HiCap™ CO

Moleculite® carbon monoxide large absorber cartridge.

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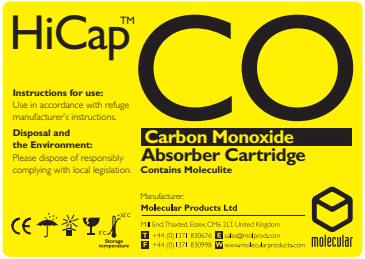
The data provided is intended for general guidance and does not necessarily cover all the operational aspects of the cartridges. Each individual case needs to be properly assessed for safe operation by the facility managers.

Further advice and help in producing your own operational procedures for the safe deployment of the large absorber cartridges is available on request from the manufacturer.



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HiCap™ CO

Moleculite® Carbon Monoxide Large Absorber Cartridge.

Important note to operators

- **The cartridge is designed to remove carbon monoxide from an enclosed environment as part of a life support system. Consideration needs to be given to any oxygen supply and carbon dioxide removal requirements.**

- **This unit is for professional use only and will therefore require operators to be suitable trained.**

A user manual is supplied, but it is the responsibility of the facility operators to supply an operating procedure and training for the end users appropriate for the intended location and conditions.

It is suggested that the supplied user manual should be used to form the basis of the local operating procedure and basic training to the end users. This procedure and training will be specific to a location and depend on the end users requirements.

HiCap™ CO

Moleculite® Carbon Monoxide Large Absorber Cartridge.

Introduction

The large scale absorber cartridges are available in two formats one for the removal and control of carbon **dioxide** (CO_2) and the other for the removal and control of the much more toxic carbon **monoxide** (CO). Both units use the same crate design to hold the active constituents and are the same physical size (Figure 1). The units are differentiated by labelling and require different operating conditions to produce the specified performance. The units are designed to seal against the base plate cut-out of fan driven air supply equipment.

Figure 1 – dimensions

Length (mm):	400
Width (mm):	300
Height (mm):	170
Total weight (kg):	14
Base cut out (mm)	270 x 370

The performance and normal running conditions for each type of unit are described below. The carbon dioxide units are normally required to remove CO_2 that is being continuously produced by people exhaling CO_2 at a steady rate for extended periods of time; hours or days. Whereas the carbon monoxide units are normally required to remove an initial high concentration of carbon monoxide to low levels as fast as is practical; usually within minutes. Each unit is supplied in a sealed gas and water resistant barrier foil packaging to ensure the cartridges are protected from contamination and remain active during storage.

Each unit is provided with a seal round the base which provides a gas tight seal when deformed by the weight of the unit against a cut-out in a fan base unit. The fan base unit is designed to pass air through the cartridge. The size of the base cut-out needs to be 270 x 370 mm (+/- 1 mm). The air stream is normally passed up through the unit (base to top) but the units will operate with the flow reversed. However the flow should not be reversed during operation as this will reduce the usable capacity.

It is important the procedures are in place to allow safe deployment of the units before they are required. It is the responsibility of the facility operators to ensure these procedures are adequate for the intended purpose and that training is provided to all personnel who may need to use these units before they are required to use them. The descriptions below assume the units are deployed in an enclosed volume that allows free circulation and good mixing of air to and from the units.

HiCap™ CO – Moleculite® Carbon Monoxide Large Absorber Cartridge

This unit uses Moleculite® to catalytically remove toxic carbon monoxide by oxidising it to the much less harmful carbon dioxide which is released back into the enclosed space. The amount carbon dioxide produced from the conversion of even lethal concentrations of carbon monoxide to carbon dioxide is normally of minor physiological significance and in most cases there will be other processes available to control the levels of carbon dioxide present. The Moleculite® has, in theory, an unlimited capacity for the removal of carbon monoxide provided there is sufficient oxygen present. However in practice the Moleculite® is deactivated by the water vapour normally present in room air and from exhaled breath of the occupants. Therefore in practice the operational life is determined by the time it takes for the Moleculite® to absorb sufficient water vapour to deactivate it. The performance figures presented below assume a high water content in the inlet air and so represent a conservative estimate of the operational duration and capacity. The deactivation is not immediate but the rate of carbon monoxide removal reduces significantly once the water content exceeds a threshold value. Table 2 and 3 below takes the effect of water absorption into account and allows the number of units required to be calculated.

