HNP Mikrosysteme GmbH

Operating manual for micro annular gear pumps
mzr-2905 / mzr-4605 / mzr-7205

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18 Declaration of media in contact with the micro annular gear pump and its components 66

1 General information

This operating manual contains basic instructions to be followed during integration, operation and maintenance of a mzr® micro annular gear pump. For this reason it is necessary to read it carefully before any handling of the device. The present manual should always be kept at the operation site of the micro annular gear pump.

In case assistance is needed, please indicate the pump type visible on the housing.

1.1 Application scope of the pumps

The micro annular gear pumps described in this manual are suitable for continuous delivery and discrete dosage of water, watery solutions, solvents, methanol, oils, lubricating liquids, paints and varnishes as well as many other liquids.

If you intend to treat any aggressive, poisonous, or radioactive liquids, you must conform to safety measures as according to the regulations in force. Any project concerning handling of corrosive liquids should be previously discussed with the pump manufacturer.

The micro annular gear pumps *must not* be used for invasive medical applications, in which the liquid having had contact with the pump is re-introduced to the body.

The micro annular gear pumps *must not* be used in aircrafts and spacecrafts or other vehicles without prior consent of the manufacturer.

Data concerning resistance of the pumps to the manipulated liquids have been elaborated according to the best of HNPM's knowledge. However, operating parameters varying from one application case to another, no warranty for this information can be given.

Information given in this manual does not release the customer from the personal obligation to check the integrity, correct choice and suitability of the pump for the intended use. The use of the micro annular gear pumps should be conform with technical norms and regulations in force.

If you wish to receive more information than comprised in this operating manual please contact directly HNP Mikrosysteme.

1.2 Product information

The present operating manual is valid for the micro annular gear pump types mzr-2905, mzr-4605, mzr-7205 manufactured after 2001 by
HNP Mikrosysteme GmbH, Juri-Gagarin-Ring 4, 19370 Parchim, Germany.

The date of release of the present manual figures on the cover.

1.3 Technical data of the micro annular gear pumps

		mzr-2905	mzr-4605	mzr-7205
Technical data				
Displacement volume [µl]		3	12	48
Measurements [mm]	L x B x H	140 x 45 x 65	143 x 45 x 65	155 x 50 x 69
Weight [g]		780	800	1080
Internal volume [µl]		85	109	525
Rotor material	tungsten carbide (WC-Ni)	●	●	●
Pump case material	stainless steel	1.4404	1.4404	1.4404, 1.4435
Bearing material	tungsten carbide (WC-Ni)	●	●	●
Dynamic sealing	graphite-reinforced PTFE	●	●	●
Static sealing	FKM (Viton®)	●	●	●
	EPDM	⊙	⊙	⊙
	FFKM	⊙	⊙	⊙
Threaded fluid supply connections	1/4"-28 UNF	●	●	–
	1/8" NPT (lateral)	–	–	●
	1/8" NPT (front)	–	–	⊙
Internal diameter of the tube		1/16''	1/16''	4 mm
External diameter of the tube		1/8''	1/8''	6 mm
Coupling	bellow coupling	●	●	●
Performance parameters				
Flow rate Q [ml/min]	min.	0.003	0.012	0.048
[ml/min]	max.	18	72	288
[l/h]	max.	1.08	4.3	17.28
Min. dosage volume [µl]		0.5	2	30
Differential pressure [bar]	viscosity 1 mPas	5	10	40 (80 *)
	viscosity 16 mPas	30	50	40 (80 *)
Max. inlet pressure [bar]		5 (10 - 40 *)	5 (10 - 40 *)	5 (10 - 40 *)
Viscosity η [mPas]	min.	0.3	0.3	0.3
	max.	50,000	50,000	50,000
	accessories			1,000,000 *
Dosage precision CV [%]		<1	<1	<1
Pulsation [%]		6	6	6
$NPSH_R$-value [m]	min.	0.9 (0.4 *)	5.7 (0.5 *)	0.5
Operating temperature [°C]	min.	-5	-5	-5
	max.	60 (150 *)	60 (150 *)	60 (150 *)
Storage temperature [°C]	min.	-5	-5	-5
	max.	60	60	60

Legend:
- ● available
- ⊙ optional / on demand
- – not available
- * with supplementary modules

CV Coefficient of variation
$NPSH_R$ Net Positive Suction Head Required

table 1 Technical data and performance parameters of the micro annular gear pumps mzr-2905, mzr-4605, and mzr-7205

