



# PCO<sub>2</sub>

## Carbon Dioxide Polishers for the Beverage Industry



domnick hunter

[www.domnickhunter.com](http://www.domnickhunter.com)

## Why choose a domnick hunter PCO<sub>2</sub> system?

The PCO<sub>2</sub> system is designed as a quality incident protection unit acting as a point of use vapour 'polisher' and is proven to be effective at removing a wide range of potential CO<sub>2</sub> impurities.

Recent improvements with on-site analysis equipment has shown that the traditional method of protecting the quality of the CO<sub>2</sub> supply by means of passing the gas through an activated carbon vessel alone cannot achieve the gas quality required.

The domnick hunter five stage purification systems, installed in over 65 countries worldwide utilise multi-layer gas purification technology. This is the industry preferred choice for CO<sub>2</sub> polishing systems, offering quality incident protection against out of specification CO<sub>2</sub> beverage gas.

### Carbon Dioxide

Carbon Dioxide (CO<sub>2</sub>) is available as a colourless, odourless, non-combustible gas, a heavy, volatile colourless liquid or as a solid in the form of dry ice.

In the beverage industry, CO<sub>2</sub> is used to carbonate soft drinks, beers and wine as well as offering some protection against microbiological growth.

CO<sub>2</sub> is typically produced as a by-product from various processes including chemical manufacturing or combustion as well as collection from natural sources.

Common sources of CO<sub>2</sub> include hydrogen and ammonia production, fermentation and collection from geothermal wells.

Prior to its use, the carbon dioxide must be purified before being considered suitable for its intended use as a direct food additive to the beverage.

Potential contamination of a CO<sub>2</sub> supply can occur as the result of natural impurities in the raw gas source not being effectively removed, or from gas contamination during storage and distribution.

To ensure that the beverage it not tainted or does not take on any flavour defects due to CO<sub>2</sub> impurities, Quality Guidelines for beverage grade CO<sub>2</sub> are detailed in the following publications;

- **International Society of Beverage Technologists (ISBT) "CO<sub>2</sub> Quality Guidelines"**
- **Compressed Gas Association (CGA) "G-6.2 Commodity Specification for Carbon Dioxide"**
- **European Industrial Gases Association (EIGA) "Carbon Dioxide Sources, Certification, Quality Standards and Verification"**

It is the responsibility of both the gas supplier and the user to take appropriate steps to ensure the quality of the carbon dioxide. Safety and good manufacturing practices for food additives should be applied throughout the process, from production, delivery, and storage to retail dispense.

Some potential contaminants are selected as indicators of the removal of certain classes of compounds. Others that are specified are of particular concern to the carbonated beverage manufacturers, as they are known to have a negative impact on the flavour and appearance of the beverage.

Voluntary quality standards as listed in the ISBT Quality Guidelines are shown below.

Potential Contaminant	Critical Limit ppm(v/v)	Rationale†
Total Volatile Hydrocarbons (as Methane)	50 ppm v/v max. including 20 ppm v/v max. as total non-methane hydrocarbons	Sensory
Aromatic Hydrocarbon Content	20 ppb v/v max.	Regulatory
Acetaldehyde	0.2 ppm v/v max.	Sensory
Total Sulphur Content* (as S): [*Total sulphur-containing impurities excluding sulfur dioxide]	0.1 ppm v/v max.	Sensory
Sulphur Dioxide	1 ppm v/v max.	Sensory
Moisture	20 ppm v/v max.	Process
Nitric Oxide/Nitrogen Dioxide	2.5 ppm v/v max. (each)	Process

Source: ISBT CO<sub>2</sub> quality & analytical procedure bibliography, 2001.

#### †Rationale definitions:

Sensory: Any attribute that negatively impacts the taste appearance, or odour of beverage.

Process: Any attribute that defines a key parameter in a controlled process and an important consideration in the beverage industry.

Regulatory: Any attribute whose limit is set by governing regulatory agencies.

### Nitrogen & Air

Whilst originally developed for the purification of CO<sub>2</sub> used in the beverage industry, the domnick hunter PCO<sub>2</sub> system is also effective at removing trace levels of hydrocarbon contamination from a nitrogen or air stream.

