mzr®- micro annular gear pumps

Pump technology between »Micro« and »Macro«

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

High-tech materials and precision mechanics guarantee the excellent quality and characteristic features of the micro annular gear pump (mzr®-pump) in low volume dosage and flow range, like accuracy and pressurization, chemical compatibility and service life.

Product range

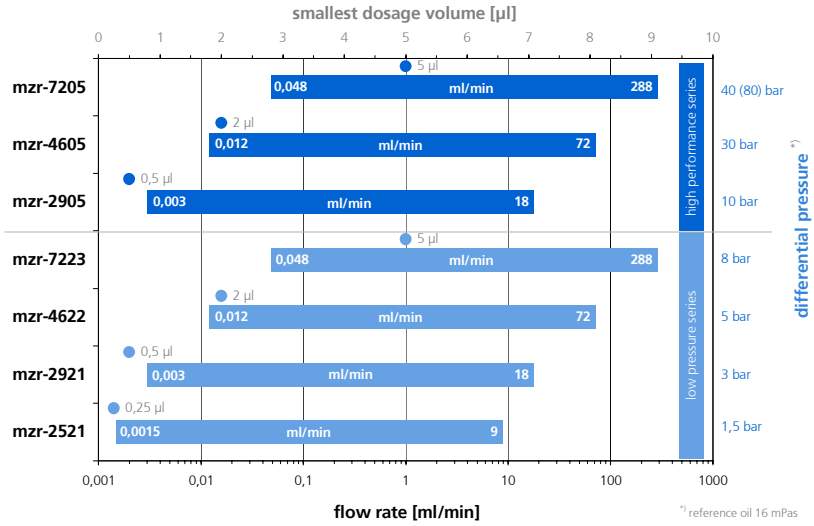
The product range of micro annular gear pumps comprises two different lines of pumps with flow rates of 1 µl/min up to 300 ml/min or discrete dosage volumes starting from 0.25 µl. The two product lines represent different constructions as well as different housing sizes and fluidic data. The precision DC drive assures a dosage precision of better 1 %. The use of extreme hard materials allows the pumping even of non lubricating liquids with constant precision during continuous operation.

Product lines

The *high performance series* of the pumps is well suited for demanding dosage tasks with high precision requirements, middle-pressure range, high temperature and viscosity of 0.5 up to 1,000,000 mPas. The pump has a double-sided bearing system and is equipped with a powerful EC servomotor including an integrated control as unique feature.

With a choice of additional modules, like a fluidic seal module, an additional heating, a thermal insulation module, reducing gears and an explosion-proof motor a pump is provided, which targets production as well as the demanding laboratory application. Depending on pump size standardized connections 1/4"-28 UNF, 1/8" NPT or M10 x 1 are offered.

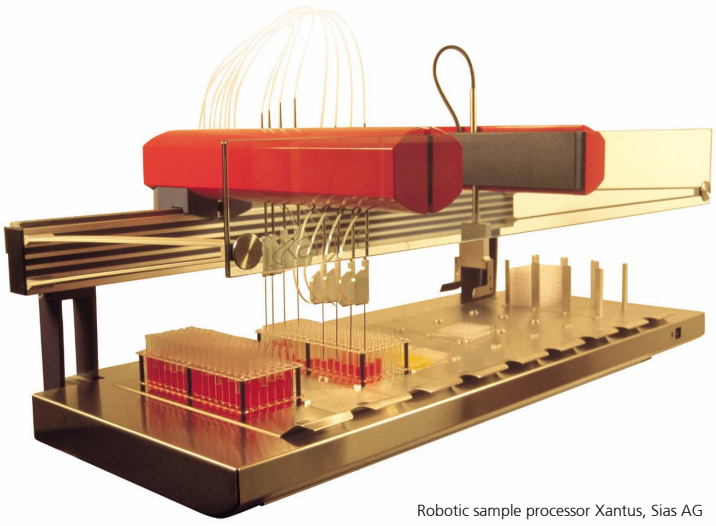
The product line of the *low pressure series* of the pumps is used in precise dosage at low pressure and low viscosity. Using DC-minimotors the pumps have surprising small dimensions, a low power consumption and they permit a simple integration into OEM applications. The compact construction is based on a one-sided bearing system. The fluidic connection can alternatively be realized with slip fittings or by a manifold assembly. With an attractive price performance relationship the low pressure pump is suitable for the use in equipment of analytical instrumentation.



