

## Gas Information Sheet No. 22

# Gas heating in hothouses and carbon dioxide enhancement

### **Introduction**

The purpose of this Information Sheet is to ensure that appropriate controls are put in place for the safety of people working in hothouses where products of gas combustion are present, especially situations where those products are being used to assist plant growth.

Any gas installation associated with a hothouse is deemed to be a 'Complex' installation. For 'Complex Installations', an Application for Acceptance of Complex Gas Installations and Type B Appliances must be submitted to ESV prior to supply approval being given.

### **Plant growth using CO<sub>2</sub> enhancement**

Carbon-dioxide (CO<sub>2</sub>) is an extremely important gas that plants absorb from the atmosphere. CO<sub>2</sub> serves as the fuel in the process of photosynthesis during which the gas and water are converted into sugars, which in turn are used to form solid building substances for the plant. The source of energy for this process is light. Consequently, CO<sub>2</sub> is a substance that is of essential importance in the growth process of a plant.

The atmosphere normally contains 0.03% or 300 ppm of CO<sub>2</sub>. Raising the percentage of CO<sub>2</sub> in a hothouse with sufficient light and at an increased temperature can accelerate plant growth. This has resulted in the concept of "CO<sub>2</sub> dosing" using the combustion products from gas appliances.

Fresh air ventilation is essential even in hothouses that do not have CO<sub>2</sub> dosing. As the plants absorb the CO<sub>2</sub> from the air, it must

be replenished. Hothouses that use products of combustion from a gas appliance also require adequate ventilation for the combustion process.

Unless fresh air is available the appliance will produce increased levels of carbon monoxide (CO) and the amount of CO<sub>2</sub> produced will substantially decrease, which is not conducive to plant growth.

### **Exposure of people to products of combustion**

Hothouses used for the propagation or enhanced growth of flowers or other plants are generally heated by in-ground hot water coils from a gas-fired boiler. In some instances the combustion products from the boiler are released into the hothouse rather than being flued to outside atmosphere.

Occasionally direct-fired air heaters are used both to raise the temperature and the CO<sub>2</sub> level in the hothouse. 'Direct-fired' means that fanned air is heated by the burner flame and the products of combustion enter the space being heated.

There are three main issues that need to be considered:

1. The exposure of workers in the hot house to products of combustion.
2. Suitable gas appliances.
3. CO<sub>2</sub> control and monitoring systems.

In relation to the exposure of workers, Safe Work Australia has set maximum allowable limits. Refer to Table 1 and Table 2.

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Table 1: Guidelines for the control of short term excursions for **carbon monoxide**

Concentration <sup>(a)</sup> (ppm)	Total exposure <sup>(b)</sup> (min.)
200	15
100	30
60	60

- (a) Short term excursions should never exceed 400 ppm.  
 (b) This duration represents the sum of exposures at this level over an 8 hour workday, and assumes no other exposure to carbon monoxide.

Table 2: Maximum exposure limits for **carbon monoxide** and **carbon dioxide**

Contaminant	Time Weighted Average (TWA) (ppm)	Exposure time (hours)
carbon monoxide (CO)	30	8
carbon dioxide (CO <sub>2</sub> )	5000	8
carbon dioxide (CO <sub>2</sub> )	3000	<8

### Notes:

- The exposure of workers to excessive levels of CO can be extremely hazardous.
- The TWA or time weighted average limit is taken as the average concentration that a person will be exposed to over the time period. These limits are generally set at such a level that they are not considered to be injurious to the health of a normal healthy adult. However, some people may have a health condition that could put them at risk when exposed to lower levels than those specified for a healthy adult.
- For further information on workplace exposure standards for airborne contaminants go to the following links:  
<http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/772/Workplace-exposure-standards-airborne-contaminants.pdf>  
<http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/771/Guidance-interpretation-workplace-exposure-standards.pdf>

### CO<sub>2</sub> dosing using combustion products from a gas-fired boiler

The method of CO<sub>2</sub> dosing most acceptable to ESV is the controlled release of combustion products into the hothouse in conjunction with in-ground heating. ESV's general acceptance requirements are as follows:

- The appliance main flame must be proven (i.e. established and stable) before any combustion gases are allowed to enter the hothouse.
- The CO level in the appliance flue must not exceed 400 ppm.

- The environment within the hot house must be continually monitored.
- The appliance must shut down or the products directed to atmosphere if the CO level in the hothouse reaches 10 ppm or 3000 ppm CO<sub>2</sub>.
- The ventilation openings must be interlocked with the gas control system.

### Appliance acceptance

Any appliance used in conjunction with a CO<sub>2</sub> dosing system will be treated as if it were a 'Type B appliance'. A submission must be made to, and accepted, by ESV before any work commences and an on-site inspection will

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subsequently be carried out by ESV. An Application for Acceptance of Complex Gas Installations and Type B Appliances is also required for the installation of the appliance and any fixed pipework.

### **CO<sub>2</sub> dosing using fixed or mobile direct fired gas appliances**

The method of CO<sub>2</sub> dosing most acceptable to ESV is the controlled release of combustion

products into the hothouse in conjunction with in-ground heating. If another method is selected then the following requirements apply.

The total gas consumption per cubic metre of room volume of all direct-fired appliances in a hothouse must not exceed the limits given in Table 3.

Table 3: Maximum gas consumption per cubic metre of room volume

Appliance type	Gas consumption
Thermostatically controlled	0.4 MJ/h/m <sup>3</sup> (LPG 0.008 kg/h/m <sup>3</sup> )
Not thermostatically controlled	0.2 MJ/h/m <sup>3</sup> (LPG 0.004 kg/h/m <sup>3</sup> )

### **Direct-fired appliances**

AS 3814: 2015, Clause 5.7.2 requires that the air supply for direct-fired heaters must be taken from outside of the building. The combustion product limits must comply with the requirements of AS 3814: 2015 Clause 5.7.7.1 (10 ppm CO and 3000 ppm CO<sub>2</sub> with a maximum CO/CO<sub>2</sub> ratio of 0.003).

### **Mobile industrial heaters**

Mobile heaters are designed for industrial heating applications. They are not designed for CO<sub>2</sub> dosing and ESV strongly recommends that they are not used for that purpose.

Where the use of a mobile industrial heater is being considered, the situation must be assessed as follows.

### **Heat only**

Where the appliance is to be used specifically to produce heat (no CO<sub>2</sub> dosing):

- It must be certified.
- It must not exceed the MJ/h/m<sup>3</sup> limits given in Table 3.
- It must be serviced in accordance with the manufacturer's instructions.
- The CO and CO<sub>2</sub> levels must be checked by the installer and will be verified by ESV before the installation is accepted.

After continuous operation of at least 2 hours, the atmosphere in the hothouse shall not exceed:

Carbon monoxide (CO)	10 ppm
Carbon dioxide (CO <sub>2</sub> )	3000 ppm

If these limits are exceeded, then additional permanent ventilation complying with AS/NZS 5601:2013, Clause 6.4.4.3 must be provided.

### **CO<sub>2</sub> enhancement**

Where the appliance (direct-fired or mobile heater) is to be used to enhance CO<sub>2</sub> levels:

- A submission must be made to, and be accepted by, ESV before any work commences. An on-site inspection will subsequently be carried out by ESV.
- A CO monitoring system is required that is interlocked to shut down the appliance if the CO level in the hothouse exceeds 30 ppm or 5000 ppm CO<sub>2</sub>.
- The CO monitoring system must be checked every three months and recalibrated as necessary.
- Test records must be kept.
- The appliance must be serviced in accordance with the manufacturer's instructions at least annually.