mzr®- micro annular gear pumps
Pump technology between »Micro« and »Macro«

Highly precise dosage in the range of microliter and milliliter as well as smallest flow rates are the demands on pumps today in analytical instrumentation, process technology, medicine, biotechnology or industrial production. Offering a high process safety, micro annular gear pumps develop a new dimension of dosage and metering for numerous applications.

High-tech materials and precision mechanics employed in the manufacture of the micro annular gear pumps guarantee their excellent quality and unique features for low dosage volumes and flow ranges in such aspects as accuracy and pressurization, chemical compatibility and long service life.

Product lines
The high performance pump series is well suited for challenging dosage tasks requiring high precision in middle pressure range, high temperatures and for viscosity values ranging from 0.3 to 1,000,000 mPas. The pump is characterized by a double-sided bearing system and is driven by a powerful DC-servomotor with integrated control.

Considering a large choice of complementary modules such as the fluidic seal module, reducing gears, and an explosion-proof motor the pumps target both industrial production and demanding laboratory applications.

Depending on the pump size, standardized connectors 1/4”-28 UNF, 1/8” NPT or 3/8” NPT are offered.

The low pressure pump series targets precise dosage tasks at low pressures and for low viscosity values. The surprisingly small dimensions, low power consumption and simple integration in OEM applications of these pumps have been achieved by using DC mini motors. As to the compact construction, it is based on one-sided patented bearing system. The liquid supply can be connected either with slip fittings or a manifold assembly.

Due to their attractive price-performance relationship, the low pressure pumps are suitable for integration in analytical devices.

The modular pump series is provided with ceramic precision-machined rotors offering optimal
tribological and chemical properties for use with aggressive liquids. As to the remaining components, a choice of different materials is provided to customize the pump depending on the nature of the delivered liquid. The rotors are available in ZrO₂ ceramics or in the proven tungsten carbide. Alloy C276, titanium and PEEK™ are the different options for the pump body. The pump meets with the needs of biotechnology, analytical instrumentation and micro reaction technology.

The hermetic and chemically inert series has been specifically conceived to fulfill the most challenging tasks in chemical processing, mini plant and microreaction technology. The functional elements of this pump series are made of partially stabilized zirconium oxide. This material, universally recognized for a high chemical resistance allows for use with oxidizing and reducing liquids, acids, bases and solvents at the same time showing excellent resistance to wear. SSiC has been used as shaft and bearing material and the body consists of alloy C22. Due to the use of a magnetic NdFeB coupling the pump is perfectly hermetic.

**Applications**

- Chemical processing
- Industrial and plant engineering
- Packaging
- Medical and pharmaceutical industry
- Mini plant technology
- Spray technology
- Dispensing of adhesives
- Ink and paint dosage
- Analytical instrumentation
- Fuel cells
- Biotechnology
- In vitro diagnostics
- Microreaction technology
- Vacuum applications
- Silicone application
- Polyurethane filling
- Separating agents, parting compounds
- Micro hydraulics

To the application scope of mzr-pumps belong mechanical and chemical engineering, material processing, analytical technology, medical, environmental and biotechnology as well as other fields in which small amounts of liquids need to be metered precisely and fast.

**Operating principle of the micro annular gear pump**

Micro annular gear pumps are positive displacement pumps provided with an externally toothed internal rotor and an annular, internally toothed external rotor turning around slightly eccentric axes. Both rotors are interlocked at any time with their cycloidal indenting and form during rotation a system of several sealed pumping chambers.

As the rotors turn around their offset axes, the pumping chambers increase on the induction side and simultaneously decrease on the delivery side of the pump. A homogeneous flow rate is generated between the kidney-like inlet and outlet. Operating without valves, the pumps are characterized by a small clearance volume and are therefore self-priming. The device works at low noise and assures a low shear stress operation.

The pump is directly connected to the motor shaft by means of a torsion-proof, flexible coupling. As to the sealing between the fluid-containing part of the pump and environment and drive, it is assured by a spring-loaded rotary lip seal.

If needed, the operating direction of the flow may be reversed.
Small dimensions
Micro annular gear pumps open, owing to their small measurements, new ways in the field of fluid handling techniques. The compact design of the pump, drive and control and what follows small cubage, short tubing and low weight make them particularly suited for integration into devices. Pumps may therefore be applied in the direct process proximity such as among other in fluid handling robots and analytical instruments.

Precision and accuracy of dosage
The special feature of the micro annular gear pumps are their high precision rotors. They stand for a precise fulfillment of both delivery and dosage tasks as well as work under elevated pressures, which, depending on the rotor size and the displacement volume, may amount up to 80 bar an higher. HNP Mikrosysteme applies highly accurate manufacture of dosage using annular gear pumps are their high precision rotors. They stand for a precise fulfillment of both delivery and dosage tasks as well as work under elevated pressures, which, depending on the rotor size and the displacement volume, may amount up to 80 bar an higher.