The units are designed to operate at a nominal flow rate of 1,000 litres per minute air flow through the units. Flow rates lower than 1,000 l/min may be appropriate if power is limited or if the requirement is to continuously remove low levels of carbon monoxide over extended periods of time. Higher flow rates (up to 2,000 l/unit) can be used if required to quickly reduce dangerously high CO levels to safe levels but this may reduce the total capacity for CO removal.

If high levels of carbon monoxide are known or suspected to be present it is important to deploy the units as quickly as possible so as to reduce the exposure of personnel to the toxic effects. The number of units and time taken to reduce the carbon monoxide to safe low levels will depend on the initial concentration and the volume of the enclosed space. Table 2 and 3 can be used to assess the number of units required for a range of cases.

DO NOT remove the barrier foil packaging until immediately before the unit is to be used.

Operating instructions: carbon monoxide (CO)

1. Remove outer foil barrier film (a pair of scissors or sharp safety blade will be required).
2. Check that the bases seal is in place and intact, then place the unit onto the base unit aperture(s).
3. Warning - all the base (fan) unit apertures must have cartridges installed for correct operation - If the base unit has more than one aperture ensure all the apertures are covered with installed cartridges – use an exhausted cartridge if fresh cartridges are not available.
4. Start the airflow through the cartridge(s) – refer to base unit operating procedure.
5. In a multi-aperture base unit, if the some units are exhausted and fresh ones are not available the exhausted units should be left in place – used HiCap™ CO will continue to remove trace (<50ppm) concentrations of carbon monoxide for some time after the specified performance period so can be left in service provided power is available for this purpose.

Sufficient cartridges need to be available to provide carbon monoxide control from the highest expected concentration down to safe levels in an acceptable time. Self contained respirator sets may be required to maintain clean breathing air for the time that the carbon monoxide is being removed.

Storage, Maintenance and Condition checks.

The units do not require any maintenance in storage but do need to be stored in such a way that the barrier foil packaging prevents moisture or contamination entering the unit.

- The units need to be handled and stored under conditions that prevent damage to the barrier foil packaging i.e. avoid sharp objects or pressure points puncturing the packaging.
- The units should be stored between 0 – 35C°, out of direct sunlight and protected from wet conditions.
- Each unit is marked with a label on the outside of the packaging that shows the original packed weight of the unit.

The units will absorb atmospheric moisture if the packaging is damaged therefore the weight change can be used as a measure of the seal integrity and the condition of the unit.

- If the weight changes by more than the weight allowed and shown on the label, then unit should be replaced.
- This weight change allowance assumes the weight change is due to water absorption and indicates the point at which the unit starts to work less efficiently than documented here.

The units gain weight due to moisture adsorption (approximately 1 kg) in normal use, therefore if a unit is weighted, the label copy on the side of the cartridge itself can be used to check if unit have been used after it has been removed from its original packaging.

Deployment (for carbon monoxide)

The number of units required will depend on the volume of the enclosure, the expected initial carbon monoxide concentration and the time available to the occupants before they have to breathe the enclosed atmosphere (assuming they enter CO contaminated enclosure on-self contained breathing equipment with some remaining capacity). These three parameters will determine the required removal rate. However, it is the moisture content of the airflow which determines the available capacity. Unfortunately the initial concentration of CO is unlikely to be known before use, therefore the facility operators will have to estimate the upper expected limit for their operating conditions. Because the time taken to reduce the initial concentration to a safe level is dependant on this initial concentration, the concept of half-life can be used to calculate the required number of units. If the half-life of CO in the enclosure volume is known then the time taken to reduce any initial concentration to any target final concentration can be readily calculated. The half-life is simply the time in minutes it takes for the concentration of CO in the enclosure to half its value.