As part of the gas purification system, the PCO<sub>2</sub> system can be used in a wide range of industries where the quality of the gas is critical i.e. life science research, bio-pharmaceutical, laboratory gases and electronics.

## The Efficient Solution

In response to increased awareness of the impact on beverage characteristics that potential CO<sub>2</sub> impurities can have, domnick hunter has developed a range of PCO<sub>2</sub> carbon dioxide purifiers. Acting as vapour polishers, these are designed to bring 'out of specification' gas back to within beverage quality guidelines.

The PCO<sub>2</sub> systems are designed to offer in-line quality incident protection against peak levels of trace contaminants that may occasionally be present in beverage grade carbon dioxide.

Potential CO<sub>2</sub> impurities may be residual contaminants carried over from the feed source or could be introduced into the bulk liquid CO<sub>2</sub> or gas cylinders from the distribution system. In either case, the domnick hunter PCO<sub>2</sub> system offers added insurance against potential contamination of the beverage, thus avoiding potential costly product spoilage.

Under HACCP principles, the quality of CO<sub>2</sub> used at the point of carbonation is defined as a Critical Control Point (CCP) and the installation of a PCO<sub>2</sub> system at this point will form part of a complete CO<sub>2</sub> quality approach.



A typical bottling plant installation

*This picture shows an MPlus 6000, 2722 kg/h (6000 lb/h) unit. In the background is the traditional carbon vessel that it replaced*

The latest development in point of use CO<sub>2</sub> polishing are disposable filters used to guarantee carbon dioxide quality at fountain dispense outlets. By removing potential CO<sub>2</sub> impurities, the PCO<sub>2</sub> filter will assure the dispensed beverage taste and appearance.



## The benefits are obvious

- Added security of CO<sub>2</sub> quality
- Protection against impurities known to result in beverage flavour defects
- Effective for removing a combination of potential contaminants
- Low pressure drop
- Easy maintenance, disposable cartridge design
- Compact design
- 10 year housing guarantee
- World-wide sales and support
- Manufactured in accordance with ISO 9001:2000
- Materials of construction independently verified to comply with FDA Code of Federal Regulations, Title 21 "Food & Drug"

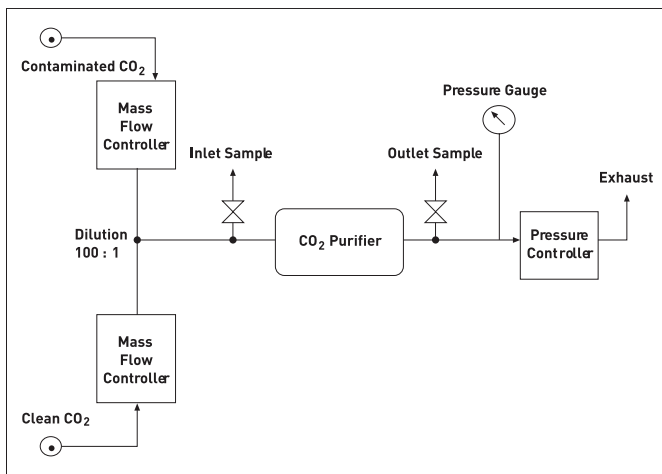


# PCO<sub>2</sub> – High performance purification of carbon dioxide for the beverage industry.

## Performance Verification

Comprehensive performance verification has been carried out using the test rig arrangement shown below. Testing comprised of setting an inlet contamination challenge by means of blending, in a set dilution ratio of specially prepared contaminated CO<sub>2</sub> mixed with a clean supply.

The resultant gas mixture was then flowed through a PCO<sub>2</sub> unit at a set pressure and flowrate with gas samples taken directly upstream and downstream of the unit. The samples were then analysed by an independent analytical laboratory to evaluate the unit's efficiency at removing trace contaminants. Some of the results are shown in the graphs opposite.

