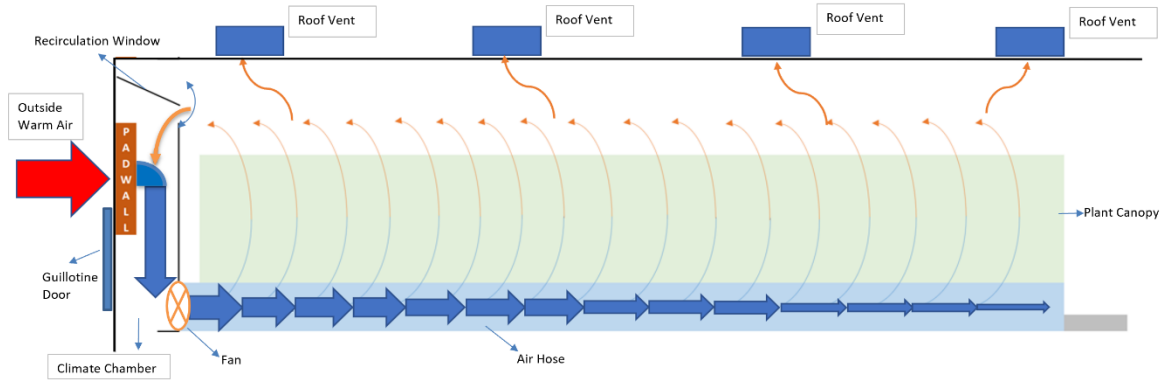
In this post I share my experience with the semi-closed glasshouse. There is much confusion on how best to grow crops in a semi-closed glasshouse, and this series of articles tries to clear up confusion, inspire new discussion and educate.



How Does a Semi-Closed Glasshouse Operate?

To explain the differences between a conventional and a semi-closed glasshouse, let's have a look at how a conventional glasshouse exchanges air. In figure 1, a simple diagram explains the airflows.