1.4 Measurements and flow charts of the mzr-2905 pump

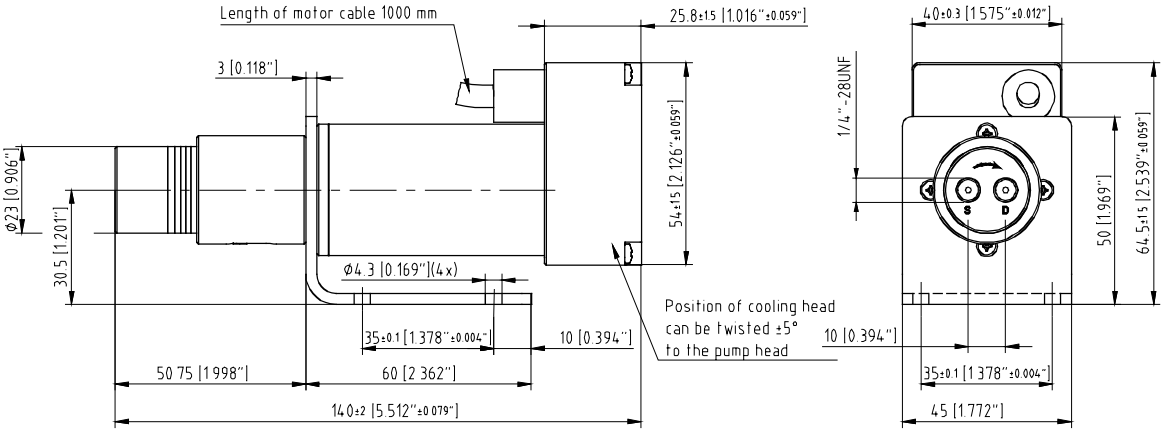


figure 1 Measurements of the micro annular gear pump mzr-2905

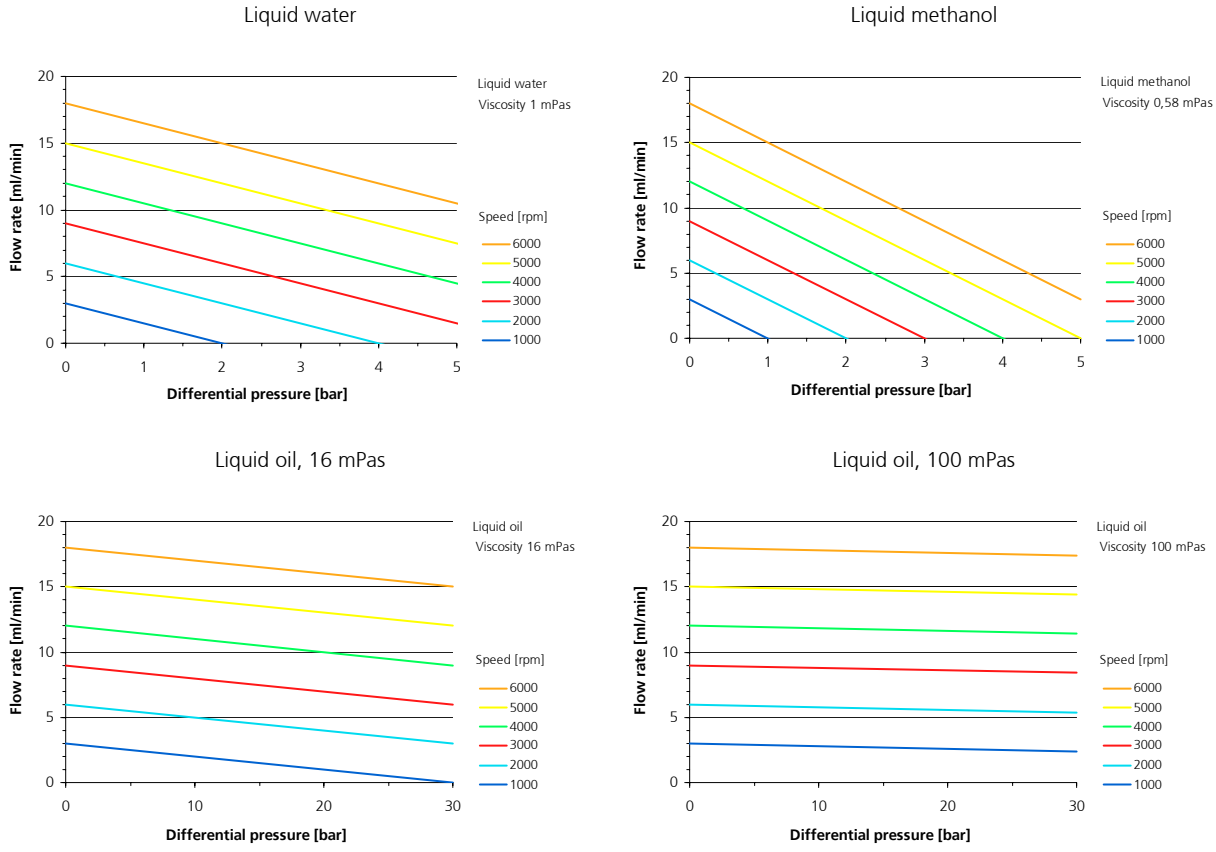


figure 2 Flow charts of the micro annular gear pump mzr-2905

1.5 Measurements and flow charts of the mzr-4605 pump

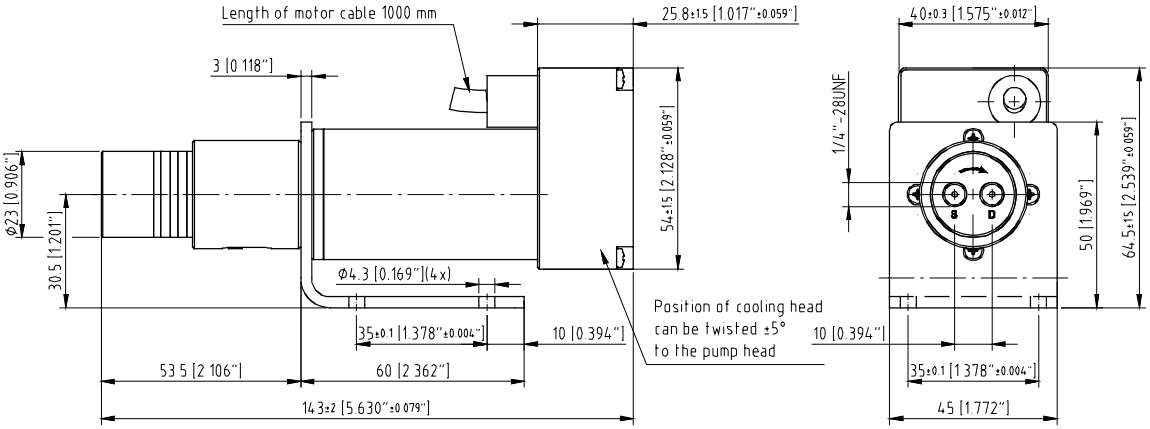


figure 3 Measurements of the micro annular gear pump mzr-4605

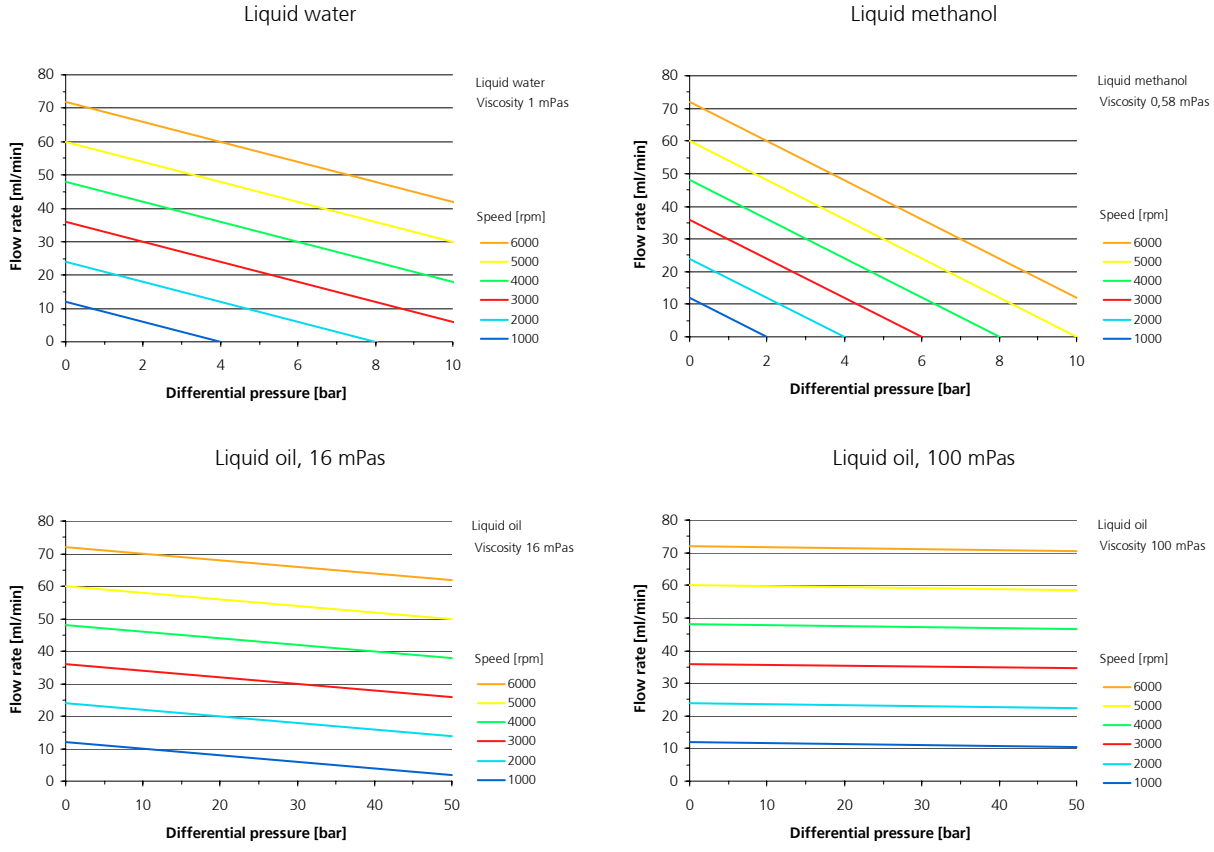


figure 4 Flow charts of the micro annular gear pump mzr-4605

1.6 Measurements and flow charts of the mzr-7205 pump

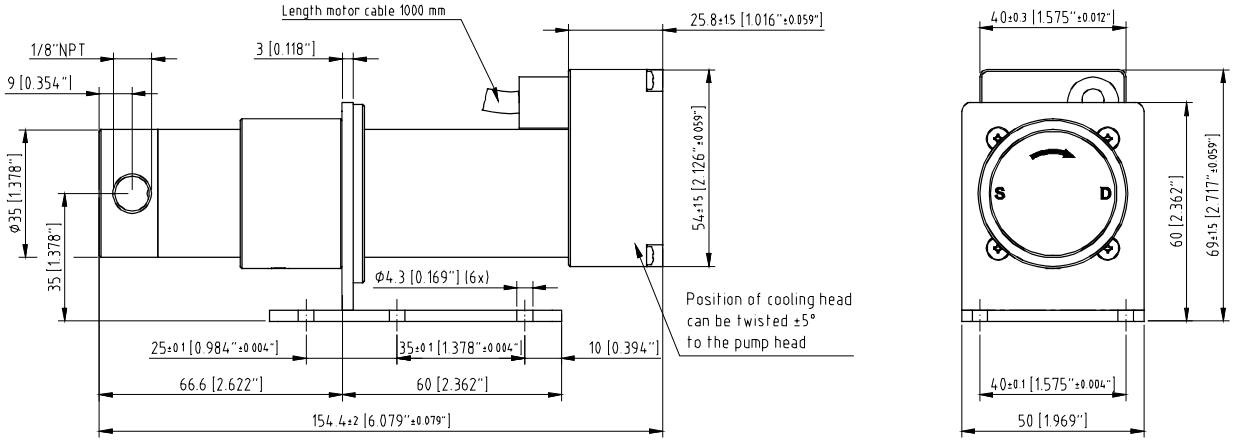


figure 5 Measurements of the micro annular gear pump mzr-7205 with lateral fluid connection 1/8" NPT

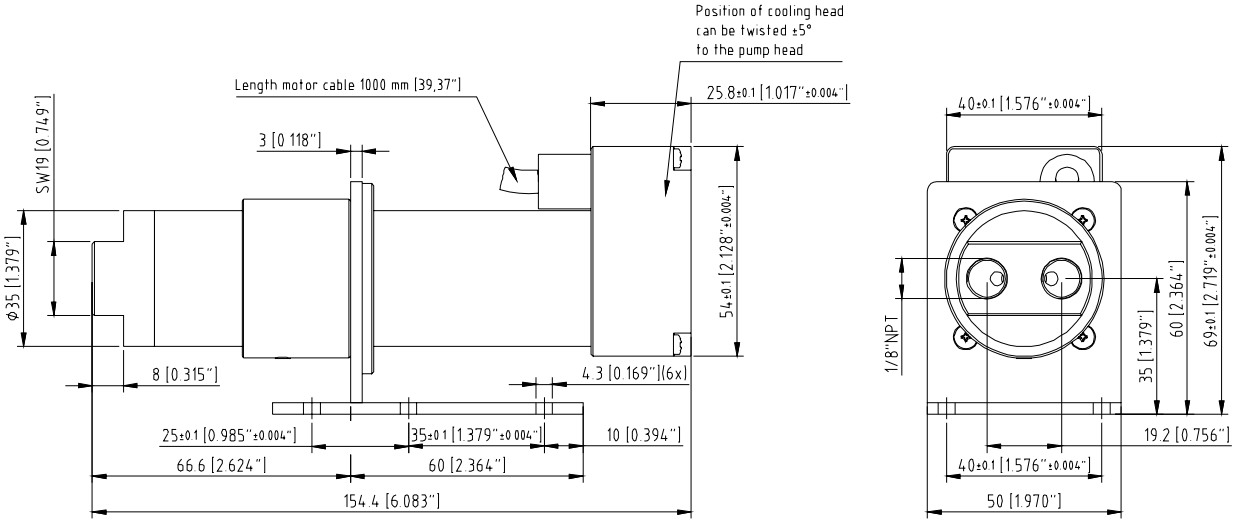


figure 6 Measurements of the micro annular gear pump mzr-7205 with front fluid connection 1/8" NPT

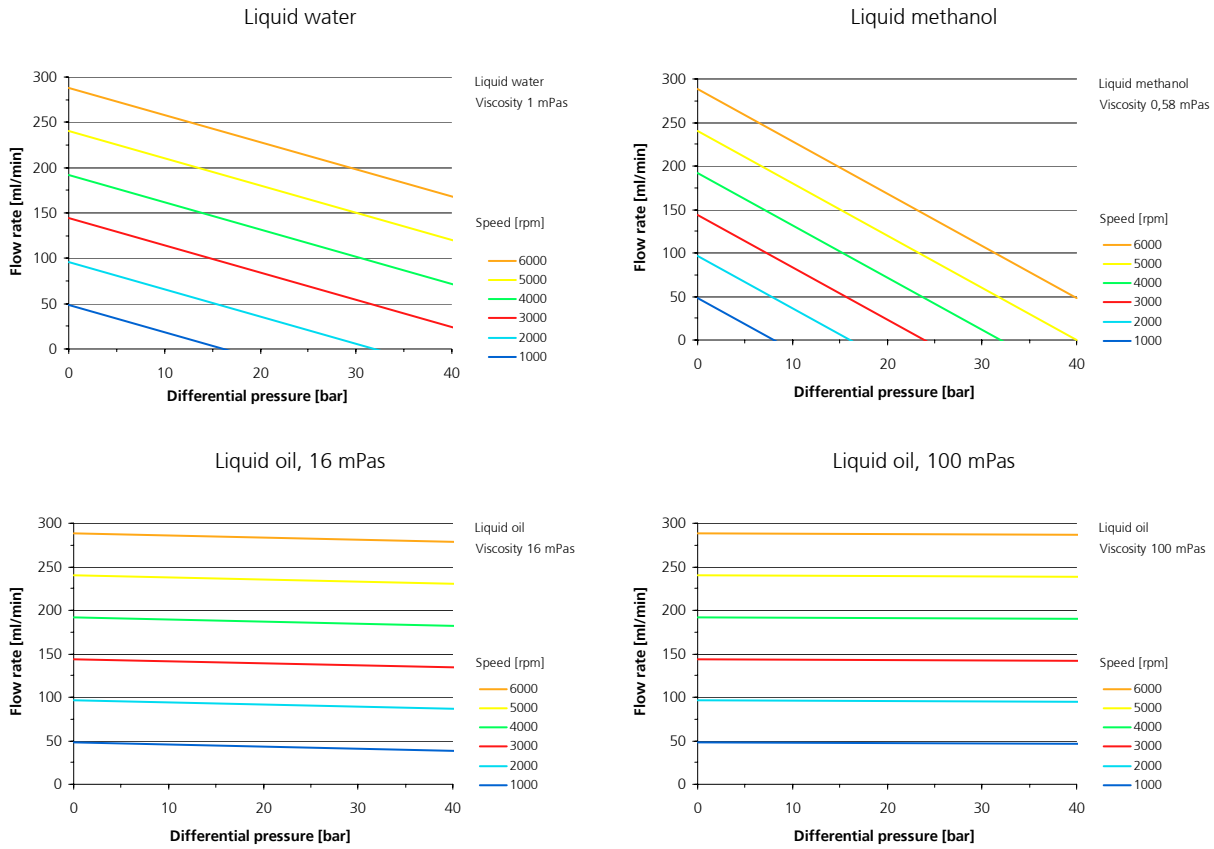


figure 7 Flow charts of the mzr-7205 pump

1.7 Technical data of the drive

The micro annular gear pumps mzr-2905, mzr-4605, mzr-7205 are driven by electronically commutated, brushless motors with integrated control. The control unit is composed of a 16-bit microcontroller and power electronics. It enables to adjust both speed and position of the motor. The motor is highly dynamic and suitable for dosing tasks performed by the micro annular gear pump. CDs or diskettes containing software running under Windows® which permits to set the parameters, as well as to program and control the pump are included in the package. The package contains also a user-friendly terminal box and a null-modem cable for an easy connection to the serial port of a PC.