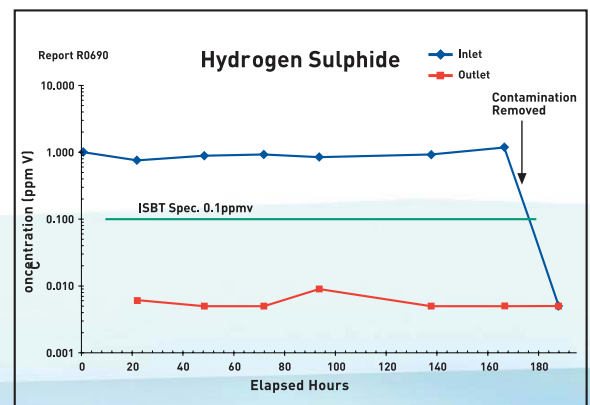
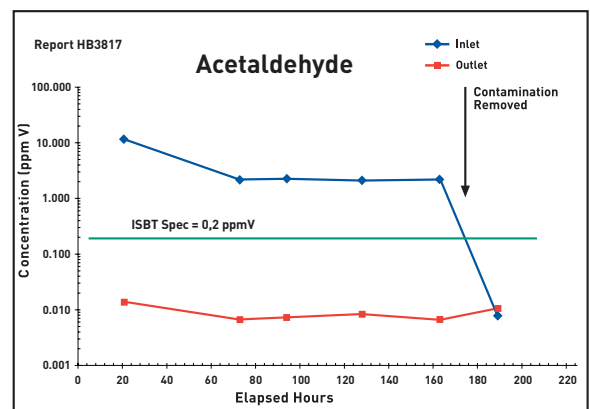
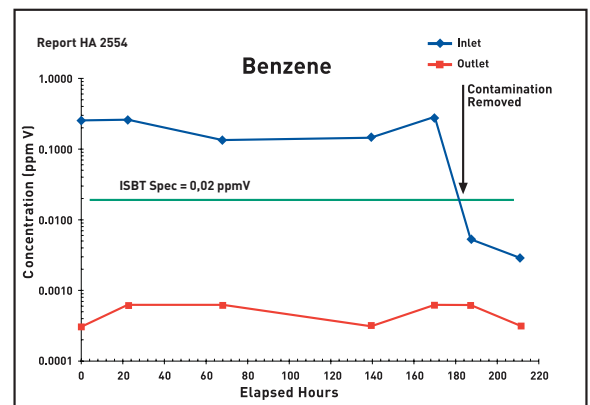


In order to measure contaminants reliably at low concentrations, the following analytical methods were used.

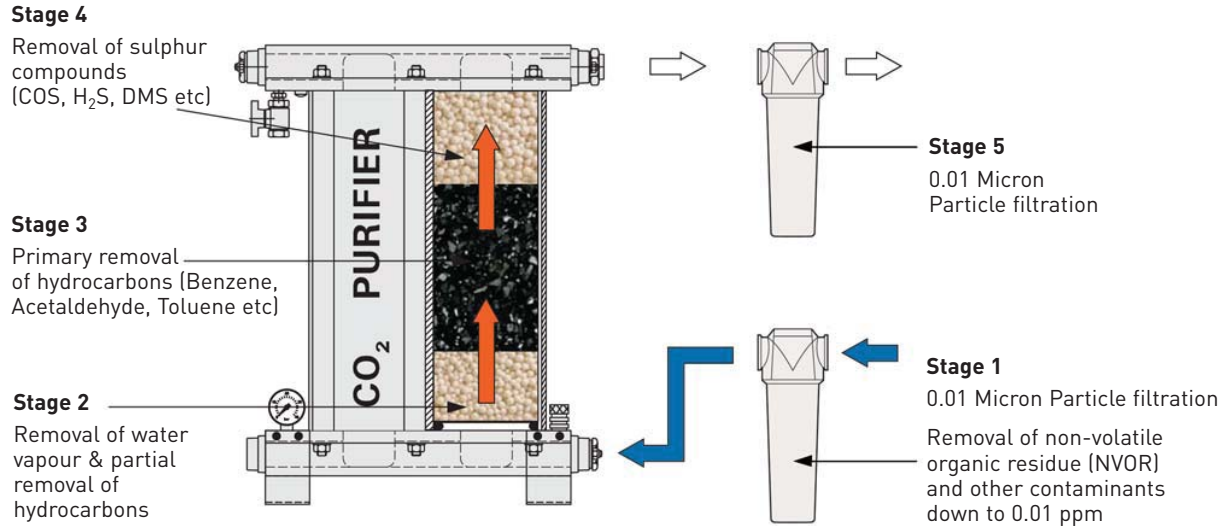
Contaminant	Sample Method	Analysis
Total Aromatic Hydrocarbons (BTEX)	Adsorption, Thermal Desorption (ATD) tubes	Gas chromatography mass spectrometry
Volatile Hydrocarbons	Adsorption, Thermal Desorption (ATD) tubes	Gas chromatography mass spectrometry
Acetaldehyde	Iso-octane / DNPH bubblers	Solvent exchange followed by HPLC
Sulphur compounds	Tedlar bag gas sample followed by solid phase microextraction (SPME).	Gas chromatography mass spectrometry

