrocarbons shall be avoided.

Old domestic boilers for wood firing – up until the 1960's – were typically equipped with a cast-iron combustion chamber completely submerged in the water to be heated.

With such a construction, the walls of the combustion chamber were cold, with a temperature close to that of the water. Hydrocarbons and tar released from the wood logs will then – if entering into these cold wall zones – either condense to form small droplets or at the very least will the flames be extinguished so that unburned hydrocarbons will escape from the combustion chamber.

In modern designs, the combustion chamber is lined with ceramic insulation, avoiding this problem.

The most modern wood-log boilers are designed for downwards combustion. In these, the gases from the coldest log will pass down, through the bed of already burning and glowing material, so that the gas is maintained at a high temperature throughout combustion, leading to even lower emissions of hydrocarbons. These boilers are also designed for batch firing, so that a specific load of logs are input, ignited and allowed to burn out completely. Hence a modern boiler save a lot of manual work since it does not require a continuous feed as did the old boilers.

The heating system may be designed mainly in two different ways – with or without an accumulator tank.

Without an accumulator tank, the water volume is comparatively small and the heating system has a low thermal mass or thermal inertia. Thus, the water will cool down rapidly and the system will require frequent energy input. This means that firing must almost be continuous during cold periods – but at the same time, the boiler must not be overloaded (*see the first paragraphs*). Hence such a system will require feeding with a new log at short time intervals, 10-15 minutes. Also; if there is no accumulator tank and if the boiler is overloaded, the capacity of the water to take store the energy released may be insufficient and boiling may occur.

If the system is equipped with an accumulator tank, and if it is properly designed, will the accumulator be able to store all the heat released from one or two full batches in the boiler. The system will then have the built-in capacity to deliver heat at an even rate during a 24 h period while the temperature in the accumulator successively drops until it is again re-stored by firing the boiler with one or two full batches of firewood. The accumulator will thus save work – since the boiler needs be fired only once per day, preferably during the evening but then it will need one or two full batches. Also will this type of firing, using the full capacity of the boiler combustion chamber but not overloading, produce the smallest possible emissions of harmful, unburned hydrocarbons to the ambient air.