Applications

Range of applications of the pumps are found in mechanical engineering, chemical engineering, materials processing, analytical technology, medical-, bio- and environmental technology, and everywhere you need small amounts of liquids which have to be fast and precisely metered.

- Chemical processing
- Industrial and plant engineering
- Packaging technology
- Medical and pharmaceutical
- Miniplant technology
- Spray technology
- Dispensing of adhesives
- Inks and paints dosage
- Analysis technology
- Fuel cells
- Biotechnology
- Laboratory automation
- Micro reaction technology
- Vacuum applications
- Siliconizing
- Polyurethane filling
- Separating agents, parting compounds
- Micro hydraulics



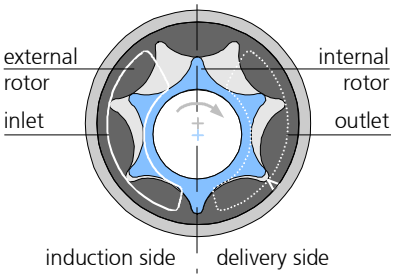
Robotic sample processor Xantus, Sias AG

Principle of the micro annular gear pump

Micro annular gear pumps are positive displacement pumps and are provided with an external toothed internal rotor as well as with an annular toothed external rotor which bear slightly eccentric to each other. Both rotors with their cycloidal indenting are at any time interlocked and form a system of several sealed pumping chambers during rotation.

As the rotors rotate around their offset axis, the pumping chambers increase on the induction side and decrease on the delivery side of the pump at the same time. A homogeneous flow rate is generated between the kidney-like in- and outlet. Further the valve-free pumps have a low clearance volume and therefore work self-priming. The pumps guarantee low shear stress and operate with low noise.

Pump and motor shaft are torsion-proof connected by a flexible coupling. The pumps are not hermetic thus they are equipped with a spring loaded rotary lip seal.



The direction of operation of the pump is reversible when a preferential direction of rotation is paid attention.

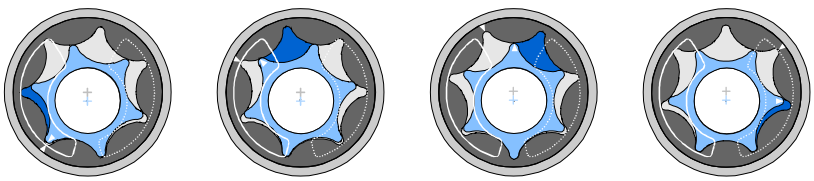
Small dimensions

Micro annular gear pumps open due to their small measurements constructively new ways for fluidic applications. The integration of pump, drive and control allows an installation into equipment with smallest cubage, short tubing length and a low weight. Range of applications result in a direct process proximity, such as in robotics or precision dosage.

Precision and accuracy of dosage

The special feature of the micro annular gear pumps are their highly precise rotors, the guarantee of excellent precision in flow rate and dosage and further in a high working pressure. This is based on the rotor size or the displacement volume and amounts up to 80 bar.

To assure the tolerances of the pumps HNP Mikrosysteme applies highly precise manufacturing methods. Positional and shape tolerance of the main components of the pumps are found within the range of 2 µm. The machining used is either grinding or electro-



discharge machining which is used to manufacture the rotor set. The functional part material, tungsten carbide or ceramics, enables these tolerances and assures excellent capacity of resistance to wear and high solidity of the flow efficiency.

The *dosage* shows a *precision* better 1 % CV (Coefficient of Variation) at constant working conditions in the given flow range or for the given metering volumes with watery solutions (viscosity 1 mPas) . Better precision or higher operating pressure is achievable at higher viscosity while these values are being reduced at a lower viscosity.

Materials and resistance

The components of the pumps which are in contact with the liquid consist of nickel based tungsten carbide, ceramics, high-grade steel 316L, nickel-silver, graphite reinforced Teflon®, Viton®, EPDM, Aflas® or FFPM depending on production series and type.