Table 1 and /or the associated data can be used to determine the half-life ($t_{1/2}$) of CO in the enclosed volume. This can then be used with the data in Table 2 to determine the time it will take for an initial concentration of CO to be reduced to a lower target final concentration. Figure 2 shows the data in Table 2 in a graphic form. The formula used to calculate the values in table 1 and 2 are included.

For Table 1: $te_{1/2} = ((Rv/10) \times t_{1/2}) / n$
Where: $te_{1/2}$ = half life of CO in the enclosed volume; $t_{1/2}$ = half life of one unit in 10 m^3
Rv = room volume in m^3; n = number of units used

Table 1 – use to determine carbon monoxide half life in enclosure

Volume of enclosure	number of units	half life (minutes)	number of units	half life (minutes)	number of units	half life (minutes)	number of units	half life (minutes)	number of units	half life (minutes)	absolute min No (# for H_2O control)
m^3									minimum	recommended	
10	1	6.3	2	3.2	3	2.1	4	1.6	1	6.3	1
20	2	6.3	3	4.2	4	3.2	5	2.5	1	12.7	1
30	3	6.3	4	4.7	5	3.8	6	3.2	2	9.5	1
40	4	6.3	5	5.1	6	4.2	7	3.6	2	12.7	1
50	5	6.3	6	5.3	7	4.5	8	4.0	3	10.6	1
60	6	6.3	7	5.4	8	4.7	9	4.2	4	9.5	2
70	7	6.3	8	5.5	9	4.9	10	4.4	4	11.1	2
80	8	6.3	9	5.6	10	5.1	11	4.6	5	10.1	2
90	9	6.3	10	5.7	11	5.2	12	4.7	5	11.4	2
100	10	6.3	11	5.8	12	5.3	13	4.9	5	12.7	2

For volumes greater than 100 m^3 please consult the manufacturer
due to water from ambient humidity degrading performance

Select the half life from table 1 and use it in formula A to calculate the time taken to reduce the CO level
$te_{1/2} = ((Rv/10) \times t_{1/2})/ n$

$te_{1/2}$ = half life of CO in the enclosed volume
$t_{1/2}$ = half life of one unit in 10 m^3
Rv = room volume in m^3
n = number of units used

Table 2 – time in minutes to reach 30 ppm from different initial concentrations as a function of CO half- life for the enclosure.

time to 30 ppm (EH40 - 8hr TWA)

$t_{1/2}$ (min)	100 ppm time (min)	1,000 ppm time (min)	10,000 ppm time (min)
2.1	4	11	18
3.2	6	16	27
4.2	7	21	35
5.3	9	27	44
6.3	11	32	53
9.5	17	48	80
12.7	22	64	106
14.8	26	75	124
16.9	29	85	142
19	33	96	159
21.1	37	107	177

