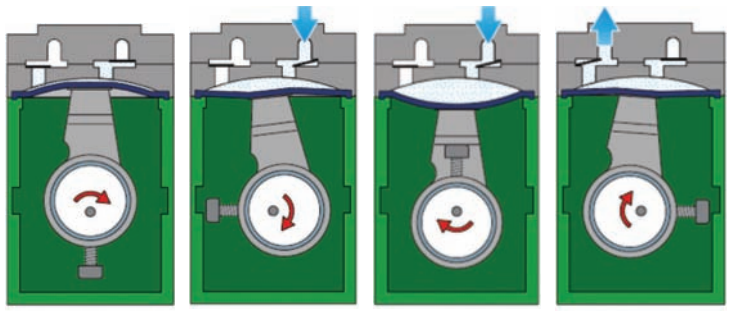
Miniature Pump Solutions for Gas Analysers

When developing a gas analysis device choosing the right sensor and additional measurement components is often the main focus. If reliance upon diffusion of the media over the gas sensor is not sufficient active air sampling is needed and hence the method of media transportation is of more importance. Miniature pumps play a critical role since selecting the optimal pump principle can significantly contribute to the accuracy and function of the entire system. The determination of pneumatic requirements for appropriate pump selection within the measuring system is essential.

Different operating principles can be used for applications in the Gas Analyser market. Depending upon the specific requirements in these markets further criteria like pump size, efficiency, leak tightness and pulsation need to be considered.

Miniature Diaphragm Pumps (motor driven)

Driven by a motor, an eccentric is changing the rotating motion of the motor shaft into a vertical motion of an elastic diaphragm. This movement leads to different volumes in the pump chamber and thereby creates vacuum or pressure. By means of a valve system air is transported from inlet to outlet (from left to right).



2002 series

3013 series

1420 JADE series

Diaphragm pumps are the mainly used miniature pump technology as they are, due to their design, gas-tight and are therefore used whenever the environment or pumped media must not be contaminated. Especially when pumping hazardous or dangerous media, the sealed working principle of diaphragm pumps provide safety of human life and the environment. With the availability of different materials of wetted parts, the pumps can easily be modified to be resistant against various aggressive media. Typical materials of elastomer parts are EPDM, FKM (Viton®) and NBR. Wherever restart at cold temperatures is needed silicon can also be an option. Teflon-coated diaphragms can also be used when higher chemical resistance is needed. Housing parts are usually injection-moulded materials like PPS (Ryton®), PC or PAA. For chemical resistant versions parts can be machined out of PVDF or PTFE (Teflon®) materials.

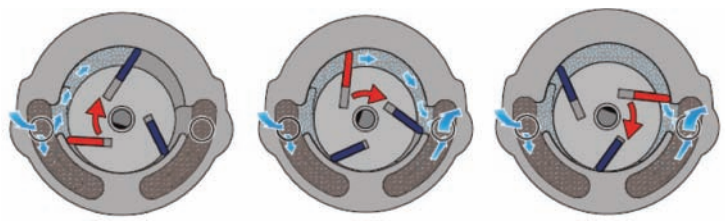
Combinations of diaphragm pump heads for gas and liquids are possible whenever saturated air has to be transported. In such circumstances the accrued condensate can be removed with the liquid head of the pump. A typical example of this configuration can be found in exhaust gas analysers.

Especially in the range of portable and handheld units, miniature diaphragm pumps driven by DC motors provide advantages due to compact size and low weight. Equipped with brushed or brushless motors in different quality levels, customers can select the appropriate version fulfilling their cost and strategic targets of the device. The high efficiency of the diaphragm principle suits portable battery powered applications since often the pump is a major contributor to battery depletion. If the device is designed to be used in an explosive atmosphere special versions to meet the intrinsic safety requirements can be provided.

Typical applications are handheld and portable gas and leak detectors, flue gas analysers, gas samplers and dust monitors.

Miniature Rotary Vane Pumps

An eccentrically placed rotor is driven by a motor shaft into a rotating motion. Due to centrifugal forces the sliding vanes located in rotor slots are pushed outwards against the housing wall and create a variable pump chambers. By changing the enclosed volume, vacuum or pressure is created and thereby air taken in or pushed out (from left to right).



G /01-K series

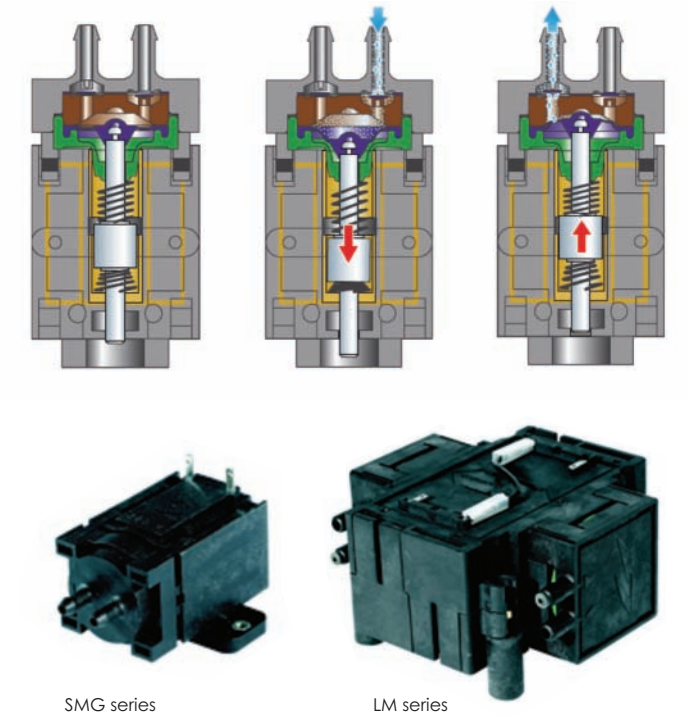
The very compact rotary vane design provides an outstanding "performance to size" ratio. Due to its principle rotary vane pumps transport the gas nearly pulsation-free, which is necessary for example in particle counters . Since these "dry-running" pumps have clearances between their moving parts, internal leakage can not be totally avoided. The achievable differential pressure is therefore usually lower compared to motor driven diaphragm pumps. However it is still sufficient for many applications in the analyser market which require that the pump only needs to overcome the flow resistance of tubing and pneumatic components. External leakage can be reduced by an additional sealing of housing and motor. Wearing parts like rotor and vanes are, according to the application, made out of hardened graphite, graphite resin compounds or plastics like PA, LCP or CF. Despite abrasion of moving parts, the pumps are considered maintenance-free, as the lifetime of these parts easily exceeds the expected motor life.