Performance characteristics of the motor	
Nominal voltage U_B	24 VDC
Supply voltage	12 – 28 V
Residual ripple	≤ 2 %
Max. continuous current	2.8 A
Max. peak current	8 A
Power	44 W
Max. continuous torque	50 mNm
Counts per turn	1000
Speed range	1 – 6000 rpm
Max speed at 24 V	9000 rpm
Max speed at 28 V	10,000 rpm
Input No. 1 (speed input)	0 – 10 V
Resistance input No. 1	18 kΩ
Fault output (input No. 2)	Open collector max. U_B / 30 mA no error: switched to GND programmed as an input: low 0...0.5 V / high 4 V...U_B
Digital input No. 3	low 0...0.5 V / high 4...30 V
Serial port	RS-232
Memory for operating programs	7936 Bytes
Protection class	IP 44
Connection cable length	1 m

table 2 Technical data for the drive of micro annular gear pumps mzr-2905, mzr-4605 and mzr-7205

Wire	Description
blue	GND
pink	+24 V
brown	Analog input
white	Fault output
gray	Analog GND
yellow	RS-232 RXD
green	RS-232 TXD
red	Digital input

table 3 Pin configuration of the motor

Motor current parameters	mzr-2905	mzr-4605	mzr-7205
Peak current LPC [mA]	600	800	8000
Continuous current LCC [mA]	500	700	2500
Max. speed SP [rpm]	6000	6000	6000
Acceleration AC [rotation/s²]	500	500	500

table 4 Programmed current and acceleration parameters at the delivery of standard pumps

Parameter setting (at delivery)	mzr-4605	mzr-7205
Peak current LPC [mA]	600	1200
Continuous current LCC [mA]	500	1000
Max. speed SP [rpm]	6000	6000
Acceleration AC [rotation/s²]	500	500

table 5 Programmed parameters at the delivery with the gear box 3.71 : 1

Parameter setting (at delivery)	mzr-4605	mzr-7205
Peak current LPC [mA]	600	1200
Continuous current LCC [mA]	500	1000
Max. speed SP [rpm]	6000	6000
Acceleration AC [rotation/s²]	500	500

table 6 Programmed parameters at the delivery with gear box 14 : 1

pin plug / socket	Description
1	GND
2	analog input
3	+24 V
4	fault out
5	analog GND
6	RS-232 RxD
7	RS-232 TxD
8	digital Input 3

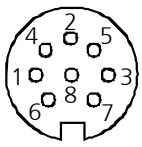


table 7 Pin configuration of the optional lengthening cable

2 Safety instructions

Comply with the general safety instructions listed in the safety section as well as with the special safety instructions listed under the other main sections. All legal and corporate safety instructions have to be obeyed.

2.1 Safety symbols in this operating manual

Please comply not only with the general safety instructions listed below, but also with specific safety instructions mentioned in the following chapters.

Non respect of the safety instructions marked with the following signs represents danger to *people*:

Danger symbol

Safety symbol according to DIN 4844 – W9

High voltage symbol

Safety symbol according to DIN 4844 – W8

Non compliance with the safety instructions marked with the following sign:

Warning

represents a risk of damage to the *micro annular gear pump*.

Operating instructions machined directly on the pump such as the indication of liquid input and output should be followed and kept in a clearly readable condition.

2.2 Staff qualification and training

The staff operating, servicing, inspecting and assembling the pumps must evidence the appropriate qualification for these works. Areas of responsibility and competence as well as monitoring of the staff must be precisely regulated by the decision maker. If the personnel do not have the necessary knowledge, they must be trained and instructed accordingly. If necessary, this can be implemented by the supplier or the manufacturer on behalf of the operator. Furthermore, the operator in charge must ensure that the content of the present manual has been fully understood by the personnel.

2.3 Safety-conscious work

The safety instructions listed in this operating manual, applicable national regulations concerning accident prevention as well as internal work, operation and safety regulations of the operator must be complied with.

2.4 Safety instructions for the operator

The surface temperature of the motor under full load may exceed 60°C. If needed, this surface should be protected on site against contact in order to avoid skin burns.

The drive should be protected against dust, water vapor condensation, humidity, splash water, aggressive gases and liquids. Please provide for adequate air ventilation and thus cooling of the motor.

The micro annular gear pumps mzr-2905, mzr-4605 and mzr-7205 must not be used in areas exposed to explosion risks or in the proximity of inflammable gases and vapors.

Possible leaks of dangerous liquids (for example from the shaft sealing) should be guided away in a way not to represent any danger for the personnel and the environment. The pump should be regularly checked for possible leakage. All legal requirements in this matter should be followed.

The existing protections against contact for the moving parts of the pump (such as for example the coupling) must not be removed during operation.

Take care that all risks resulting from the electric energy are excluded. (For details please refer to the instructions provided by the authorities in charge or your power supplier.)

Warning Please insure, that the totality of the liquid supply accessories such as tubes, hoses, filters etc. are free from dust or dirt particles. Impurities such as metal, plastic or glass particles may impair or damage the pump leading to its failure.

Warning Please, operate the pump with a filter featuring 10 µm or smaller pores. It will protect the pump.

2.5 Safety instructions for maintenance, check and assembly of the pump

As a rule all maintenance work on the device should be performed when the device is at a standstill. The shutdown procedure described in this manual must be followed. Pumps delivering liquids hazardous to health must be decontaminated. Immediately after the work had been completed all safety equipment and protection measures should be applied.

Before starting the operation, please take into notice the instructions listed in the chapter 7.

Warning

Should a malfunction of the pump occur, do not dismantle the pump on your own but contact one of HNP Mikrosysteme's service staff for professional assistance.

2.6 Unauthorized pump conversions and spare part manufacture

Conversions or modification to the device are only permitted with prior consent of the manufacturer. Original spare parts and accessories authorized by the manufacturer ensure safety. The use of other parts will annul the liability of the pump manufacturer for any resulting consequences.

2.7 Improper modes of operation

The safety of operation of the delivered device can only be insured by correct use, as described in chapter 1. The limit values given in this manual must not be exceeded in any case.

2.8 General safety instructions

Please observe the following safety instructions

The pump may operate at high pressures. For this reason please use only the delivered accessories and ensure that the employed fittings and tubing have been prescribed and approved for these pressures.

In order to decrease the pressure, provide the system with a *pressure control valve* directing the excess liquid to the initial tank or back onto the suction side.

At a standstill, the liquid may flow through the pump in the direction of the falling pressure. In order to avoid this unwanted movement, please integrate *non-return valves* (see accessories).

Protect the micro annular gear pump and the electric drive against strokes and shocks.

Under normal working conditions the shaft sealing rings integrated in the pump prevent the liquid from leaking out of the device. The micro annular gear pumps are "technically leak-proof" however not "hermetically sealed" which means it may occur that gases or liquids enter to or escape from the pump.

The allowed operating parameters of the drive should not be exceeded. In particular an *incorrect polarity setting* of the supply voltage may lead to damage of the control unit.

Warning

Please insure, that the totality of the liquid supply accessories such as tubes, hoses, filters etc. are free from dust or dirt particles. Impurities such as metal, plastic or glass particles may impair or damage the pump leading to its failure.

Warning

Please operate the pump with a filter featuring 10 µm or smaller pores. It will protect the pump.

3 Transport and intermediate storage

3.1 Shipment of the pumps and protection measures

The pumps leaving the factory are secured against corrosion and shocks. The inlets and outlets of the pumps are protected with plastic plugs in order to prevent any foreign bodies from penetrating into the device.

3.2 Transport

In order to avoid any damage related to transport, the package must be protected against shocks. HNP Mikrosysteme guarantees, that all goods leave the factory in the best condition. Any noticed damage should be reported to the concerned forwarding agent, authorized dealer or to HNP Mikrosysteme, as manufacturer.

3.3 Intermediate storage

Following points concerning pump storage should be observed:

- Necessary conservation procedure (see also chapter 7.4.1)
- The protective plugs must be left screwed in
- The pump should not be stored in humid places
- For storage temperature - refer to chapter 1.3 of the present manual

4 Description of the micro annular gear pump

4.1 Operating principle of the micro annular gear pump

Micro annular gear pumps are positive displacement pumps. They contain two rotors, bearing slightly eccentrically to each other; an externally toothed internal rotor and an annular, internally toothed external rotor (see figure 8). Due to their cycloid indenting, the rotors remain interlocked at any time, forming during rotation a system of several sealed pumping chambers. As the rotors revolve around their offset axis, the pumping chambers increase on the induction (suction) side and simultaneously decrease on the delivery side of the pump (see figure 9). A homogenous flow is generated between the kidney-like inlet and outlet.

