03-03: Wood-chips firing in small-scale district heating…

As pointed out in 03-00, a "small" district heating network would be considered anything with a peak thermal power less than about 5-10 MW, but there is no strict limit.

In chapter 00-01, the relationships between fixed and variable costs as a function of scale were clarified. This is also what decides whether a small district heating system should be pellet fired or fired with wood chips. Generally, one might say that in the upper half of the interval, from about 5 MW up, wood chips are dominant.

Economy of scale – choice of fuel
The initial investment in a district heating system will always be significant and if nothing else is known one may assume that the investment in the distribution network is about the same order of magnitude as that for the boiler installation. And the cost for the boiler installation as a whole will be split in four parts of similar magnitude, namely the boiler itself, the boiler house, the fuel storage/handling/feeding system and the control system.

To this comes the cost for the customer heat exchangers, but that cost would typically be paid by the customers themselves once they connect to the system.

The choice of fuel will mainly affect the investment in the fuel handling and storing system and the storing and feeding of wood chips puts higher demands on the system mechanics than the feeding of a smooth and uniform fuel like pellets. Also the combustion of a non-uniform fuel is more challenging and the boiler itself will be more expensive in the case of wood-chips firing since it must be dimensioned for a fuel of non-uniform quality. Choosing a wood-chips fired system does also put high demands on the procurement procedure and on the level of detail in the tendering process, since any components of an inferior quality in system will cause stoppages, failures and may become disastrous to the long-term economy of the installation.

The major gain from choosing wood-chips is the potential flexibility of the system and the possibility to choose the cheapest fuel at any single instance. It must also be remembered that the fuel handling system and the boiler in themselves will represent only a part of the total investment while the other parts, the boiler house, the control system and the piping for the distribution net, will be unaffected by the choice of fuel. Hence, a cost increase to these parts may well pay-off in the long run due to the inherent fuel flexibility.

Limits to the combustion process
Any fireplace is designed to work best with a specific fuel at a specific firing rate (i.e. thermal output). Good combustion equipment – fed with the correct fuel at the correct rate – will provide a complete burnout of the fuel in combination with minimal amounts of air pollutants. As already pointed out in chapter 00-01, the combustion process is an intricate combination of aerodynamics, heat- and mass-transfer, and chemistry.

With a boiler for district heating applications, the boiler will be large enough to be equipped with computerized combustion control and it might also be large enough to accommodate a more advanced particle separation from the flue gases than a multi-cyclone. In the upper end of the interval – about 6-10 MW – electrostatic precipitators are becoming economically viable. You will find more details about these things in chapter 03-00, but here we shall only touch upon a few things of major importance for systems using wood chips firing:

- Wood-chips firing will typically be used in plants larger than pellet-fired systems and may include several hundred or thousands households and up to a few hundred km of distribution tubing. Hence there is a greater flexibility to the location of the boiler in these systems than is the case with pellet-firing. This will mean that the demands on noise from fuel unloading, fans, smell and other disturbances around the boiler house become less strict because the boiler house may be separated from the residential area supplied with heat from the boiler.
- Storing and feeding wood chips is significantly more complicated than storing and feeding of pellets. Since the chips exhibits much lower energy density (MJ/m^3_{bulk}) will the storage hopper have to be larger, and this is further emphasized by the fact that the plant will be larger and the fuel consumption consequently will be larger. Loading/unloading operations will thus be more frequent than with pellets. Chips are also more biologically active than pellets and may prove a good substrate for mould and for rot fungi which – in turn – means that the store may be a source of allergens and, in the worst case, bad smell
- Feeding of wood chips may well be done by screws but it has to be remembered that the inclination of the screw for chips may be steep enough to be prohibitive to pellets feeding. Hence, a plant laid out for chips firing may well be impossible to fire with wood pellets.

Relevant standards

At this scale there are no standards available for the boiler design but one is dependant on individual designs made by the manufacturers. However, EN 15316-4-7 covers the dimensioning methods for building heating systems and may prove helpful to dimension the customer heat exchangers.