Materials and resistance
Depending on the pump series and type, the wetted components of the pumps consist of nickel-based tungsten carbide, ceramics $\text{Al}_2\text{O}_3$, $\text{ZrO}_2$, $\text{SiC}$, high-grade steel 316L, alloy C276, alloy C22, titanium, nickel-silver, PEEK™, graphite-reinforced PTFE, FPM, EPDM and FFPM.

The use of tungsten carbide, material showing an excellent resistance to both corrosion and wear and a high stability in longtime loads, assures high reliability of construction elements that are moved against each other.

The use of the above mentioned materials stands for a good media resistance allowing the delivery of a large variety of lubricating and non-lubricating liquids such as deionized water, water solutions, solvents, methanol, oil, fats, adhesives, dyes and ink as well as high viscosity liquids. In the case of the modular series and the hermetic and chemically inert series also highly aggressive oxidizing and reducing liquids such as acids, bases and solvents may be handled.

Liquids that chemically react in contact with oxygen or water may be delivered by a high performance pump equipped with an optional fluidic seal module. The module enables to manipulate crystallizing liquids and other problematic media. Owing to this additional seal and a low NPSHₘₐₚ value, the pump can deliver liquids showing high steam pressures and is adapted to vacuum applications.

Liquid compatibility

<table>
<thead>
<tr>
<th>Low pressure / high performance series</th>
</tr>
</thead>
<tbody>
<tr>
<td>acetic acid</td>
</tr>
<tr>
<td>acetonitrile (ACN)</td>
</tr>
<tr>
<td>acrylic emulsion</td>
</tr>
<tr>
<td>adhesives</td>
</tr>
<tr>
<td>alcohol</td>
</tr>
<tr>
<td>alkyd resin varnish</td>
</tr>
<tr>
<td>blood</td>
</tr>
<tr>
<td>glycerin</td>
</tr>
<tr>
<td>diesel</td>
</tr>
<tr>
<td>dye</td>
</tr>
<tr>
<td>emulsion</td>
</tr>
<tr>
<td>epoxy resin</td>
</tr>
<tr>
<td>oil</td>
</tr>
<tr>
<td>fats-lacquer</td>
</tr>
<tr>
<td>fruit juice</td>
</tr>
<tr>
<td>gasoline</td>
</tr>
<tr>
<td>glycerin/syrup</td>
</tr>
<tr>
<td>glue</td>
</tr>
<tr>
<td>glue for cigarettes</td>
</tr>
<tr>
<td>heparin, EDTA</td>
</tr>
<tr>
<td>hydrochloric acid dilute</td>
</tr>
<tr>
<td>hydrochloric acid strong</td>
</tr>
<tr>
<td>hydrofluoric acid</td>
</tr>
<tr>
<td>ink</td>
</tr>
<tr>
<td>isocyanate</td>
</tr>
</tbody>
</table>

Legend: +...suitable o...conditionally suitable –...unsuitable
Note: Liquid determines pump configuration

<table>
<thead>
<tr>
<th>Wetted parts</th>
<th>High performance series</th>
<th>Low pressure series</th>
</tr>
</thead>
<tbody>
<tr>
<td>rotors</td>
<td>tungsten carbide Ni-based</td>
<td>tungsten carbide Ni-based</td>
</tr>
<tr>
<td>shaft</td>
<td>tungsten carbide Ni-based</td>
<td>tungsten carbide Ni-based</td>
</tr>
<tr>
<td>bearing</td>
<td>tungsten carbide Ni-based, sapphire</td>
<td>tungsten carbide Ni-based, Al$_2$O$_3$</td>
</tr>
<tr>
<td>case</td>
<td>stainless steel 316L (1.4404, 1.4435)</td>
<td>stainless steel 316L (1.4404, 1.4435)</td>
</tr>
<tr>
<td>static seals</td>
<td>FPM, EPDM, FFPM</td>
<td>FPM, EPDM, FFPM</td>
</tr>
<tr>
<td>shaft seal</td>
<td>PTFE, spring 316L</td>
<td>PTFE, spring 316L</td>
</tr>
</tbody>
</table>

PEEK™ is a registered trademark of Victrex plc.
For the modular as well as for the hermetic and chemically inert pump series the liquid compatibility goes far beyond the values stated in the chart above.

The operating temperature range of the pumps lies between -20° and +60° Celsius. By using supplementary measures, such as the heat-insulation module, the temperature range for the high performance pump series can be extended to up to 150° Celsius.

In the case of the high performance pumps the construction materials are uniform showing the same coefficient of thermal expansion. This enables to expand the liquid temperature range in order to deliver melts or liquid gases.

Service life, Maintenance

Compared to other metal or plastic made metering pumps, micro annular gear pumps have considerably longer service lives. They show only smallest changes in dosage precision over longer operating periods. Hard and wear-resistant materials enable to use the pumps even for liquids containing particles.

Due to the internal tothing, micro annular gear pumps show excellent tribological properties and a limited transmission loss. This is because the relative speed at the touching points of the rotors is reduced by the factor of the teeth number of the outer rotor.