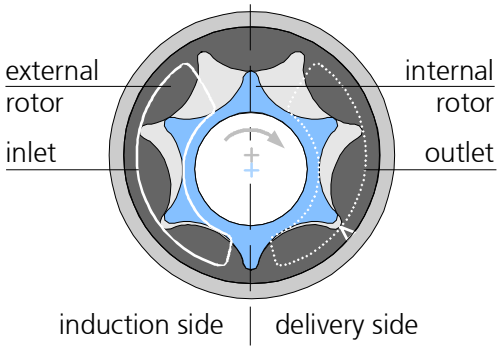


figure 8 Principle of the micro annular gear pump

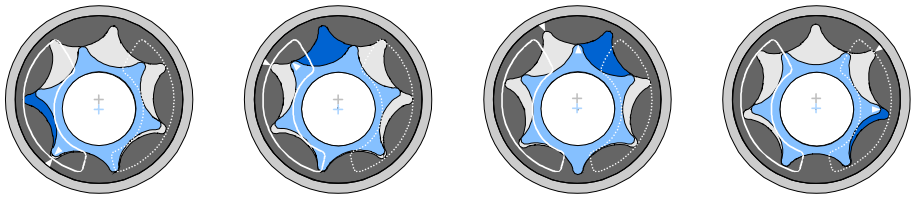


figure 9 Operating principle of the micro annular gear pump

In the case of rotary displacement pumps, the delivered amount of liquid may be easily calculated form the displacement volume V_g of the pump and the number of revolutions of the rotor n. Displacement volume stands for the volume of liquid that is moved within one revolution of the rotor. This relationship is illustrated by the following formula:

$$Q = \eta_{Vol} \cdot V_g \cdot n$$

The volumetric efficiency η_{Vol} shows the relationship between the actual and the theoretical flow rate. The existing differences result from internal movement of the liquid during the operation.

Example: According to the formula mentioned above the mzr-7205 pump featuring a displacement volume of 48 µl delivers at 3000 rpm and with a volumetric efficiency of 100% 144 ml/min. The table 8 shows theoretical flow rate values depending on speed expressed in ml/min and ml/h.

Rotation speed	**mzr-2905**		**mzr-4605**		**mzr-7205**	
[rpm]	**Q** [ml/min]	**Q** [ml/h]	**Q** [ml/min]	**Q** [ml/h]	**Q** [ml/min]	**Q** [ml/h]
500	1.5	90	6	360	24	1440
1000	3	180	12	720	48	2880
2000	6	360	24	1440	96	5760
3000	9	540	36	2160	144	8640
4000	12	720	72	2880	192	11,520
5000	15	900	60	3600	240	14,400
6000	18	1080	72	4320	288	17,280

table 8 Theoretical flow rate of the micro annular gear pumps

Pressure generated by the pump is determined by the configuration of the fluid delivery system and results from both the hydraulic pressure and the hydraulic resistance (tubing, narrow passes etc.). The *volumetric efficiency* of a pump decreases when the differential pressure rises.

The *viscosity* of the manipulated liquid has an important impact on the volumetric efficiency. The volumetric efficiency increases for higher viscosity values because the *internal leakage* values go down.

Cavitation is an effect which, starting form a certain limit speed value, may reduce the volumetric efficiency of a pump. In the case of highly viscous liquids this limit speed value is lower. That happens because of the liquid-specific drop of vapor pressure in the suction tube which leads to gas formation inside the pump.

The particularity of the mzr-pumps is their highly precise construction, which provides for both high operating pressures and a high dosage precision. The gap between both rotors and between the rotors and the adjacent case parts lies in the range of a few micrometers. This precision is the key factor enabling to achieve volumetric efficiency close to 100%.

4.2 Construction

The micro annular gear pump is composed of the pump head, the coupling unit, the drive and the angle support (see figure 10).

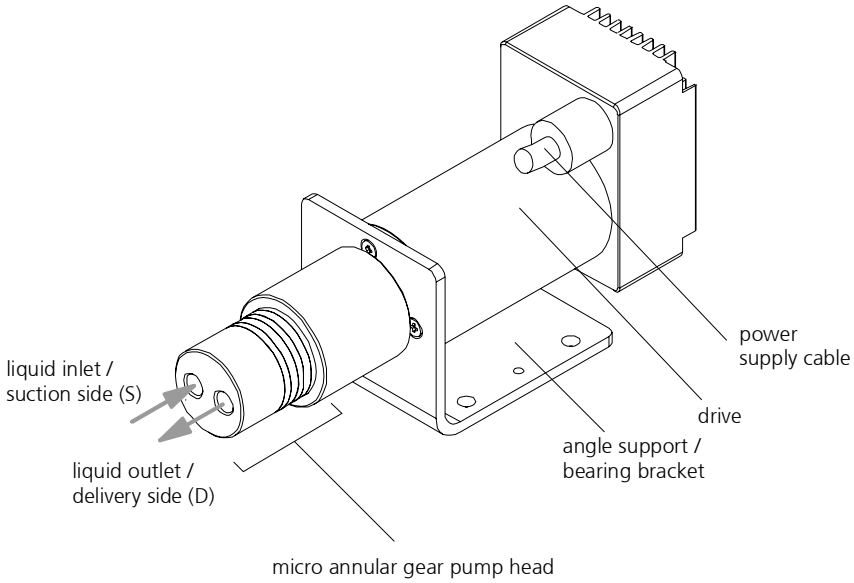


figure 10 Construction of the micro annular gear pump

4.3 Construction materials

Wetted parts	mzr-2905, mzr-4605	mzr-7205
Pump housing	stainless steel 316 L (1.4404, 1.4435)	stainless steel 316 L (1.4404, 1.4435)
Rotors, shaft, bearing	tungsten carbide Ni-based	tungsten carbide Ni-based
Shaft sealing	graphite-reinforced Teflon®, 316L spring	graphite-reinforced Teflon®, 316L spring
Static sealing	FKM (Viton®), optional: EPDM, FFKM	FKM (Viton®), optional: EPDM, FFKM

table 9 Construction materials of the wetted parts

The resistance of the construction materials to the delivered liquids should be verified by the operator for each individual application. Pumps handling non-lubricating liquids have shorter service lives.

4.4 Liquid supply

	mzr-2905, mzr-4605	mzr-7205
Liquid inlet/outlet	1/4"–28 UNF, front	lateral 1/8" NPT internal thread front 1/8" NPT internal thread optional: front connection M10 x 1.0
Tubing	OD 1/8" plastic tubes or stainless steel tubes (optional outer diameter 1/16")	tube/hose OD 6 mm

table 10 Liquid supply

The suction side is indicated with the letter »S« the delivery side with the letter »D«. An arrow in the front of the pump indicates the operating direction of the shaft.

In order to prevent foreign bodies from penetrating into the pump, the liquid inlet and outlet are protected with plastic plugs or screws. Please remove them before you assembly the pump.

5 Optional modules

The spectrum of applications of the high performance micro annular gear pump series may be expanded by using different additional modules. The modules allow for special applications, which could otherwise not be accomplished with a standard pump version. The modules may be combined with each other and with almost all available pump heads and motor versions.

- *Fluidic seal module* prevents possible chemical reactions between the delivered liquid and the surrounding environment
- *Thermal insulation module* extends the operating temperature range of the pump by protecting the motor from overheating
- *Heating module* enables to regulate the temperature of the fluid-containing parts of the pump
- *Gear box module* increases the torque of the drive allowing to deliver high viscosity liquids and provides for a constant operation of the motor at low speeds.
- *Gas-tight sealed* version: almost hermetically sealed pump, delivered as standard with the high performance mzr-pumps

The configuration of a given pump version should in each case be discussed with consideration to the specific requirements of the application. *Additional* customized modules may be designed on demand.

5.1 Fluidic seal module

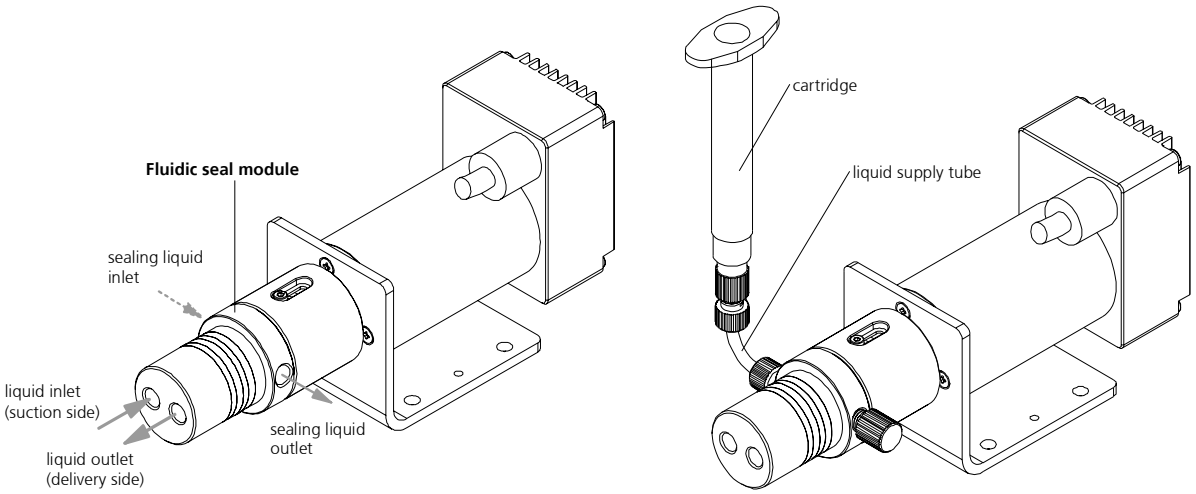


figure 11 Layout of the micro annular gear pump with the fluidic seal module, example of mzr-4605 (the layout on the right: with the optional sealing liquid delivery set)

The role of the fluidic seal module is to prevent moisture and oxygen in the surrounding atmosphere from penetrating into the pump. This eliminates the risk of unwanted chemical reaction between the atmospheric gases and the handled liquid (such as for example the crystallization reaction). The module limits at the same time the possibility for the manipulated liquids to escape from the pump.

The function of the fluidic seal module

The shaft sealing employed in the high performance micro annular gear pump is designed in a way that allows for the formation of a boundary layer in which the delivered liquid comes into contact with the surrounding environment. Small amounts of water vapor and oxygen may penetrate through the protective boundary liquid film into the pump. The fluidic seal module enables to control this influx - only a chosen and compatible liquid may come into contact with the delivered liquid. The fluidic seal module prevents also the inverse movement of the liquid - from the pump to the environment - which could otherwise not be excluded.

With the fluidic seal module, a second sealing is added to the existing shaft sealing. A cylindrical chamber with input and output openings displaced by 180° is located between the two seals (see figure 12). When the chamber is filled with an appropriate sealing liquid, the manipulated liquid does not enter into contact with water vapor and oxygen, but dilutes at a small ratio in the sealing liquid. The dilution ratio depends on the existing pressure relations and drops with increasing viscosity.

