Vacuum pumps

Cryogenic sorption

Features

- 1 x 10^{-3} mbar vacuum level
- Economical roughing source
- No moving parts
- Vibration free operation
- Heat regeneration
- Positive pressure safety vent
- Multiple pump capability
- Clean and non-contaminating operation

Sorption roughing pumps or sorption pumps are used for pumping systems from atmospheric pressure to a pressure of approximately 10^{-2} mbar. They rely on the dispersion forces existing between a gas and a surface to bind gas molecules on chilled surfaces inside the pump. In other words, they pump by cryosorption.

Sorption pumps typically consist of a cylindrical canister or body that is filled with an adsorbent material. The adsorbent is usually a molecular sieve material, or zeolite, which consists of pellets made of a calcium or a sodium alumino-silicate crystalline matrix. The canister is placed in a dewar cooled by liquid nitrogen. Zeolite is a poor heat conductor, so an array of aluminium fins inside the pump is used to improve thermal contact with the sieve material. The pump body and internal cooling fins are specially designed for maximum heat transfer. The pump neck and flange are made of stainless steel. The pump is mounted and supported by the flanges and since stainless steel is a poor thermal conductor-frosting of adjacent components is minimized. Sorption pumps need liquid nitrogen to operate and, as with any capture pump, they have to be periodically regenerated. Sorption pumps are very clean, non-contaminating roughing pumps and are ideal for low-throughput applications. They are used in conjunction with getter pumps, ion pumps, or mechanical cryopumps.

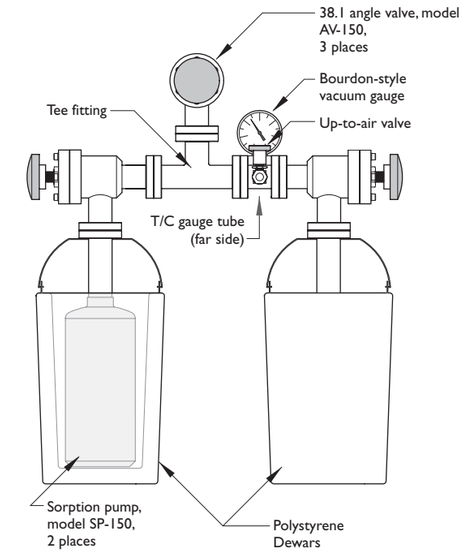
In a sorption pump, molecules are held on the zeolite surface by physical adsorption. The number of molecules that can be held on an adsorbent is dependent on the temperature of both gas and surface, the chemical nature of gas and surface, the microscopic roughness of the surface, and the incident flux of molecules. The key is to have equilibrium conditions such that practical amounts of gas can be captured at the desired pressures. It follows that a large surface area at low temperatures will have the capability of adsorbing large volumes of gas. By providing large surface areas, practical amounts of nitrogen can be pumped. The key elements of a sorption pump include an aluminium body, an array of fins that remove heat from the zeolite, and a pressure relief mechanism. All Caburn-MDC sorption pumps are fitted with an elastomer stopper that automatically releases positive pressure. When a sorption pump is saturated with air and allowed to warm up to room temperature, very high pressures can be generated. The elastomer stopper is a key safety element of Caburn-MDC sorption pumps and operation of this stopper should never be obstructed or disabled.

The adsorbent used is a type 5A synthetic zeolite molecular sieve material. Zeolite is a highly porous material with a surface to volume ratio of about 800 square meters per cubic centimetre. It is supplied in pellets of about 1.6mm in diameter with molecular sized cavities that are linked by 5 Angstrom size pores. These pores are large enough to trap nitrogen, oxygen, and argon molecules, the main constituents of air. Zeolite also has a very high affinity for water vapour. Water vapour accumulated through repeated pump cycles of a chamber filled with ambient air will eventually saturate the sieve material, reducing and eventually eliminating its capacity for adsorbing nitrogen and oxygen. To remove the accumulated water and regenerate the adsorbent material, the pump must then be baked to 250°C or higher. Under normal operating conditions, the sieve material can be recycled indefinitely.