## Removal efficiencies

Below are some samples of the efficiency graphs for typical contaminants. Other graphs are available on request.



## PCO<sub>2</sub> - Designed for performance



The domnick hunter PCO<sub>2</sub> polishing system offers five stages of CO<sub>2</sub> purification in a compact, modular design to give the highest level of protection to the beverage industry. In addition to inlet and outlet particulate filtration, the plant scale Maxi and MPlus systems incorporate a unique 3-layer adsorption bed, pre-loaded into cartridges for ease of maintenance. The materials used have been carefully selected for their ability to preferentially adsorb potential contaminants, thus ensuring the optimum removal efficiency of the system during its operational life.

This proven five stage technology has also been utilised in the design of smaller point of use polishers used to offer protection against potential CO<sub>2</sub> contamination in retail dispense applications.

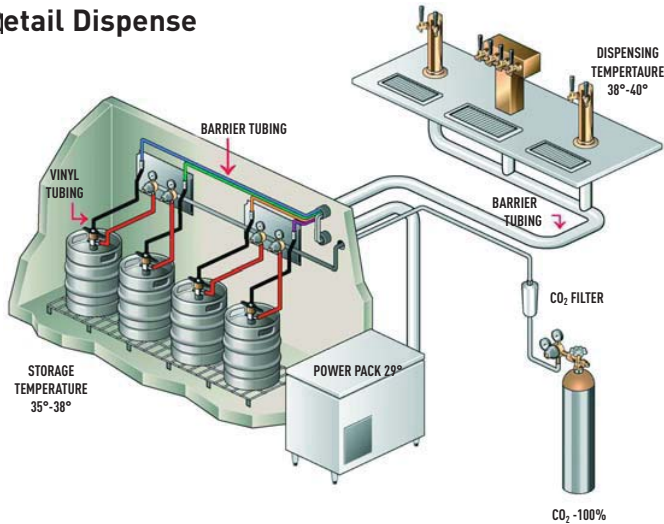
## Preferential adsorption table

4 Good Adsorption    4 Partial Adsorption    g No Adsorption

Example Contaminants	Adsorbent Material		
	2nd Stage Adsorbent	3rd Stage Adsorbent	4th Stage Adsorbent
	Dryfil®	Dryfil®	Dryfil®
Benzene	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
Toluene	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
Xylene	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
Cyclohexane	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
Acetaldehyde	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
2-Butanone	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
Dimethyl Ether	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
Isoamyl Acetate	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
Ethyl Acetate	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
styrene	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
MIBK	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
Ethanol	<span style="border: 1px solid red; padding: 2px;">g</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
Methanol	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
Water	<span style="border: 1px solid green; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>	<span style="border: 1px solid black; padding: 2px;">4</span>
COS	<span style="border: 1px solid red; padding: 2px;">g</span>	<span style="border: 1px solid black; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>
H <sub>2</sub> S	<span style="border: 1px solid red; padding: 2px;">g</span>	<span style="border: 1px solid black; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>
SO <sub>2</sub>	<span style="border: 1px solid red; padding: 2px;">g</span>	<span style="border: 1px solid black; padding: 2px;">4</span>	<span style="border: 1px solid green; padding: 2px;">4</span>