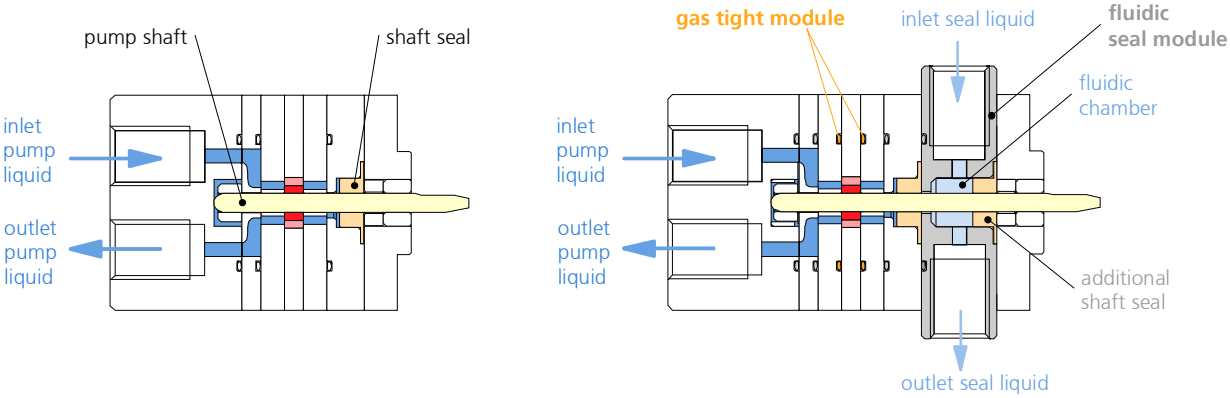


figure 12 Pump head without the fluidic seal module Pump head with the fluidic seal module

Pump operation with the fluidic seal module

Only liquids compatible with the delivered liquid may be used as sealing liquids. That means no liquids that could possibly react with the delivered liquid should be employed. The composition of the sealing liquid should be determined by the operator.

While filling up the fluidic seal chamber a particular attention should be paid to proper venting of the chamber through the two openings featuring a 1/4 - 28 UNF thread. These openings are slightly shifted downwards and upwards to facilitate the degassing of the sealing chamber (see figure 14). The chamber is filled through the bottom opening. The sealing liquid should be filled in so long, till it flows free of air bubbles out of the top opening. Now the inlet should be screwed down.

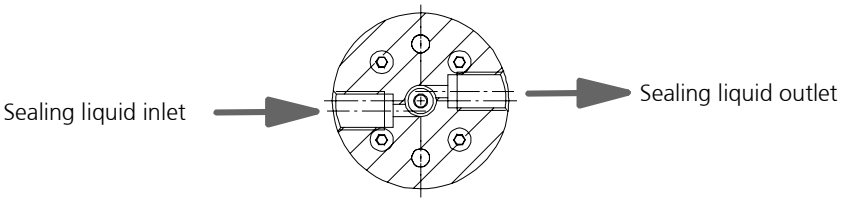


figure 13 Sectional view of the fluidic seal module

A cartridge may be used to supply the sealing liquid to the chamber (see figure 11). In special cases compressed air may be applied to the sealing liquid in order to enhance the sealing function. The sealing chamber may be flushed.

Make sure that enough sealing liquid is supplied to the fluidic seal chamber in order to prevent any penetration of air and water vapor to the module.

If the fluidic seal chamber is empty, the pump should immediately be stopped. Dry operation may lead to shaft seal damage.

In case the pump is not installed in the standard way (pump name read horizontally), it is possible to shift the outlet and inlet openings of the pump. However an appropriate supply of the sealing liquid should still be ensured and all presence of air bubbles within the fluidic seal chamber should be avoided.

Use of the fluidic seal accessories

The fluidic seal set is mounted at the bottom inlet (see figure 13).

During assembly it is important to check if the ferrule is tightly attached to the tube and that the tube is tightly screwed to the inlet of the fluidic chamber.

figure 14 Assembly of the fluidic seal accessories (standard version)

Liquid supply set in stainless steel version (as separate accessory)

Stainless steel liquid supply set is available on request. The use is the same as with the standard version. The liquid supply is done by a glass syringe.

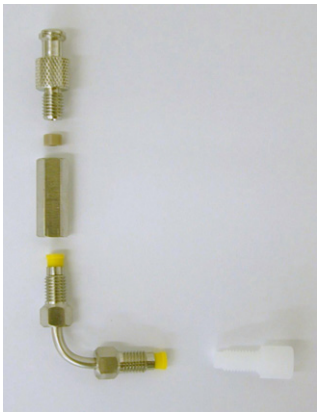


figure 15 Stainless steel set for the fluidic seal module

5.2 Heat insulation module

The heat insulation module enables to deliver hot liquids up to temperatures of 150° C (302 °C). It comprises thermally insulating coupling components made of plastic (PEEK) located between the pump and the drive. The drive should not be exposed to overheating. For this reason the heat transfer from the pump to the drive should be limited. An additional thermal barrier is provided by the plastic motor housing. If the surrounding temperature rises, the pump is working over a longer period or the manipulated liquid features a high temperature, convection cooling of the motor is recommended.

5.3 Heating module

5.3.1 Electric heating module

The electric heating module enables active heating of the pump head up to 150° C (302 °C) operating temperature. The heating module consists of a heating jacket covering the pump head and a thermal element type L. Depending on the pump size, the thermal element will be integrated on the pump head in different ways. In order to adjust the temperature of the pump head, an additional heat regulating device may be delivered.

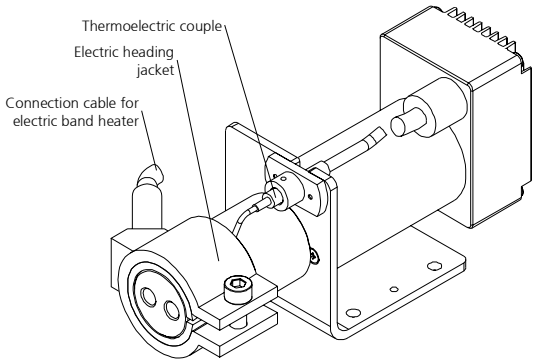


figure 16 Micro annular gear pump mzr-2905 with the electric heating module

⚠ Before connecting the heating jacket and the thermal element to the power supply, please observe the following technical data.

Themal element	
Type	MT-1.5
Thermal element	Type L (Fe-CuNi DIN 43710)
Temperature measuring range	0 to 400 °C
Diameter of the sensing device	1.5 mm
Material	V4A (1.4541)

Heating jacket	**mzr-2905/4605**	**mzr-7205**
Voltage	230 VAC	230 VAC
Power output	80 W	240 W
Diameter	23 mm	35 mm
Width	40 mm	40 mm

table 11 Technical data of the electric heating module

5.3.2 Fluidic heating- and cooling module

The fluidic heating and cooling module permits active heating or cooling of the pump head in the operating temperature range from -20 °C (-4 °F) to a maximum of 150 °C (302 °F). The module consists of a double casing covering the pump head and a thermoelectric couple type L, whose mode of integration varies depending on the pump size. Oil, water, superheated steam or adapted cooling liquids may be used as thermal liquids. If you are not sure, which heat transfer liquid is the best adapted in your case, HNP Mikrosysteme will help you find the suitable one. The thermal liquid ports 2 x G1/8" are displaced by 45°. The inlet for the heat transfer liquid is situated at the back (beveled) and the outlet is in the front (see figure 17).

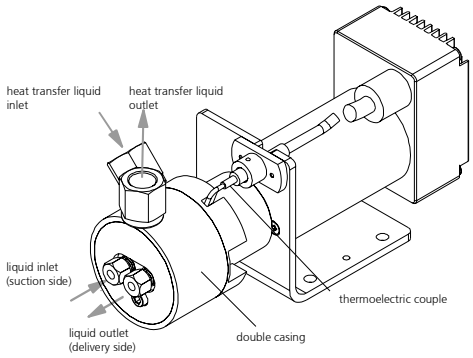


figure 17 Micro annular gear pump with integrated fluidic heating- and cooling module (example of mzr-2905)

⚠ This heating module is not certified for use in areas exposed to explosion hazards!

⚠ Before connecting the liquid supply, please observe the following technical data! The maximal pressure of the heat transfer liquid should not exceed 20 bar.

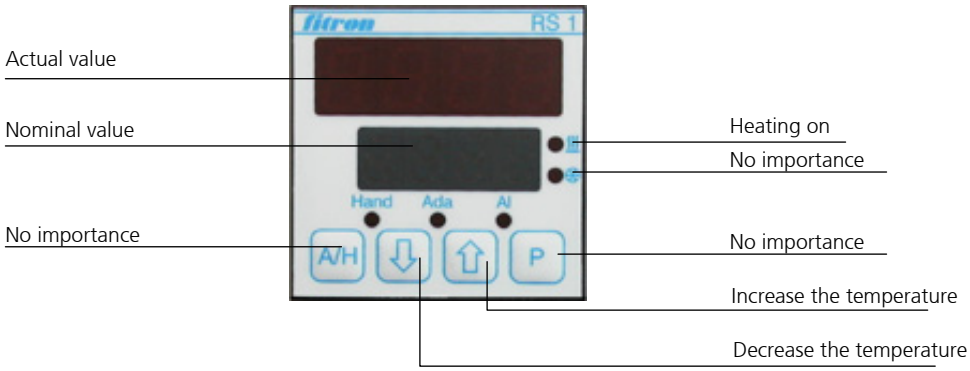
Thermal element	
Type	MT-1.5
Thermal element	Type L (Fe-CuNi DIN 43710)
Temperature measuring range	0 to 400 °C
Diameter of the sensing device	1.5 mm
Material	1.4541

Double jacket	**mzr-2905**	**mzr-4605**	**mzr-7205**
Length	34.25 mm	37.0 mm	45.5 mm
Diameter	42.5 mm	42.5 mm	48.3 mm
Double jacket material	stainless steel 316L	stainless steel 316L	stainless steel 316L
Inlet	2xG1/8" (45° distance)	2xG1/8" (45° distance)	2xG1/8" (45° distance)
Operating temperature range	-20 to 150 °C	-20 to 150 °C	-20 to 150 °C
Max. pressure	max. 20 bar	max. 20 bar	max. 20 bar
Flow rate	max. 0.5 l/min	max. 0.5 l/min	max. 0.5 l/min

table 12 Technical data of the heating and cooling module

5.4 Heating device „*JET*micro“

The heating device „*JET*micro“ has been designed for use with the electric heating module (see chapter 5.3.1).



Hand: Blinks during temperature set in the manual input mode

Ada: Ada display blinks during the automatic control adjustment

AL: Alarm display – not configured, no importance

Actual value display:

OPEn	=	sensor failure
cLLo	=	sensor reverse polarity
cHHo	=	actual temperature value transgressed

With ⇩ or ⇧ the nominal temperature may be set.

Power supply

Shock-proof plug, 3 m long, 90-230 VAC

Electrical connection

10-pole bush insert, 16 A/250 V

	Heating		Sensor	
	L	N	+	-
Zone 1	1	6	2	7
Zone 2 (Option)	4	9	5	10

table 13 Pin configuration of the heating device

5.5 Gear box module

The gear box module enables to increase the torque of the drive in order to deliver high viscosity liquids or to handle liquids at high differential pressure. The gear box module is available with a 3.71 : 1 and 14 : 1 reductions for the pump types mzr-4605 and mzr-7205. The micro annular gear pump with the gear box module is longer of about 30 mm. The position of the controller housing to the pump head may be shifted at about ± 10° depending on the pump head.

