Energy saving in the boiler house

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Published in the Grower 60(6), 2005, p. 31-32

Energy saving in a greenhouse starts with getting the most heat out of the fuel. The trick is maximising the boiler efficiency and minimising heat loss from the boiler. In hot water pipe heating systems, a burner converts fuel to heat; then a boiler transfers heat to water; and heating pipes deliver hot water to the greenhouse, where the heat is transferred to air. This article discusses boiler efficiency, burner capacity, water content, air supply, flue gas condensor, insulation, and possible solutions.

Boiler efficiency
Boiler efficiency is a percentage indicating how much heat (in the form of hot water) is produced from fuel combustion. The boiler efficiency can be below 80% or over 90%, which makes more than 10% difference in energy costs. Regular cleaning and maintenance helps the boiler efficiency. However, some boilers can never become highly efficient. Some older type boilers are not as efficient as a modern one, as technology improves continuously. An old burner can waste a lot of energy, and can have problems such as a relatively high emission of pollutants. This is particularly undesirable when the flue gases are used for CO2 enrichment.

Burner and boiler capacity
There are quite a few heating systems with a too small burner, and there are quite a few (especially coal-fired) systems with insufficient water content relative to the amount of water in the pipes. If the capacity of the burner (the flame) is too low, it is impossible to maintain a high enough water temperature under cold conditions. Hence the temperature of the boiler, pipes and greenhouse air will be too low in cold nights. This may cost production.
Other boilers can have a small water content, which means little spare hot water, which will lead to fluctuating temperatures. When the computer suddenly calls for a high pipe temperature (due to sunset or colder weather), hot water will be sent to the greenhouse to deliver the heat. The hot water delivers it heats, and returns as cold water. But when the cold return water comes back into the small boiler, the water temperature in the boiler will abruptly go down ('the boiler collapses'). Hence the temperature of the pipes and thus of the greenhouse air will be low for a while. If the burner is powerful enough, it will go full-speed and bring the boiler water temperature up, and the pipes will become warm again. This temperature fluctuation can continue. So with a small boiler capacity it is hard to maintain a nice constant greenhouse climate.

New boiler, buffer or screen
In some cases it is possible to replace the burner only, and not the boiler. This should be discussed with the supplier or professional who installs the systems.
If the burner or the boiler is too small, there are some solutions. A radical solution is replacing the old burner/boiler by a modern one. This can be economically feasible, especially if the boiler is inefficient and obsolete. Also increasing fuel prices can make it economic to move to a more efficient burner/boiler. It can be the preferred solution if there is also a need to get a larger boiler, either for better climate control or for expansion.
Another option is installing a buffer. This is an insulated tank with water that can be heated. This provides an extra volume of hot water additional to the water in the boiler. In case of a sudden heat demand, there will be plenty of hot water available from the buffer. The burner will get time to adjust to the higher heat demand, and in this way any strong temperature fluctuations can be avoided.

The third option is installing an energy screen (thermal screen). This is quite an investment and also has disadvantages (e.g. light loss throughout the year). But in some situations it can be earned back by saving energy and by avoiding production losses due to too cold temperatures in the winter. A thermal screen is more likely to be feasible in colder regions, more so if the fuel is expensive, and in particular if the boiler capacity is too small.

Air inlet & outlet
A burner draws a lot of fresh air from the surroundings for oxygen supply to the combustion chamber. Sufficient air supply is critical. Lack of fresh air can lead to the production of carbon monoxide (CO) which is lethal, and ethylene gas (CH4) which kills plants. Air for combustion is often drawn from outside. This is cold air. When the air leaves the chimney (in the form of flue gas) it is burning hot. The heat is taken from the combustion process, and all this heat is lost via the stack. The heat loss is larger when more air flows through the burner, and also when the incoming air is colder, or the outgoing air is hotter. It is possible to save energy by improving any of these factors: reducing the amount of air flowing through (without coming near the critical minimum!), using warmer air for combustion (from inside) or reducing the temperature of the flue gases (e.g. with a condensor). More about this in the next issue.

Flue gas condensor
A flue-gas condensor is a device behind the boiler where the flue gases pass through. A condensor retrieves energy from the flue gases by cooling them down from over 200 °C to (possibly as low as) 40 °C. A condensor also regains energy by condensing all the hot steam in the flue gas. By preventing that a lot of energy disappears out of the chimney, a condensor can save 6-8% energy. A condensor is absolutely recommended whenever possible. Unfortunately a condensor can only be used for gas-fired burners.

Insulating the boiler & transport pipes
Most boilers are pretty well insulated along the long sides. The front and back can be quite hot, and will emit some heat there, but this is inevitable. It is not inevitable though, that heat is lost from the heat transport pipes. These pipes can be around 100 °C, and loose a lot of energy. This can be largely reduced by lagging (insulating) these pipes. Where insulation material is in place, no heat can escape.

Insulating the boiler house
Some boilers are standing outside under a shelter, or in a separate area of the glasshouse. It is much better to place the boiler in a well-insulated boiler house. The huge volume of air are that is drawn through the burner chamber for oxygen supply is then pre-heated, and requires less energy to reach the flame temperature. Therefore an insulated boiler house saves energy. When insulating the boiler house, make sure there is always sufficient inflow of fresh air (see above). Relying on opening a door for air supply is dangerous.

***Acknowledgements**. The photos were taken in the Vegfed-SFF project "Improving energy efficiency in greenhouse vegetable production". With thanks to the growers and Vegfed, SFF, NGC and Solid Energy for project funding.*

Photo 1: *Most modern boilers are very efficient. Note the insulation (silver coloured). This will be covered by a stainless steel sheet.*

Photo 2:
A flue gas container behind a gas-fired boiler can save 6-8 % on energy costs.