When designing a device using a rotary vane pump, it is recommended to install the pump after the sensor at the end of the measuring section. This prevents the tiny abrasion particles from rotor and vanes interfering with the measurement or contaminating the sensor. Due to the low pulsation, no damping device is needed, which offers space advantages especially with handheld devices.

Miniature rotary vane pumps often use similar motors as miniature diaphragm pumps, whereas requirements on bearing load are lower due to the operating principle.

Diaphragm pumps with Linear or Vibrating Armature Drive

Basically the same operating principle as a motor driven diaphragm pump however with a different drive mechanism. No eccentric is required since the drive motion is already in linear direction. With almost wearless motion linear or vibrating armature pump drives provide excellent lifetime results when compared to dc motor driven pumps with either brush or bearing limitations.



SMG series LM series

The achievable differential pressures of linear or vibrating armature driven pumps are lower compared to same sized pumps with motor drive since the available torque is lower. They are therefore mainly used in applications where the working point is close to free flow.

These pumps are often used in stationary devices for continuous sampling or monitoring, hence they require extraordinary pump life. Devices supplied with an AC supply can drive the pumps directly. Battery powered device require electronics to generate the appropriate supply for the pump.

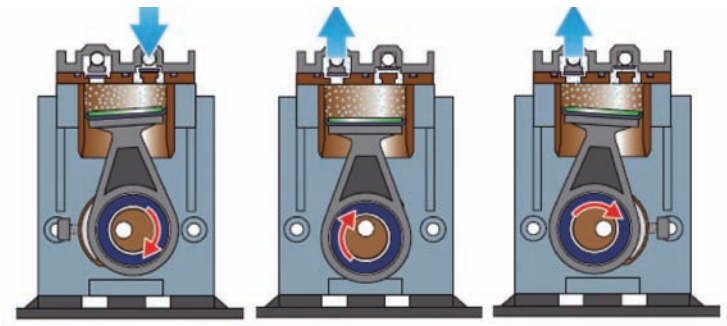
The materials used for the housings and elastomer parts are usually similar to those of motor driven diaphragm pumps.

WOB-L Piston Pumps

Very similar to the operating principle of diaphragm pumps is the principle of WOB-L piston pumps. The main difference is that a piston is moved instead of a diaphragm. Similar to diaphragm pumps, intake and outlet of gas is controlled by a valve system. The maximum vacuum levels available are comparable to those of similar sized diaphragm pumps. Flow rate and maximum pressure levels are slightly higher since the clearance volume in the pump chamber can be optimised without the need for taking the elastic characteristic of a diaphragm into consideration.

8003 series

There are two reasons why WOB-L piston pumps usually are seldom used in the analyser market. The sealing component between cylinder and piston does not provide a total leak-free operation, especially not in a cold environment. Therefore contamination of either the environment or pumped media cannot be prevented. The second point which could effect pump selection in the segment is efficiency. Due to permanent friction between cylinder and piston sealing power consumption is noticeable higher compared to diaphragm pumps. However outside of gas sampling the range of applications for these pumps is very wide, especially in are pressure applications, for example to clean probes.



Conclusion:

Miniature pumps are used in a wide range of applications within the gas analysis market. Diaphragm is by far the most popular pump principle. The variability in motors and materials allows operation also in difficult applications like gas and leak detectors, flue gas analysers, gas samplers or dust monitors. But even if its advantages are outstanding, other principles can definitely be successful with specific advantages in niche market segments. Therefore the advice is to consider all technologies and all application factors with your supplier before choosing a pump. The result is likely to be the "best value" pump for your own successful product.

Selection Table

	Size@Flow	Efficiency	Leak-tightness	Pulsation
Diaphragm (motor driven)	+	++	+	o
Diaphragm (linear)	+	++	+	o
Diaphragm (vibrating armature)	o	++	+	o
Rotary Vane	++	+	o	++
WOB-L Piston	+	+	-	-

++ (Excellent), + (Good), o (Neutral), - (Weak)

AUTHOR DETAILS

Bernhard Hofmann
Product Manager
Gardner Denver
Thomas GmbH
Email:
bernhard.hofmann@gardner-denver.com

READER ENQUIRES

Herbert Hansel
Marketing
Gardner Denver
Thomas GmbH
Tel: +49 89 80900 -1340
Fax: +49 89 80900 - 1309
Email:
herbert.hansel@gardnerden-ver.com
Web: www.gd-thomas.com