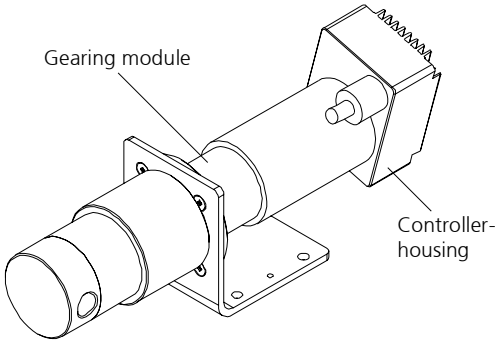


figure 18 mzr-7205 with the gear box module

Please take into notice that for the micro annular gear pump with the gear box module the power supply should be specifically set (see chapter 1.7)

Please take into notice that the operating temperature range is changed from -20 °C (-4 °F) to a maximum of 120 °C (248 °F), if the gear box module and the heating module are combined.

5.6 Gas-tight seal module

Under normal operating conditions the sealing rings employed in the construction of the micro annular gear pump prevent the liquid from escaping out of the pump. The micro annular gear pumps are "technically tight" but not hermetically sealed, which means, it may occur that gases or liquids enter into or escape from the pump. In the case of a gas-tight version, the pump housing is sealed with supplementary rings.

Used together with the gas-tight seal module and the fluidic seal module the pumps are almost perfectly hermetic.

Up from March 2006 all micro annular gear pumps mzr-2905, mzr-4605 and mzr-7205 are delivered in a gas-tight version as a standard.

6 System integration

6.1 Check before the first assembly

Inspect the pumps for potential damage during the shipment (see chapter 3.2).

Please check, if the right pump type has been delivered, as according to the following points:

- Compatibility with the delivered liquid
- Viscosity range
- Pump performance (displacement volume, dosage volumes, operating pressures)
- Operating temperature range

If you notice any difference between the required and the delivered pump type, please contact HNP Mikrosysteme. Do not put the pump into operation without prior approval.

6.2 Mounting of the micro annular gear pump

The micro annular gear pump is mounted on an angle support with M4 screws. The favored mounting position of the micro annular gear pump is horizontal. However, if the pump has to be operated vertically, the motor must be located above the pump head in order to prevent the liquid from entering into the motor.

Warning

Install the pump in such a way that in case of failure no liquid can enter the motor or controller.

Take precautions that in case of leakage no surrounding objects or environment will be damaged.

Install the micro annular gear pump only in places that fulfill the required conditions for safe pump operation.

The motor must be protected against humidity, dust or sweat.

6.3 General instructions for the assembly of the liquid supply network

Please always cut the tubing at a right angle with an adapted hose cutter. If metal tubes are used, an intensive cleansing procedure will be necessary. After machining the tubing has to be cleansed and flushed throughoutly. The smallest piece of swarf within the liquid delivery system may cause failure of the micro annular gear pump.

Please note that correct integration of the tubing with the pump head is a necessary condition to ensure the right direction of flow. If you wish to operate the pump in a reverse direction, please contact HNP Mikrosysteme, since it is not possible in every case.

In order to protect the interior of the pump from pollution, the pump heads are delivered with protective plugs. They should be put on when the pump is at a standstill.

For the best performance the suction tube should be as short as possible and have a large internal diameter.

Warning

In most cases the pump should be operated with a filter featuring pores that do not exceed 10 µm. The filter protects the pump from particles and dirt.

6.4 Assembly instruction for tubing and accessories for mzr-2905 and mzr-4605

The micro annular pump head has two front threaded ports 1/4"–28 UNF for liquid supply connection.

The fluid connection fittings feature standardized plastic tubing or stainless steel tubing with a diameter of 1/16" (1.588 mm), 3 mm 1/8" (3.175 mm). The fluid connection fittings are composed of a threaded part, a lock ring and a ferrule. The seal effect is obtained thanks to the plane ending of the ferrule and the tube. The threaded part assures the required pressing force.

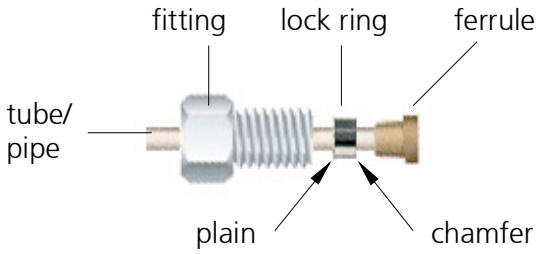


figure 19 Fluid connection fitting 1/4"-28 UNF, stainless steel

1. Cut the tube with a hose cutter to the 90° angle. Metal tubing, that produce swarf during cutting must be throughoutly cleansed and flushed. The smallest piece of swarf in the delivery system may cause failure of the micro annular gear pump.

2. Slide the fitting on the hose or tube.

3. Slide on the lock ring, chamfer towards the end of the hose or tube.

4. The ferrule should be stuck on the hose or tube in a way that the end of the tubing and the ferrule fit tightly together. The conical part of the ferrule should be directed towards the thread.

5. Put the hose or tube with the ferrule into the liquid supply ports of the micro annular gear pump. Hold the tube or hose firmly and screw in the threaded part. Retighten the stainless steel threads with a wrench by turning it about 1-1½ times. It is important that during this operation the tube remains pressed against the bottom of the liquid supply port.

6. In order to avoid dry operation of the device, provide before each operation for a sufficient liquid supply.

Warning

Prolonged dry operation of the micro annular gear pump may damage in particular the bearing and the sealing. However, a short dry working phase at the beginning of the operation is harmless.

6.5 Assembly of the fluid connection fittings for mzr-7205

The micro annular gear pump mzr-7205 is available in two versions. The liquid supply openings may be lateral with an 1/8" NPT thread screw, or front, with an integrated 1/8" NPT (M10x1) compression ring screw connection for hoses or tubes with 6 mm OD. Pump heads equipped with the heating module are available with front liquid ports only.

Lateral screw connection 1/8" NPT

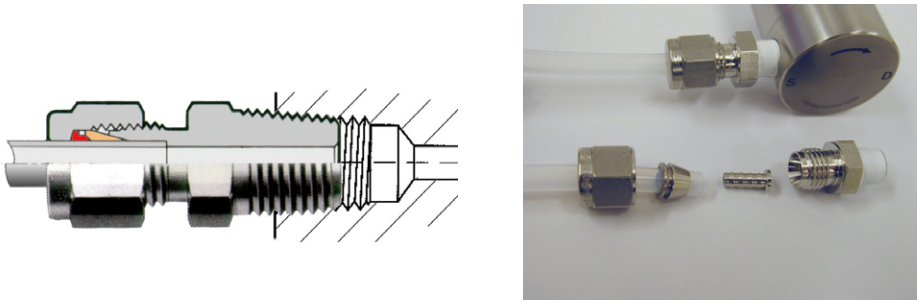


figure 20 Fluid connection fitting 1/8" NPT, stainless steel

1. The thread of the fitting should be wrapped with 2-3 layers of Teflon tape and screwed in the NPT thread. First manually, then tightened with ½ to ¾ wrench turns.

2. Cut the tube or hose to the right angle with an adapted hose cutter. Metal tubing, that produces swarf during cutting must be throughoutly cleansed and flushed. The smallest piece of swarf in the liquid delivery system may cause failure of the micro annular gear pump.

3. Screw the tube or hose (the latter always with a support tube) in the fluid inlet/outlet port of the pump first manually then tighten it with 1¼ wrench turns. During this operation use a second wrench to hold the hose against the bottom of the inlet/outlet port.

4. In order to avoid dry operation, provide for a sufficient liquid supply before each use.

Front fluid supply connection 1/8" NPT (M10x1)

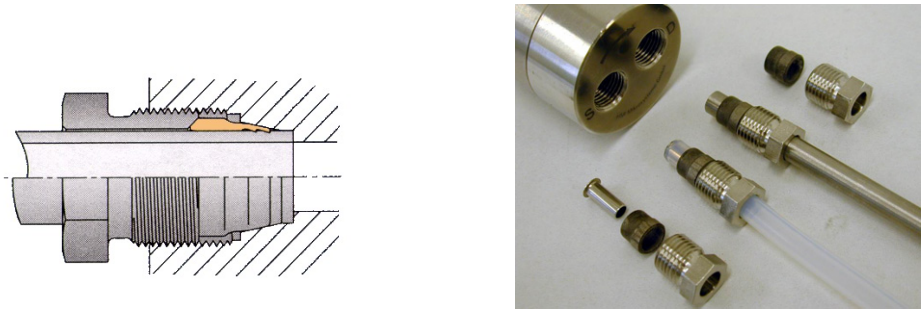


figure 21 Fluid connection fitting 1/8" NPT (M10x1), stainless steel

1. Cut the tube or hose to the right angle with an adapted hose cutter. Metal tubing, that produces swarf during cutting must be throughoutly cleansed and flushed. The smallest piece of swarf in the delivery system may cause failure of the micro annular gear pump.

2. Slide the pressure screw on the tube (the latter always with a metal support tube).

3. Slide on the clamping ring, bevel towards the end of the tube or hose.

4. Screw the tube or hose (the latter always with a metal support tube) in the liquid supply port first manually then tighten it with 1¼ wrench turns

5. In order to avoid dry operation, check before each use that enough liquid is supplied to the pump.

Warning Dry operation of the micro annular gear pump may damage in particular the bearing and the sealing. However, a short dry working phase at the beginning of the operation is harmless.

6.6 Filter selection and use

In majority of cases it is recommended to integrate a filter on the suction side of the micro annular gear pump to ensure its secure operation. The recommended filter pores or mesh size should not exceed 10 µm. The penetration of particles or swarf that could cause a blockage or damage to the pump can only be avoided by using an adapted filter.

HNP Mikrosysteme offers a choice of standard filters covering a broad spectrum of applications. You may count on our assistance for the selection of the most suitable one.

In order to select the best adapted filter, such operating parameters as flow rate, viscosity and degree of pollution of the liquid will be needed. An increase

in at least one of the mentioned terms will require the use of a bigger filtering element or the pressurization of the delivered liquid. In case no suitable filter for high viscosity liquid can be found, it is possible to use a filter with slightly larger pore size. Prior discussion with HNP Mikrosysteme is here recommended. A filter with larger pores is still better than no filter at all. Alternatively an already filtered liquid may be used.

Warning Because filters have a large internal volume, it is recommended to fill in the filter and the suction tube with already filtered liquid in order to avoid a longer dry operation of the pump during the startup.

Warning Please control regularly the filtering elements for pollution. Cleanse regularly the filter or replace it with a new one. A polluted filter may considerably decrease the volumetric efficiency of a pump. Furthermore, because of the cavitation effects dosage imprecision and even pump damage may occur.