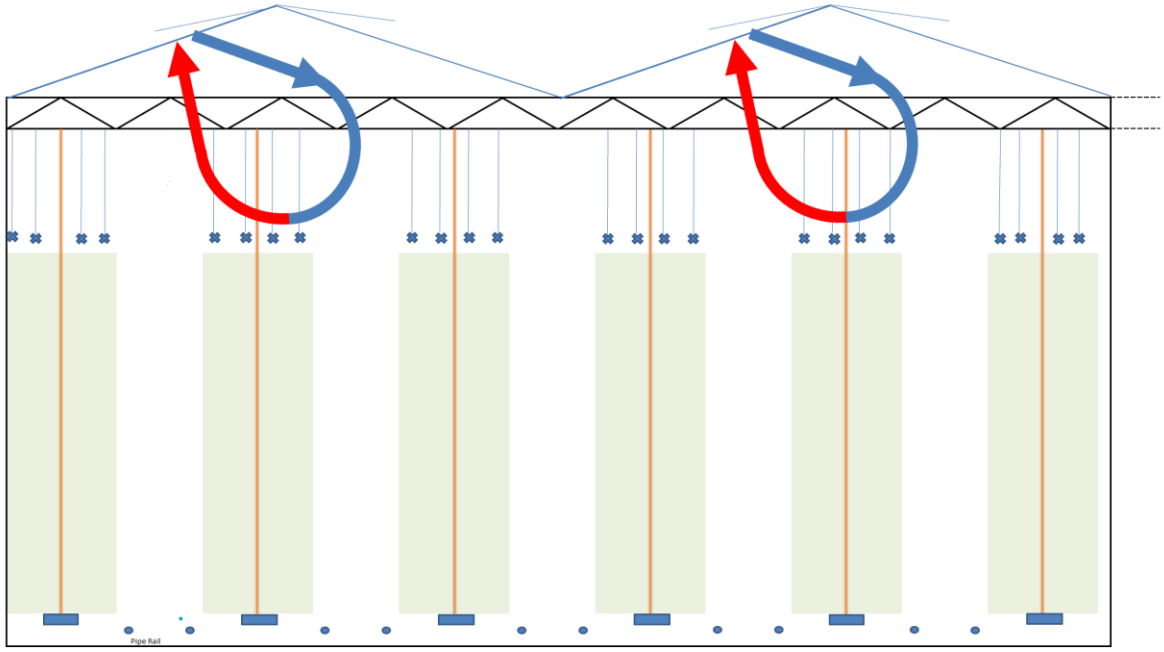


Figure 1, Airflows in a semi-closed glasshouse

The green coloured area represents a fully-grown vine crop. The rows of vines create a barrier preventing air from penetrating low into the glasshouse. Most of the air exchange takes place above the crop in the top of the glasshouse. The many windows in the roof exchange enough air to keep the glasshouse cool on a warm summer day. After the cool outside air enters the glasshouse it is warmed up by the sun and it leaves the glasshouse as warm air through the same vents. The temperature in this glasshouse is largely determined by the outside temperature, the rate of air exchange (vent opening and wind speed), cooling capacity of the crop and the intensity of the radiation. Glasshouses with hanging gutters achieve a better penetration as air can move through the space underneath the gutters.

The development of a commercial semi-closed glasshouse is considered by some to be the most profound change in glasshouse design of the last 40 years. In Figure 2 the airflow in a semi-closed glasshouse is schematically expressed. The difference in air movement between the two types of glasshouse becomes clear immediately. In a semi-closed glasshouse, all the air enters the glasshouse from the bottom. To leave the glasshouse the air must move upwards past the plants. This has significant consequences for transpiration and CO2 uptake. The outside air is sucked into the climate chamber through a cooling pad wall. The temperature of the air entering the glasshouse can be as low as 10°C below the temperature of the glasshouse air. This is achieved by placing a cooling pad at the point where the outside air enters the climate chamber. The fans blow the cooled air into the hose and the small holes in the hose distribute the air evenly throughout the glasshouse. There are