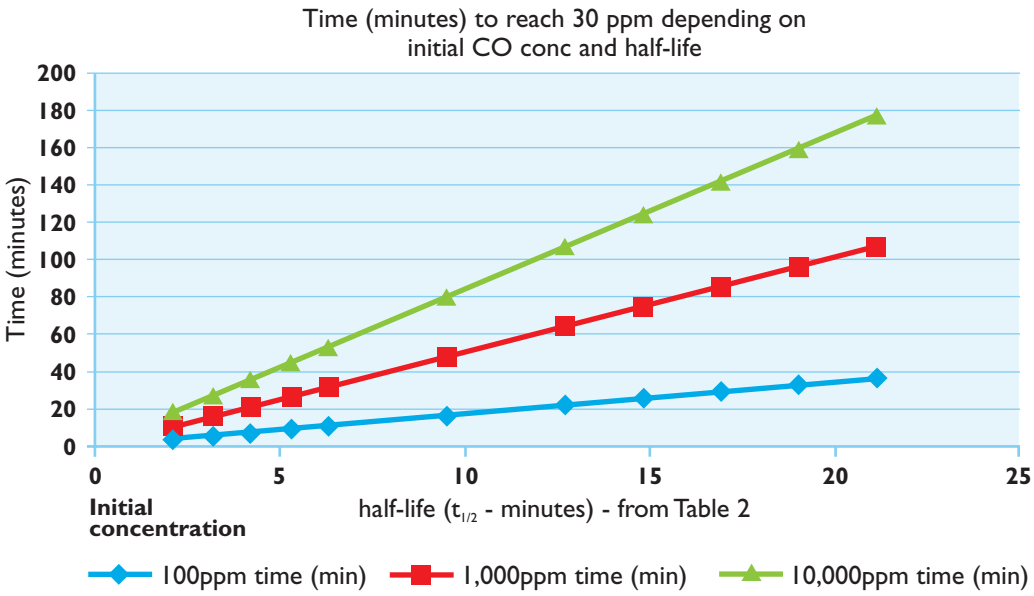
Formula A - used in Table 2:

$t = t_{1/2} \times \log(\text{final conc} / \text{initial conc}) / \log 0.5$

t = time in minutes for concentration to fall from initial to final concentration.
$t_{1/2}$ = half-life (from table 1) for enclosure and number of units deployed (concentration can be in ppm or %)

ref. EH40 – UK HSE Occupational Exposure Limit 8 hour time weighted average.

Figure 2 – data from Table 2 in graphic form.



The data provided above is intended for general guidance and does not necessarily cover all the operational aspects of the units. Each individual case needs to be properly assessed for safe operation by the facility managers.

Technical data sheets and safety data sheets are available for the fill material on request or from the website. Further copies of this manual or advice and help in producing your own operational procedures for the safe deployment of the CO absorber cartridges are available on request from the manufacturer.

Residual risks:

The units produce heat as the reaction to oxidise CO to CO_2 proceeds. At high inlet CO concentrations this can lead to significant heat being produced at the outlet with the outlet air temperature reaching circa. 90°C at approximately 8,000 ppm CO. For this reason the inlet concentration of CO is limited to 1% in normal operation. Consideration of this additional heat load should be incorporated into the design of the system in which it is to be used.

Disposal of used or time expired units

The units are constructed from polypropylene which can be recycled when emptied and cleaned. The fill can be disposed of to land fill via a licensed waste disposal contractor. Local legislation may apply to disposal or recycling. Advice on individual cases can be sought from the manufacturer or your local supplier.

Specification

Operational range	0 to 10,000 ppm (1%) carbon monoxide in air
Unit weight (gross as supplied)	15 kg
Dimensions	400 x 300 x 170 mm
Carbon monoxide capacity	Depends on operating volume and moisture levels (see user manual)
Normal operating gas flow rate	1,000 litre per minute per unit
Operational flow rates	800 to 1,200 litres per minute per unit
Pressure drop per unit – not more than	30 mm H_2O gauge at 1,000 litres / minute flow
Pressure variation between units - not more than	+/- 2 mm H_2O gauge @ 800 l/min
Storage life	5 years (can be monitored by weight change)

Appendix 1 – air recirculation equipment interface requirements

The units are designed to seal against the base plate cut-out of fan driven air supply equipment.