The valve-free mzr-pumps offer good maintainability and a long service life. From the economic point of view this yields to longer maintenance intervals and lower costs for spare parts compared to other pump technologies.

Pulseless delivery

Due to the use the annular gear technology, the mzr-pumps show an outstandingly low pulsation and can therefore be used in applications demanding a high flow rate constancy.

The geometry of the gearing is decisive for the operating parameters of the pump. The number of teeth, the design and the dimensional tolerances considerably influence the achievable dosage precision, differential pressure, cubage and pulsation of the flow. HNP Mikrosysteme has developed its own calculation and simulation models which permit to determine an optimal, application-specific geometry of the gearing.

Dynamic features

Because of their low mechanical inertia micro annular gears have excellent dynamic features. They are suitable for fast dosing tasks within a large flow rate range, as the liquid is sucked in and discharged through large inlet and outlet in a slewing motion of 180°. At the same time the cavitation effects in the induction area are being reduced.

Delivery of suspensions

The delivery of liquids with solid content is possible, however each individual application requires a throughout check. Positive experiences with ink, dye, suspension for polishing or with catalysts as well as liquids containing silicate have been carried out. A feasibility test should be done prior to such applications.

Low shear stress

The geometry and kinematics of the cycloid gears assure low shear stress during the delivery of sensitive liquids like biological cell solutions, blood etc. The observed damage rate of cells is as low as 2 %.

Drive technology

Offering economic dimensions and advanced control technique DC drive technology is the basis for a compact design of the mzr-pumps.

Due to the high function-related requirements exclusively precision motors are used. Depending on the dosage requirements, constant flow rates can be achieved with standard motors for continuous delivery. In the positional control mode the pumps can be applied for precise metering tasks. If special demands are submitted, HNP Mikrosysteme offers cus-
tomer-specific drive solutions such as stepper motors, AC-motors or DC-motors with higher power rates or explosion-proof motors.

The default resolution of the rotation with 16/32/100 increments per turn for the low pressure pump and 1,000 increments for the high pressure pump can be increased by using reduction gears.

By this measure the speed of rotation and consequently the flow rate can be decreased.

The execution of different dosing tasks is controlled by means of the PC-program »Motion Manager«, delivered with the device. It permits to specify the desired dosage amounts or flow rates and the timing via a graphical interface under MS Windows®. By using the ASCII command-language program and a RS-232 interface various parameters, data and programs can be transferred and stored in the EEPROM. A library of sample programs supports the user in fulfilling individual dosing tasks.

**Supplementary modules for high performance series**

A system of different supplementary modules has been conceived to increase the application spectrum of the universal high performance micro annular gear pumps.

For the delivery of liquids sensitive to air or water and for vacuum applications the fluidic seal module, a fluid chamber installed behind the pump shaft, can be provided. The sealing liquid prevents the delivered liquid from contact with the outer environment.

With the use of the heat insulation module hot liquids of up to 150° Celsius may be delivered.

This module made out of a synthetic material PEEK™ includes a thermally isolated coupling assembly between the pump and the motor in order to prevent the overheating of the latter. For applications in medicine and in food processing a hot steam resistant, sterilizable version (SIP) of the pump head is available.

To stabilize the temperature of the pumped liquid, a heating module actively increases the temperature of the pump head.

Different drives and reduction gears can be chosen for the high performance pump with regard to the output, speed and position control. Also an explosion-proof motor according to ATEX is optionally available for this type of pump.

For the dispensing of particle-free adhesives, screw-fixing varnish, lubricating and sealing liquids as well as for other highly viscous liquids a dosage module including a standard supply cartridge with a Luer-Lock fitting is provided. The cartridge is easy to replace and the system can be flushed by means of a three-way cock.

**Patents and Trademarks**


**System design**

As each new metering and dispensing application is submitted to specific conditions, we advise our customer to discuss every new project with one of our application engineers both during the
system design and the initial operation. We are open to extending the spectrum of our products by developing new customized solutions. These may include the adjustment of specific drives and flanges, development of gears or even new pump types.

HNP Mikrosysteme offers complete solutions for customized applications - turn-key dosage systems. You may count on our professional assistance as far as the engineering in micro fluidics and control techniques for the integration of the pumping systems are concerned.

Especially in micro fluidics an overall tuning of all components from the tank to the dosing nozzle is necessary.

**Accessories**

HNP Mikrosysteme provide fluid supply accessories such as fittings, filters, hoses, tubes and valves needed to operate the micro annular gear pumps. Filters are offered in many different sizes and designs. Considering the large range of accessories, a retrofit or an extension of the existing mzp-pumping systems is possible at any time.

**Customer service**

The satisfaction of our customers with the mzp-pumps is our most important concern.

For requests regarding the first operation of the pumps or drive systems, as well as the required accessories you may count on our support at any time.

We put all our efforts to optimize the range and performance of our products. As a young firm, we are eagerly looking forward to your ideas and encouragement.

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