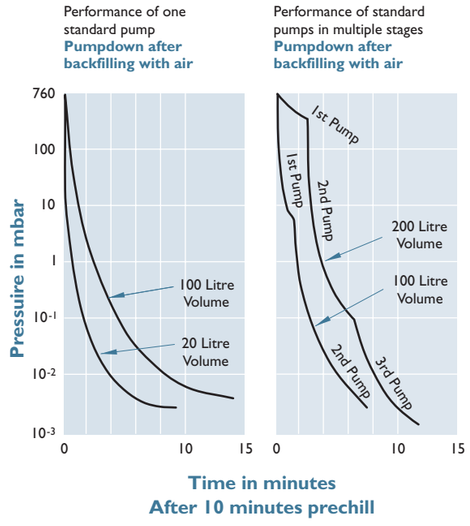
During pump operation, do not run the heater while it's immersed in liquid nitrogen.

Noble gases, such as neon and helium are pumped poorly by sorption pumps. For instance, if neon is pumped together with air, its capacity will be less because the neon will be replaced by the active air gases, starting at pressures below 7.5 mbar. For this reason, sorption pumps are quite often staged. When two pumps are staged, one pump is used to achieve a pressure of 7.5 mbar and is then valved off. The second pump is then opened and the pressure is further reduced. By this method, 99% of the air is removed with the first pump, and noble gases are also swept into this pump and cannot backstream into the system when pressure is further reduced. Staged, or multiple pump-assemblies are fitted with both Bourdon and thermocouple vacuum gauge tubes for monitoring vacuum levels. These manifolds are supplied with three manual UHV angle valves which allow the isolation of each pump and the manifold from the main vacuum system.

Pump operation is simple and fast. To begin pumping, add liquid nitrogen to the dewars. No electrical power is required and there are no moving parts and no vibration. A single sorption pump can evacuate a 100 litre chamber from atmosphere to 10^{-2} mbar in approximately 10 minutes. Each sorption pump has a capacity of 60,000 mbar/litres. Multiple pump systems are commonly used as they are faster and more efficient. Double and triple pump systems are mounted or connected to the chamber via a vacuum manifold. Single pumps, on the other hand, mount directly to a chamber. Pumpdown begins as soon as the adsorbent material in the pump is chilled with liquid nitrogen.



- DN40CF flanges are joined using copper gaskets
- Liquid nitrogen supplied by user



Vacuum pumps

Cryogenic sorption

Features

- Contamination-free roughing
- Requires only LN_2 for operation
- Fail-safe pressure relief valve
- Aluminium construction for high-rate heat transfer
- No moving parts – no vibration

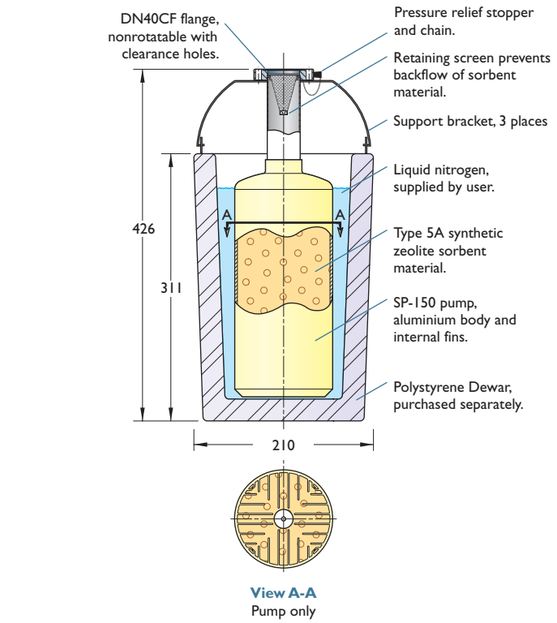
Specifications

Material	
Pump, wall and internal fins	Aluminium
Flanges	304ss
Dewar	High density rigid polystyrene
Fastening	
Bolts, M6	16 Nm
Vacuum range	5×10^{-3} mbar
Temperature range	
Pump	-210ºC to 450ºC
Dewar	-210ºC to ambient
Weight – without LN2	
Single pump with Dewar added	3 kg
Double pump system	13 kg
Dimensions	See drawings