Warning A too small filter (too little filtering surface) may considerably decrease the volumetric efficiency of the micro annular gear pump. What is more, because of the cavitation effects dosage imprecision and even pump damage may occur.

6.7 Connection of the micro annular gear pump to the power supply

In order to operate the pump a supplementary source of 24 VDC will be required. The ampacity of the voltage source should amount to around 3 A for the micro annular pumps mzr-2905 and mzr-4605 and 5 A for the mzr-7205.

The micro annular gear pump is connected via the Terminal Box S-G05. This enables an easy startup of the pump due to:

- the possibility to connect the voltage supply with the delivered screw clamp terminal
- an alternative voltage supply via a DIN connector conform with DIN 45323
- speed set via potentiometer
- analog voltage input 0-10 V and 0 (4)-20 mA for speed control
- change of speed setting mode with a DIP-switch
- 9-pole connection plug for the RS-232 interface
- error output programmable also as trigger input or frequency output
- digital input with a screw connection
- possibility of installation on a 35 mm top hat rail

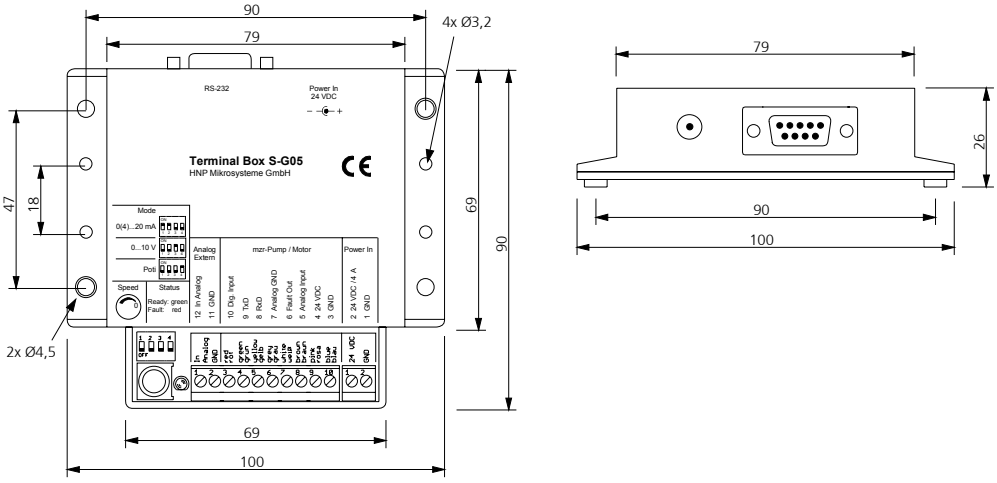


figure 22 Measurements of the Terminal Box S-G05

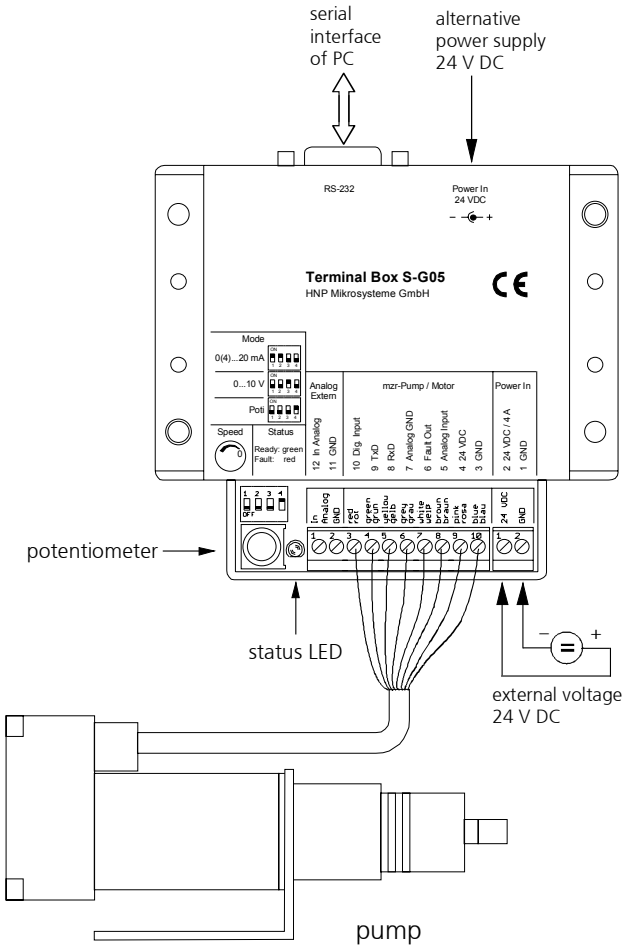


figure 23 Connection of the micro annular gear pump to the power supply

Wire	Function	Terminal Box
blue	Ground	GND
pink	Voltage supply	24VDC
brown	Analog input	Analog Input
white	Error output	Error Out
gray	Ground analog input	Analog GND
yellow	RS-232 interface signal reception	RxD
green	RS-232 interface signal transmission	TxD
red	Digital input	Dig.Input

table 14 Wire configuration between the drive and the Terminal Box S-G05

The operating speed of the micro annular gear pump may be set with:

- the potentiometer of the Terminal Box S-G05
- an external voltage signal 0-10 V
- an external, analog current signal 0 (4)-20 mA
- the RS-232 interface

Individual start up procedures are described in the following points.

Startup with potentiometer

1. Connect the drive with the eight colored wires to the terminal box S-G05. The colors of the corresponding wire connections are printed on the terminal box S-G05 as described in the table 15.

2. Bring the potentiometer knob to null position by turning it clockwise to the limit stop.

3. Put the DIP-switch to the »Poti« position.

4. Connect the 24 VDC voltage supply to the screw clamp terminal or to the DIN connector

Make sure that the polarity of the supplied direct current is correct, otherwise electronics will be damaged.

5. Provide for a steady liquid supply to the pump in order to avoid dry operation.

6. The pump may now be put into operation by turning on the potentiometer knob.

Remarks:

– You may adjust speed of the micro annular gear pump without the need to connect it to the serial interface.
– In case error occurs for example due to motor overload - the green status LED on the Terminal Box S-G05 will turn red.

Startup with external 0-10 V signal

1. Connect the drive with the eight colored wires to the terminal box S-G05. The colors of the corresponding wire connections are printed on the terminal box S-G05 and described in the table 15.

2. Bring the potentiometer knob to the null position by turning it clockwise to the limit stop.

3. Put the DIP-switch to »0…10 V« position.

4. Connect an external 0-10 V voltage supply to the terminal clamps »AnalogIn« and »GND« to the S-G05.(see figure 24)

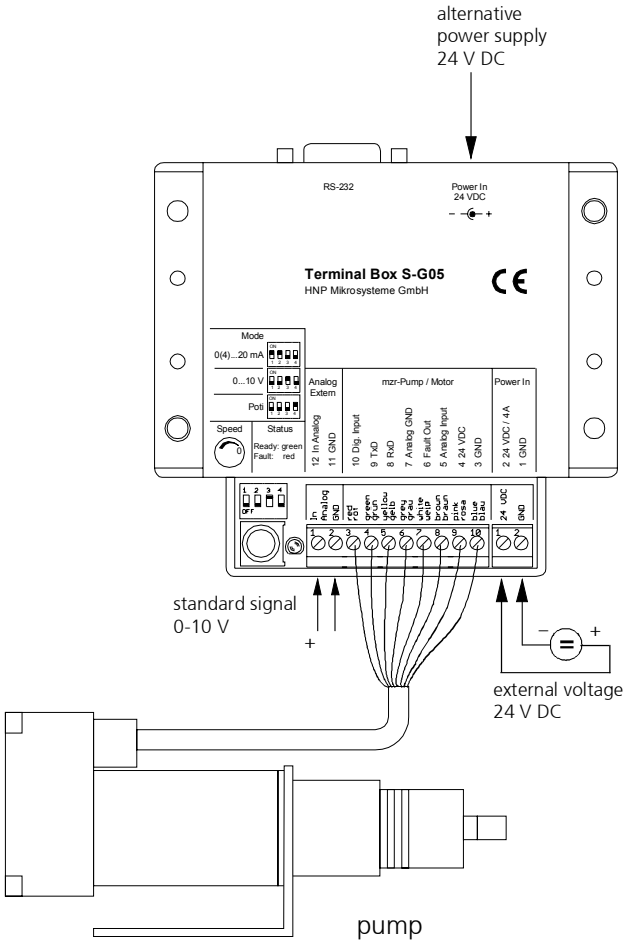


figure 24 Startup with an external 0-10 V voltage signal

5. Provide for a steady liquid supply to the pump in order to avoid dry operation of the device.

6. Connect the 24 VDC voltage supply to the screw clamp terminal or to the DIN connector

Make sure that the polarity of the supplied direct current is correct, otherwise electronics will be damaged.

The input circuit at the analog input is layed out as a differential amplifier. If the analog input is "open" there is already a voltage of 2 V. That means in this case that the motor would be turning at a speed of about 2000 rpm. In order to set 0 rpm the input must be connected over a low ohm resistor to the analog ground (AGND) or connected to the AGND-voltage level.

7. The micro annular gear pump may now be put into operation by increasing the external voltage signal. A voltage signal of 0 V corresponds to 0 rpm and 10 V to the maximal programmed speed (see table 5).

Remarks:

– You may adjust speed of the micro annular gear pump without the need to connect it to the serial interface.
– In case error occurs for example due to the motor overload - the green status LED on the terminal Box S-G05 will turn red.

Startup with an external 0(4)-20 mA current signal

1. Connect the drive with the eight colored wires to the terminal box S-G05. The colors of the corresponding wire connections are printed on the terminal box S-G05 as described in the table 15.