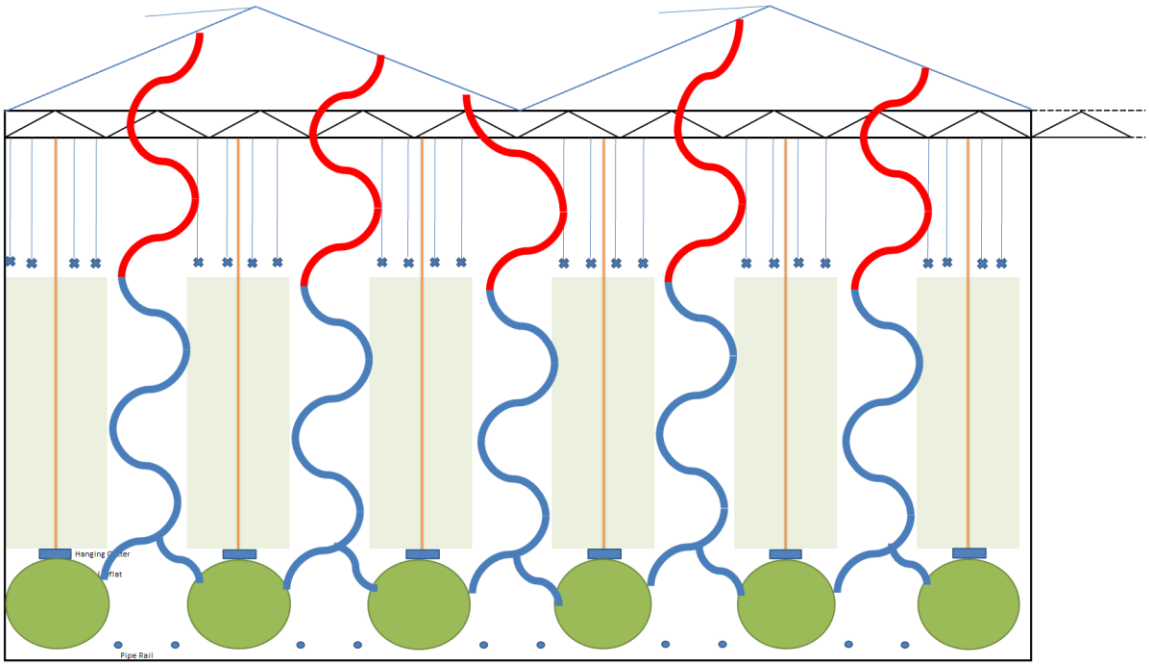


Figure 2, The Semi-Closed Glasshouse front view

two ways that this air can leave the glasshouse. Either through the roof vents, or through recirculation. Venting through the roof vents means that the air is pushed outside. In recirculation mode the glasshouse air re-enters the climate chamber through the recirculation window and is blown back into the glasshouse (see figure at top of the post). The outside conditions largely determine the mode of operation. A grower can also use both options at the same time. When the air is pushed outside it is considered a non-closed system. In recirculation mode the air is re-used, and the glasshouse operates in a “closed” mode. Hence the name “semi-closed”.

As the air rises above the plant canopy it gets exposed to sunlight and warms up. The semi-closed glasshouse has layers of air with different temperature. Cold air enters the glasshouse from the bottom and hot air rises the top. In the roof of the glasshouse, the air can be as hot as 40-50°C. If the

fan speed is too high and turbulence occurs, the hot air can be drawn down onto the crop. In sunny conditions the hot air may be warming up faster than the speed with which the fans can push the air out. If despite screening and evaporative cooling the temperature still rises, the fan speed needs to be increased. When the fan speed is fast enough, the cooler air pushes the warm layer up faster than the sun can warm it up. In non-recirculation mode, the outside air can be cooled by evaporative cooling in the climate chamber. The air pushed into the glasshouse is thus cooler compared to outside air entering through the roof vents in a conventional glasshouse. To maintain the same temperature, the semi-closed glasshouse will therefore require less air exchange. The reduced air exchange results in higher CO2 levels, which is one of the reasons in which a semi-closed glasshouse can be financially justified.

MEASURING BOX

In semi-closed glasshouses, measuring boxes should be hung one meter above the crop, rather than near the heads of the plants as is custom in a conventional glasshouse. This is to prevent warmer layers of air descending on to the tops of the plant.

Aside from superior air movement and cooling, the semi-closed glasshouse provides some significant other advantages. The fans pressurise the glasshouse. This means that the vents in the roof work opposite to vents in a conventional glasshouse. Instead of scooping air in, the vents let the air out. In this process the roof vents become pressure relief valves and consequently less vents are used. A typical glasshouse has about 400 vents per Hectare, versus 80 in a semi-closed glasshouse. The positive pressure and reduced number of vents make it possible to put insect netting on the vents. The air inlet is also screened which results in a significant lower insect pressure in the glasshouse. All crop damaging insects, except for russet mites (and small thrips) will be screened out. The mesh size of the screen cannot be reduced to a smaller size because tiny holes would become clogged with dust particles. The positive pressure inside the glasshouse will create an airflow to the outside so that when a door opens, it is harder for small insects to fly into the glasshouse. The reduced introduction of plant attacking insects by no means completely prevents an outbreak. However, it makes it far more likely that an Integrated Pest Management (IPM) introducing beneficial insects will be successful. Screening the air in-, and outlets changes the odds to the farmers advantage. The fans are never turned off, providing ample air movement at night, reducing the incidence of fungal diseases without having to heat.

Farmers are choosing semi-closed glasshouse types to reduce pesticide and fungicide use. The success rate of IPM will be higher and paves the way for reducing chemicals. This is especially true in warmer climates where insect pressure is higher. The semi-closed glasshouse can cool a glasshouse down from 40+ degrees Celsius to below 30 Celsius. Besides shading, the semi-closed glasshouse cools with the awesome power of evaporative cooling which will be discussed in the next edition.

Last Week's Post

As a result of the statement in my post to encourage climate computer companies to calculate the reduced light sum that the plant receives as a result of shading or whitewash, I was contacted by Hoogendoorn who let me know that recent advances have made it possible to do just that. Better still, they can connect the climate computer to weather forecasting models to aid the grower with screening in such a way that the plants receive the optimum light every day.

If you like to be copied in on future articles or would like to know more and have questions, follow me on LinkedIn Godfrey Dol, or email Godfrey@glasshouse-consultancy.com