By manufacturing the pumps out of these materials a large *media resistance* is achieved allowing to deliver a variety of lubricating as well as non-lubricating liquids such as deionized water, watery solutions, solvents, methanol, oil, fat, adhesives, dye and ink as well as high viscous liquids.

Liquid which chemically reacts under oxygen or water contact can be delivered by the high performance pump with an additional fluidic seal module. Using this module furthermore crystallizing and other problematic liquids can be pumped. Through this supplementary seal and the low $NPSH_R$ value the pump is able to deliver liquids with a high steam pressure and supports the use for vacuum applications.

Liquid compatibility

acetone	+	mercury	+
acetonitrile (ACN)	+	methanol	+
acrylic enamel	–	mineral acids	–
adhesives	+	nitrocellulose lacquer	–
alcohol	+	oil	+
alkyd resin varnish	+	organic acid	o
blood	+	paraffin	+
cyanoacrylate	–	pentosin	+
diesel	+	polishing slurry	+
dye	+	polyhydroxy alcohol	+
emulsion	+	polyurethane varnish	+
epoxy resin	+	radioactive iodid solution	+
fat	+	salt solution, 0.9 %	+
foto-lacquer	+	screw locking coating	+
fruit juice	+	silicone gel	+
gasoline	+	silicone oil	+
glucose-syrup	+	soap solution	+
glue	+	solvents	+
glue for cigarettes	–	stearin	+
heparin, EDTA	+	sugar solution	+
hydrochloric acid dilute	o	tetrahydrofurane (THF)	+
hydrochloric acid strong	–	titanium oxide susp.	+
hydrosilicon	o	UV-adhesives	+
ink	+	water deionized	+
isocyanate	+	watery solution	+

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

The use of tungsten carbide as material with excellent *wear resistance* quality and a high stability for longtime loads guarantees the performance of all parts of the pump which are function defining and moved against each other.

The *operating temperature range* of the pumps lies between -20 and +60° Celsius. By supplementary measures the temperature range for the high performance pump can be enlarged up to 150° Celsius, such as by use of the heat isolation module. Due to the uniform material a further expansion of the liquid temperature range is possible for delivering melts.

Service life, Ease of maintenance

Micro annular gear pumps have considerably higher service lives compared to metering pumps which are metallic or produced out of plastic. They show only smallest changes in their dosage precision over a longer operating time. The hard and wear resistant materials enable the use of the pumps even for liquids containing particles.

Due to the internal toothing micro annular gear pumps have favorable wear qualities with the reduced transmission, where the relative speed at the touching points of rotors is limited since it is reduced in the touching points of the rotors by the factor of the tooth number of the outer rotor.

With its *high service life* the valve free micro annular gear pumps offer good *maintainability*. Economically this yields to longer maintenance intervals and lower costs for spare parts compared to other pump technologies.

Pulseless delivery

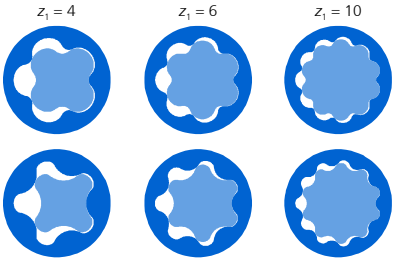
Micro annular gear pumps have an especially *low flow pulsation* due to the technology of the gear

Wetted parts

	high performance series	low pressure series
rotors	tungsten cabide Ni-based	tungsten cabide Ni-based
shaft	tungsten cabide Ni-based	tungsten cabide Ni-based
bearing	tungsten cabide Ni-based, sapphire	tungsten cabide Ni-based, Al_2O_3
case	stainless steel 316L (1.4404, 1.4435)	nickel-silver, 316L (1.4404), epoxy resin
static seals	Viton®, EPDM, Aflas®, FFPM	Viton®, EPDM, FFPM
shaft seal	Teflon®, spring 316L	Teflon®, spring 316L

tooth forming and can therefor be used for applications which demand a high flow rate constancy.