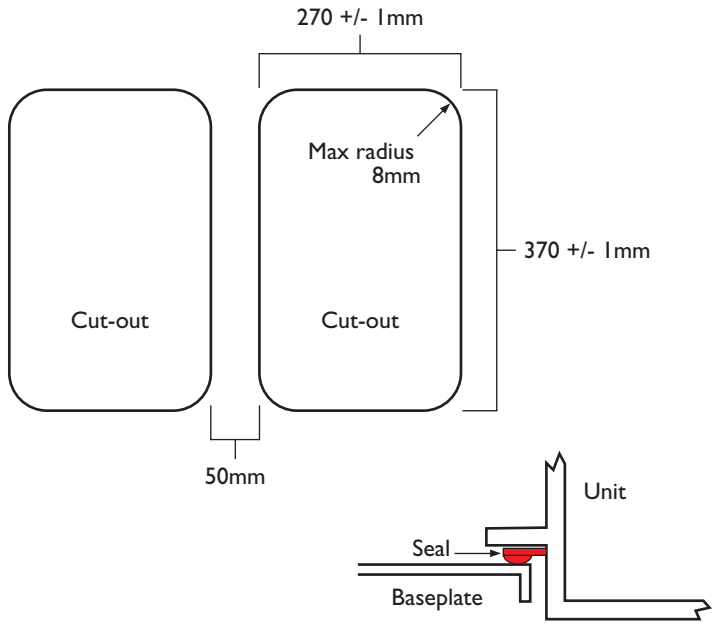
This base plate cut-out design allows the unit's base seal to provide a gas tight seal under the weight of the unit. In order to achieve this, the base plate needs to be flat with a cut out of the correct size to allow the seal to function.

The units weigh circa. 15kg – 33lbs each so the base plate must be sufficiently stiff to support the weight and prevent distortion of the base plate preventing the seal from working. It is recommended that the base plate should be constructed from flat stainless steel sheet that is sufficiently thick, or stiffened, to prevent distortion in use. A turned over edge is preferred to prevent sharp edges damaging the seals or the fingers of the operators. The recommended dimensions are given below.

Base cut-out dimensions:

- Length 370 mm +/- 1 mm
- Width 270 mm +/- 1 mm
- Maximum radius of corners 8 mm (but can be any value less)
- Minimum recommended separation between units – 50 mm between inside edges of cut-outs.

Baseplate details



If the units need to be secured in position the top edge of the base flange can be used to clamp against. Care should be exercised to ensure the base seal is not distorted to the point it fails to seal if the units are fastened or clamped in position. The outside edge of the upper surface can be used to seal against if the units are to be used in a fully ducted system.

The provision of air flow through the unit is the responsibility of the equipment provider but it is advised that the airflow should be blown from base to top up through the units. The units should not encounter reversed gas flow during use as this will reduce the capacity of the units. Please contact the manufacture if advice is required on non-standard operating conditions. Units must remain sealed until ready for use. Opened, unsealed units left on the base for extended periods of time may have significantly reduced performance. Only remove the barrier sealing foil immediately before use. The foil barrier film is a strong material and provision needs to be made to ensure a suitable knife or scissors is always available for removal of the protective barrier foil packaging. The packaging cannot be torn fully open by hand.

Conditions of use and limit of liability – HiCap™ CO - Moleculite filled large absorber cartridge

The units are designed to be used as part of a purpose built air purification system that can operate within the documented design parameters. No liability or guarantee of performance can be accepted for units operated outside these conditions.

The performance is guaranteed only if the units are used and stored within the declared operational limits set by the manufacturer and documented in the user manual.

The units are supplied in a sealed barrier foil bag. The seal must not be broken until the unit is required for use as the unit absorbs water from the atmosphere that will slowly reduce its CO removal performance. The performance of units that have been opened, but not used, for more than a few hours in a moist environment cannot be guaranteed or predicted.

Units with damage to the sealed packaging should not be used. The units are supplied with a weight check and weight tolerance label that allows the user to establish if the units have remained sealed prior to use. The use of units that have failed this weight check requirement or that have damaged packaging cannot be guaranteed by the manufacturer as the performance may be affected.

The way that the units are used is the responsibility of the user and /or facility operator. It is strongly recommended that the facility operator should carry out a risk assessment of the way in which the unit(s) are to be used before they are deployed.

The units comply with the essential safety requirements of the EU Mechanical Directive and are labelled accordingly.

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