04-03: Wood-chips firing in CHP-plants…

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.

In chapter 04-00 you will have found that the differences between combined heat-and-power installations and district heating installations seem fairly small: A CHP-plant is basically a district heating plant with a generator added… Now, it is not all that simple, but there is a little more to it: It was mentioned in 00-01 that to obtain a high electricity conversion ratio, one has to use high steam pressures and high steam temperatures – the higher the better. This will affect the cost for the boiler significantly and in most cases a smaller boiler unit (less than about 20 MW_{TH}) will not be able to carry the costs for pressures higher than about 25-40 bars. For the same reasons will the small boiler in most cases not be able to carry the costs for high superheating temperatures.

Steam turbines are mechanical, rotating devices and the smaller they get, the more relatively important will friction losses and other fixed losses become. Hence will a small turbine exhibit significantly lower efficiency than a larger unit.

The combination of the above effects is that small systems typically will have relatively low electricity conversion efficiencies, down to 15 or 20 %. Such low efficiencies are typical for systems in the range below 10 MW_{TH} while – at thermal loads exceeding about 50 MW – the electricity conversion may be raised to about 35 %.

As you will have seen in chapter 04-00, the electricity conversion factor – often expressed as the ratio between electricity production and heat production, α – in combination with the customers' willingness to pay for the heat, is a determining factor for economy of the unit. Try using the equation suggested in 04-00 as the α-value drops to 0.2 and you will see what happens to the required fuel price…

To maintain economy in small-scale CHP, it becomes extremely important to guarantee the lowest possible fuel price, and this is one reason that wood-chips are the preferred fuel for such applications.

At the same time, the use of wood chips in combination with superheated steam might give rise to problems: The superheater surfaces are exposed directly to the flue gases with their content of ash, and since the superheater surfaces are hot the might be subject to depositions of molten ash (slagging) that might cause tube corrosion (fouling) and even might destroy the tubes completely. Hence will the ash properties have a strong impact on the lifetime of the unit and on the maintenance cost. Now, one reason that wood-chips is a cheap fuel is that there is usually no guarantee whatsoever on the fuel quality – including ash properties…

Limits to the combustion process

- Everything said in 03-00 about district heating boilers applies also to boilers in CHP applications.

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.