Low vacuum

Sorption pump model SP-150

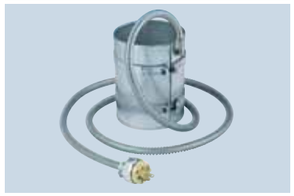
Shown installed in polystyrene Dewar



View A-A
Pump only

Dewar

Bakeout heater



Sorbent material

Stopper

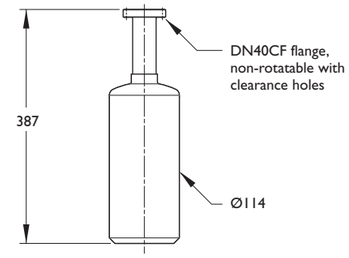
Description	Wt kg	Reference	Part number	£	€	SFr.
Dewar polystyrene	0.5	SPD-150	**500001**	51	71	111
Bakeout heater (240V)	1.8	E-SPH-150	**500007**	218	295	451
Sorbent material	1.4	SPMS-150	**500003**	25	38	58
Stopper	0.06	VSCA-18	**950011**	3	4	6

All dimensions are nominal in millimetres unless specified Weights given are approximate

Roughing components

Section 3.2
Vacuum pumps
Cryogenic sorption

Single pump

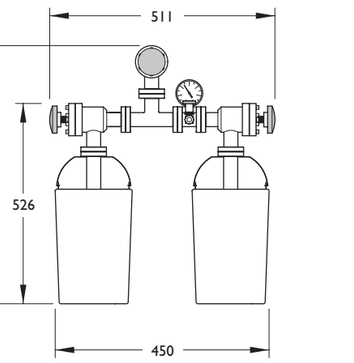


Individual pump includes

- Aluminium body with stainless steel neck
- DN40CF flange
- Includes initial sorbent material charge, copper gasket and hardware
- 3.2 kg shipping weight

Reference	Part number	£	€	SFr.
SP-150	**500000**	431	647	948

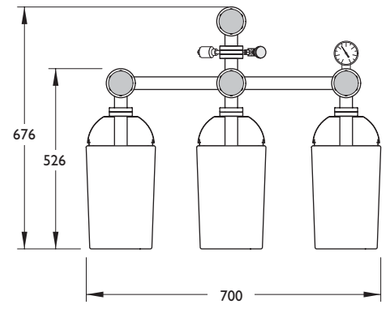
Multiple pump



Dual system includes

- Two each SP-150 pumps with sorbent material
- Two each SPD-150 Dewars
- Three each AV-150 manual right-angle valves
- One each CFT40 tee fitting
- One each gauge nipple assembly, including thermocouple gauge tube, up-to-air valve and Bourdon vacuum gauge
- 12.7 kg shipping weight

Reference	Part number	£	€	SFr.
SPS-2-150	**500004**	3008	4512	6918



Triple system includes

- 3 each SP-150 pumps with sorbent material
- 3 each SPD-150 Dewars
- 4 each AV-150 manual right-angle valves
- 2 each CFT40 Tee fitting
- 1 each gauge nipple assembly, including thermocouple gauge tube, up-to-air valve and Bourdon vacuum gauge
- 16 kg shipping weight

Reference	Part number	£	€	SFr.
SPS-3-150	**500005**	3861	5791	8879

All dimensions are nominal in millimetres unless specified Weights given are approximate

Caburn-MDC Europe Limited Telephone +44 (0)870 428 7646 www.caburn.co.uk