## Installation

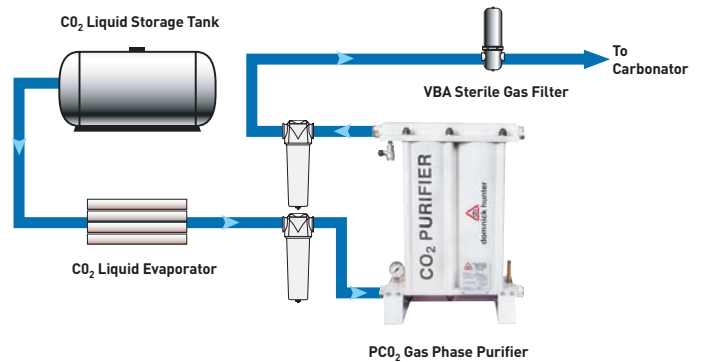
### Retail Dispense



- Suitable for installation in retail outlet cellar applications.
- Easy installation, quick release.
- Fully sealed tamperproof design.
- Integrated absolute rated membrane filtration.
- 12 months service interval.
- Disposable design made from food grade polypropylene.

### Plant Scale

- Single bank flow capacities up to 4,537 kg/h (10,000 lb/h)
- Flow capacities above 4,537 kg/h (10,000 lb/h) achieved by multi-banking
- Pressure rated to 20.7 bar g (300 psi g), optional 24.1 bar g (350 psi g) version available.
- Easy installation, compact design.
- 6 months service interval.
- Easy change disposable cartridges reducing maintenance times.



A Typical PCO<sub>2</sub> Installation



## PREVENTATIVE MAINTENANCE – PERFORMANCE ASSURANCE

The domnick hunter PCO<sub>2</sub> carbon dioxide polishing system has minimal maintenance requirements with just two maintenance procedures required each year.

Removal of trace CO<sub>2</sub> impurities occurs within the multi-layered adsorption cartridges, housed inside the main body of the PCO<sub>2</sub>. During operation the adsorption capacity of these cartridges is used to a point where effective contamination removal no longer takes place. To maintain continued performance these adsorption cartridges must be changed every six months or immediately following a know quality incident.

Pre and post filters are fitted for added protection. These filters contain elements, which must be replaced once every year to provide continued protection against larger contaminants such as particulate and oil.

domnick hunter offer numerous service solutions to compliment your maintenance plan, such as scheduled supply of consumables in line with your service intervals or complete service carried out by our approved engineers.

## Selection Criteria

### Mini PCO<sub>2</sub>

Model	Max. Pressure		Flow Rate	
	bar g	psi g	L/min (ANR)	lb/h
MF-5*	4.1	60	5	1.2

\*This unit should be replaced every 6 months.

### Maxi & MPlus PCO<sub>2</sub>

Stated flow rates are at 20.7 bar g (300 psi g). For flows at other pressures apply the correction factors shown below.

Model	Max. Operating Pressure		Flow Rate @ 20.7 bar g (300 psig)		Replacement Elements		
	bar g	psi g	kg/h	lb/h	Adsorption Element Kit (1)	Pre-Filter Element (2)	After-Filter Element (2)
PCO2/0	20.7	300	150	330	1 x EPCO2	020AA	020AAR
	24.1	350				K145AA-TS	K145AA-TS
PCO2/1	20.7	300	300	661	2 x EPCO2	025AA	025AAR
	24.1	350				K145AA-TS	K145AA-TS
PCO2/2	20.7	300	600	1322	4 x EPCO2	030AA	030AAR
	24.1	350				K145AA-TS	K145AA-TS
PCO2/3	20.7	300	900	1980	6 x EPCO2	030AA	030AAR
	24.1	350				K145AA-TS	K145AA-TS
MPlus 4000	20.7	300	1814	4000	1 x 60 607 0630	040AA	040AAR
	24.1	350				K220AA-TS	K220AA-TS
MPlus 6000	20.7	300	2722	6000	1 x 60 607 0640	045AA	045AAR
	24.1	350				K220AA-TS	K220AA-TS
MPlus 8000	20.7	300	3629	8000	1 x 60 607 0650	050AA	050AAR
	24.1	350				K220AA-TS	K220AA-TS
MPlus 10000	20.7	300	4537	10000	1 x 60 607 0660	055AA	055AAR
	24.1	350				K220AA-TS	K220AA-TS

(1) Replace every 6 months. (2) Replace every 6 months.