The gearing of micro annular gear pumps was optimized with regards to smooth running, low pulsation and high dosage precision since the geometric parameters of the gearing define the pump's characteristics like flow, dissipation power and others. By tooth number and design of the cycloid gearing as well as the production tolerance achievable dosage precision and difference pressure, the cubage and the pulsation of the flow are influenced. HNP Mikrosysteme has developed *calculation* and *simulation models* as tools of its own where an optimal application specific gearing geometry can be calculated.



Dynamic features

Micro annular gears have excellent dynamic features based on *low mechanical inertia*. They further fit as sprinter with a large pumping range, as the pumping medium is inducted and discharged, according to its large intake and outlet respectively to the slewing motion over 180°. The cavitation effects in the induction range are reduced at the same time.

Delivery of suspensions

The delivery of liquids with solid content is possible. It requires, however, a thorough check. There are positive experiences with ink, dye, suspension for polishing or of catalysts as well as liquids containing silicate. A feasibility test should be carried out in such applications.

Low shear stress

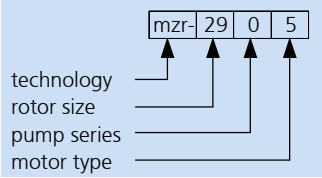
The geometry and kinematics of the cycloidic gears stand for low shear stress at the delivery of shear sensitive liquids like biological cell solutions, blood etc. Damage rates of cells as small as 2 % have been experienced.

Driving technology

The DC driving technology forms the starting point for the compact micro annular gear pump construction with its economic space as well as its excellent control technique quality.

Due to the highly construction and function-related requirements exclusively precision motors are used. Depending on dosage requirements constant flow rates can be achieved with standard actuators for *continuous delivery*. In the positional control mode the pumps can be applied for *precise metering* tasks. If special requirements are submitted, HNP Mikrosysteme offers specific customer oriented actuator 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 at the low pressure pump and 1,000 increments at the high performance pump can be increased by use of reduction gears. The achievable speed of rotation as well as the resulting flow rate can be decreased by this measure.

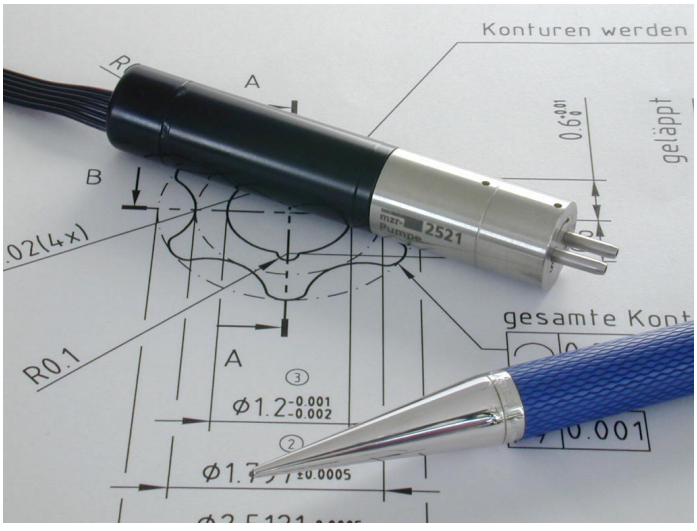


Nomenclature pumps

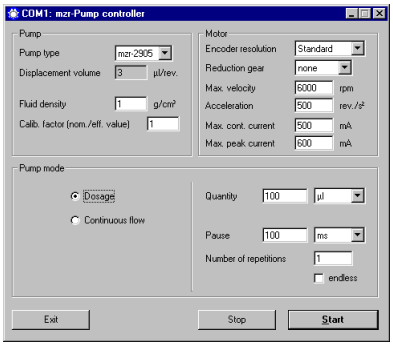
Control

The product program comprises a supplementary kit of control modules, carefully arranged in addition to the drive technology. Various OEM circuit board solutions are offered optionally for the high performance pump series as well as for the low pressure series. *Console drive modules* are available for both pump types.

The control permits operation of the micro annular gear pump either supported by the built-in potentiometer or an external analog interface (0–10 V). The execution of *PC* and *process computer-controlled* dispensing tasks is carried out via a RS-232 interface. With multiplexer circuit boards the *simultaneous operation* of up to 255 pumps is possible using one single RS-232 interface.



Two software programs support the user in operation of the pumps. The user-friendly control program »mzr pump control« can be applied for laboratory and test operation of the pump. The programming or the operation of the pump is offered through the program modes »continuous dosage« and »discrete dosage«. The program also includes the simple adjusting of motor parameters like velocity profile, maximum speed and motor current.



The implementation of different dosing tasks is enabled according to the PC-program »Motion Manager«, delivered with the product, and permits to specify dosage amount and flow rate, as well as time intervals via the graphical interface under MS Windows®. Using the ASCII command language program and a RS-232 interface parameters, data and programs can be transferred and stored in the EEPROM. A library of *sample programs* supports the user in fulfilling his dosing tasks.

Patents and Trademarks

Micro annular gear pumps (and housings) are protected by assigned patents: EP 852 674 B1, US 6,179,596, US 6,520,757 B1, DE 198 43 161. In the US, Europe and Japan are additional patents pending. mzr® is a registered German trademark of HNP Mikrosysteme GmbH.

Supplementary modules for high performance series

To expand the application fields of the universal micro annular gear pump, for the high performance series a modular system was created which increases the scope of application ranges of the pump with the help of supplementary modules.

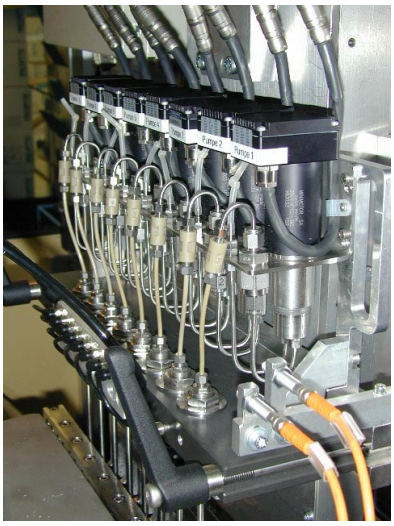
For the delivery of air- and water-sensitive liquids as well as for vacuum applications a *fluidic seal module* is provided, where a fluid chamber behind the pump shaft seal is installed. The seal liquid prevents the pumped liquid from contact with the outside.

Hot liquids can be delivered up to 150° Celsius with the *heat insulation module*. The module which is made out of synthetic material includes a thermally isolated coupling assembly between pump and motor to prevent the motor's overheating. For applications in medicine and food processing a hot steam resistant, sterilizable version (SIP) of the pump head is deliverable.

An active heating of the pump head is provided by the *heating module* to stabilize the temperature of the liquid pumped.

Different drives with regard to performance and control (speed or position control) as well as *reduction gears* can be chosen for the high performance pump. Optionally an explosion-proof motor according to ATEX is available for this pump type.

For dispensing of particle free adhesives, screw fixing varnish, lubricating and sealing liquids as well as for other highly viscous liquids a *dispensing module* is provided which includes a standard supply cartridge with a Luer-Lok fitting. The cartridge can be easily replaced and by means of three-way cock the system can be flushed.



System design

As each metering application has new specifications involved at the same time, we advise to discuss the matter with one of our application engineers during system design and before initial operation of the micro annular gear pump. We are open to widen the scope of our products by new developments in customized solutions. This can include the adaption of specific drives and flanges, development of gears or even new pump types.

For customized applications HNP Mikrosysteme offers complete solutions e.g. turn-key dosage systems. HNP Mikrosysteme offers engineering in microfluidics as well as in control technique to integrate and program the pumps. Especially in microfluidics an overall tuning of all components starting from a tank to the dosing nozzle is necessary.

Accessories

For the fluidic connections HNP Mikrosysteme provides *fittings, hoses, tubes* and *valves*, needed to operate the micro annular gear pumps. Filters are offered in many different sizes and designs. Respectively to the large range of accessories retrofit or extension of the existing mzr-pumping systems is possible at any time.

Customer service

The satisfaction of our customers according to the successful operating of our mzr-pumps is our most important concern.

For requests regarding the initial operating of the pumps or actuator systems, as well as for the choice of the accessories required you may of course expect our service by telephone at any time.

We work intensely to offer an optimum product range and steadily improving and more efficient products to our customers. As young enterprise we look forward to your suggestions and encouragement.

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