### Pressure correction factors

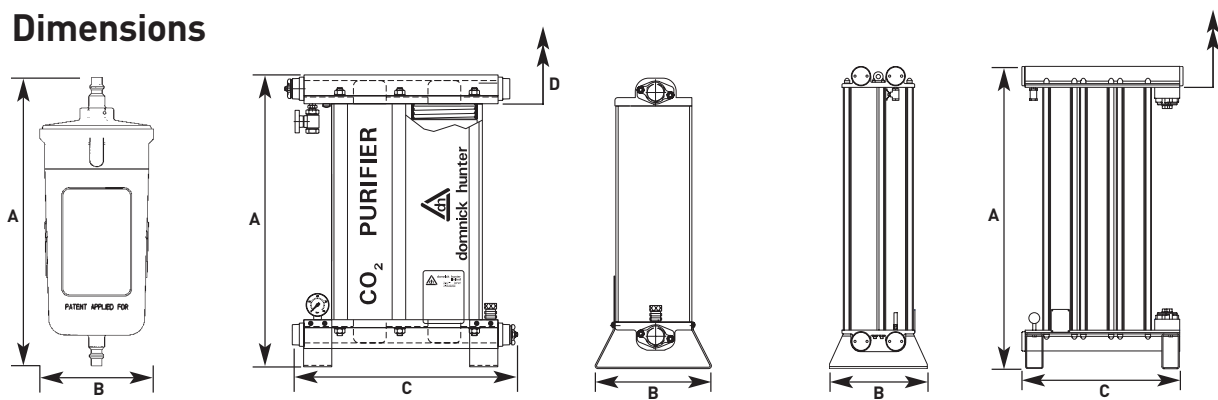
Inlet Pressure	bar g	3	4	5	6	7	8	9	10	11	12	13
	psi g	44	58	73	87	102	116	130	145	160	174	189
Correction factor		0.19	0.23	0.28	0.33	0.38	0.42	0.47	0.52	0.57	0.61	0.66

Inlet Pressure	bar g	14	15	16	17	18	19	20	21	22	23	24
	psi g	203	218	232	247	261	275	290	304	319	333	348
Correction factor		0.71	0.76	0.80	0.85	0.90	0.95	1	1	1	1	1

## Technical Specifications

		MINI	MAXI	MPlus
Maximum operating pressure	bar g	4.1	20.7 (24.1 optional)	20.7 (24.1 optional)
	psi g	60	300 (350 optional)	300 (350 optional)
Maximum operating temperature	°C	40		
	°F	104		
Minimum operating temperature	°C	1.5	-20	-20
	°F	35	-4	-4
Particle removal	micron	1	0.01	0.01

## Dimensions



Mini PCO<sub>2</sub>

Maxi PCO<sub>2</sub>

MPlus PCO<sub>2</sub>

Model	Polisher Connections*	A		B		C		D		Weight	
		mm	ins	mm	ins	mm	ins	mm	ins	Kg's	lbs
Mini MF-5	Hofman SA25 Stem	216	8.5	86	3.4	n/a	n/a	n/a	n/a	0.3	0.7
Maxi PCO2/0	G1	615	24.2	250	9.8	322	12.7	510	20.0	32	70
Maxi PCO2/1	G1	621	24.5	250	9.8	464	18.3	510	20.0	48	106
Maxi PCO2/2	G1	621	24.5	250	9.8	788	31.0	510	20.0	92	203
Maxi PCO2/3	G1	621	24.5	250	9.8	1113	43.8	510	20.0	130	287
MPlus 4000	G2 <sup>†</sup>	1390	54.7	450	17.7	741	29.2	1155	45.5	270	596
MPlus 6000	G2 <sup>†</sup>	1390	54.7	450	17.7	910	35.8	1155	45.5	348	768
MPlus 8000	G2½ <sup>†</sup>	1390	54.7	450	17.7	1079	42.5	1155	45.5	434	955
MPlus 10000	G3 <sup>†</sup>	1390	54.7	450	17.7	1270	50.0	1155	45.5	518	1140

\*Please specify BSP or NPT (excluding the MF-5 model.)

<sup>†</sup>24.1 bar g (350 psig) versions all 2" connections

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**domnick hunter**

Parker Hannifin Ltd  
Dukesway, Team Valley Trading Estate  
Gateshead, Tyne and Wear  
England NE11 0PZ  
Tel: +44 (0)191 402 9000  
Fax: +44 (0)191 482 6296  
www.domnickhunter.com

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