2. Bring the potentiometer knob to the zero position by turning it clockwise to the limit stop.

3. Put the DIP-switch to »Poti« position.»0(4)…20 mA«.

4. Connect the external current source to the screw clamps »AnalogIn« and »GND« to the S-G05. (see figure 25).

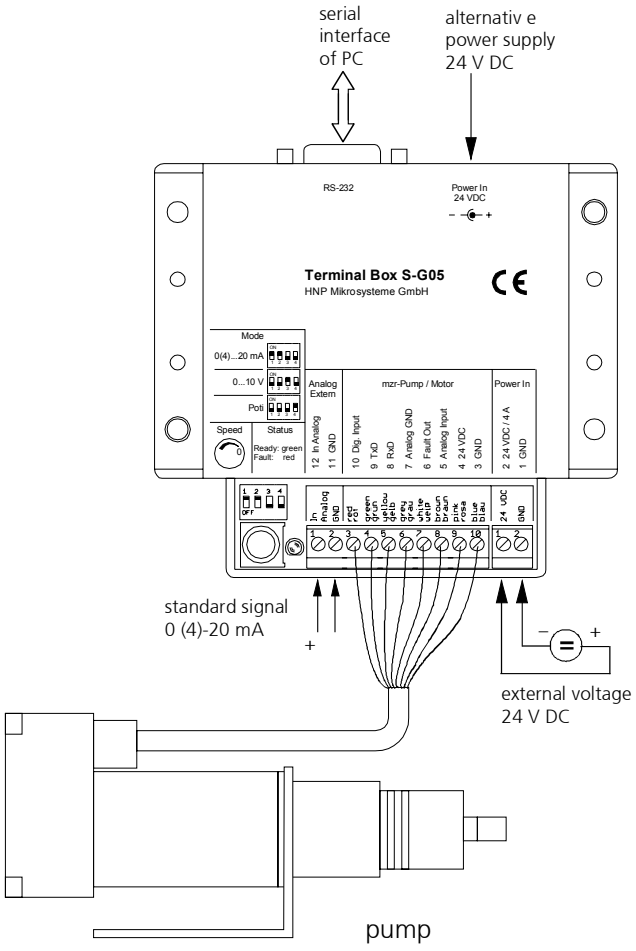


figure 25 Operation via an external 0 (4)-20 mA voltage

5. Provide for a sufficient liquid supply to the pump in order to avoid dry operation of the device.

6. Connect the 24 VDC voltage supply to the screw clamp terminal or to the DIN connector.

Make sure that the polarity of the supplied direct current is correct, otherwise electronics may be damaged.

7. The micro annular gear pump may now be put into operation by increasing the external current signal. 0 mA corresponds to 0 rpm and 20 mA to the maximal programmed speed (see table 5).

Remarks:

– For operation with 4…20 mA an offset of about 2.1 V should be set by entering the MAV2170 command. In order to set the nominal values the micro annular gear pump must be put into operation via the RS-232 interface and with the » Motion Manager « software
– Speed of the micro annular gear pump may be set by sending an external voltage signal without the need to connect the pump to the serial interface.
– In case error occurs for example due to a motor overload - the green status LED on the Terminal Box S-G05 will extinguish and a red one will light up.

Startup with the RS-232 interface

1. Connect the drive with the eight colored wires to the S-G05. The colors of the corresponding wire connections are printed on the S-G05 as described in the table 15.

2. In order to prevent uncontrolled startup of the pump, bring the potentiometer knob to the null position by turning it clockwise to the limit stop.

3. Put the DIP-switch to »Poti« position.

4. Connect the RS-232 interface of the Terminal Box S-G05 with a free serial interface of a PC. Use for that the delivered 9-pole null-modem cable.

5. Now install the delivered software as described in the chapter 8 or chapter 9).

6. Connect the 24 VDC voltage supply to the screw clamp terminal or to the DIN connector

7. Provide for a steady liquid supply to the pump in order to avoid dry operation of the device.

8. The micro annular gear pump may now be put into operation with the available software (operating mode RS-232 see chapter 9.1).

Remarks:

– In case error occurs for example due to the motor overload - the green error status LED on the Terminal Box S-G05 will turn red.

6.8 Startup with the connection board (optional)

For operation via connection board an additional source of 24 VDC will be needed. The ampacity of the power supply unit should amount to about 3 A for the micro annular gear pumps mzr-2905 and mzr-4605 and 5 A for the mzr-7205.

The micro annular gear pump is connected via a PCB. This enables a simple operation of the micro annular gear pump due to:

- the possibility to connect the voltage supply to the delivered connection sockets for 4 mm banana plugs
- alternative voltage supply via a DIN connector conform with DIN 45323 or with screw clamps
- possibility to control speed via potentiometer
- external 0-10 V voltage signal for speed set
- switching of speed source with a jumper
- 9-pole connection plug for the RS-232 interface
- error output programmable also as trigger input or frequency output

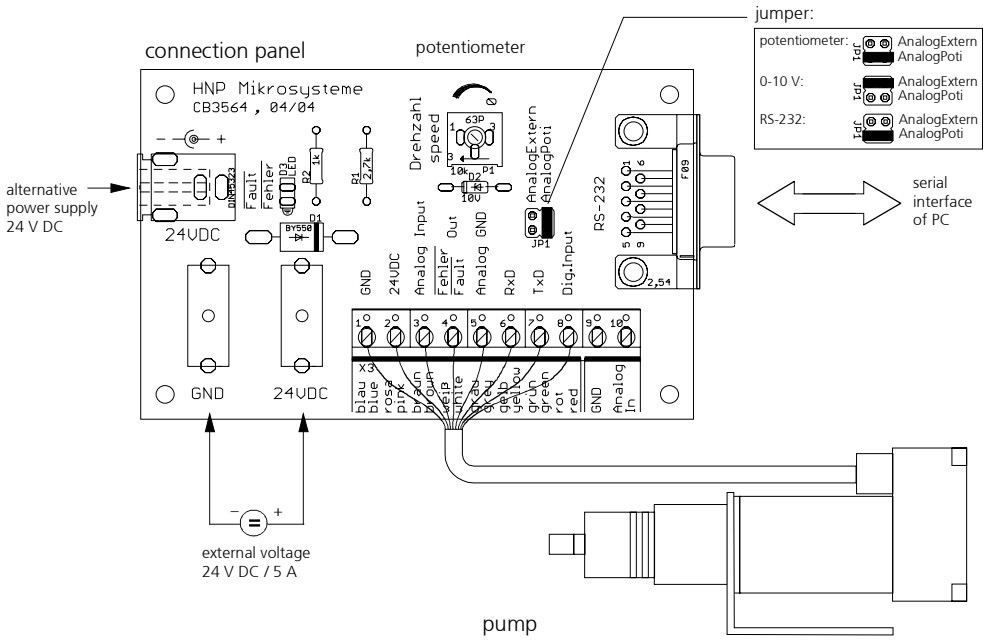


figure 26 Electric connection of the micro annular gear pump

Wire	Function	Connection board
blue	Ground	GND
pink	Voltage supply	24VDC
brown	Analog input	Analog Input
white	Error output	Fehler Out
gray	Ground analog input	Analog GND
yellow	RS-232 interface signal reception	RxD
green	RS-232 interface signal transmission	TxD
red	Digital input	Dig.Input

table 15 Wire configuration between the drive and the connection board

During operation of the micro annular gear pump speed may be set with:

– the potentiometer knob on the connection board
– an external analog 0-10 V voltage signal
– the RS-232 interface

Individual start up procedures are described in the following points.

Startup with a potentiometer

1. Connect the drive with the eight colored wires to the connection board. The colors of the corresponding wire connections are printed on the connection board as specified in the table 15.

2. Bring the potentiometer knob to null position by turning it clockwise to the limit stop.

3. Put the jumper JP1 on the connection board to the »Analog Poti« position.

4. Connect the 24 VDC voltage supply to the plug sockets or to the DIN connector

Make sure that the polarity of the supplied direct current is correct, otherwise electronics may be damaged.

5. Provide for a steady liquid supply to the pump in order to avoid dry operation of the device.

6. The pump may now be put into operation by turning on the potentiometer knob.

Remarks:

– You may set speed of the micro annular gear pump without the need to connect it to the serial interface.
– In case error occurs for example due to the motor overload - the green error LED on the connection board will extinguish.

Startup with external 0-10 V signal

1. Connect the drive with the eight colored wires to the connection board. The colors of the corresponding wire connections are printed on the connection board as described in the table 15.

2. Bring the potentiometer knob to null position by turning it clockwise to the limit stop.

3. Put the jumper JP1 on the connection board to the »AnalogExtern« position.

4. Connect an external 0-10 V voltage signal to the terminal clamps »AnalogIn« and »GND« on the connection board (see figure 24).

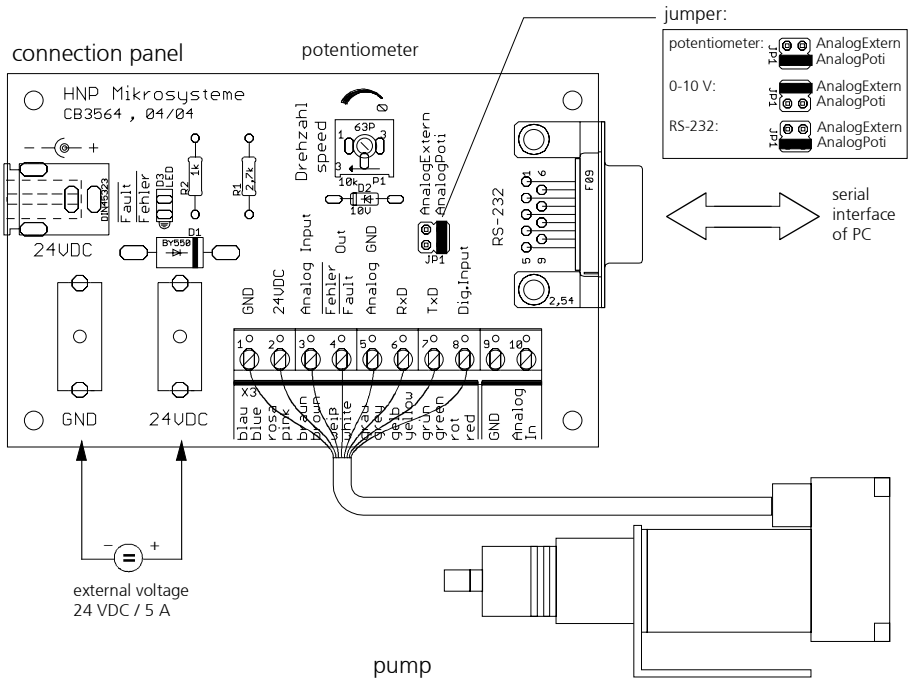


figure 27 Operation with an external 0-10 V voltage signal

5. Provide for a steady liquid supply to the pump in order to avoid dry operation of the device.

6. Connect 24 VDC voltage supply to the plug sockets or to the DIN connector.

Make sure that the polarity of the supplied direct current is correct, otherwise electronics may be damaged.

The input circuit at the analog input is layed out as a differential amplifier. If the analog input is "open" there is already a voltage of 2 V. That means in this case that the motor would be turning at a speed of about 2000 rpm. In order to set 0 rpm the input must be connected over a low ohm resistor to the analog ground (AGND) or connected to the AGND-voltage level.

7. The micro annular gear pump may now be put into operation by increasing the external current signal. 0 V correspond to 0 rpm and 10 V to the maximal programmed speed (see table 5).

Remarks:

– Speed of the micro annular gear pump may be set by sending an external voltage signal without the need to connect the pump to the serial interface.

– In case error occurs for example due to the motor overload - the green error LED on the connection board will extinguish.

Startup with the RS-232 interface

1. Connect the drive with the eight colored wires to the connection board. The colors of the corresponding wire connections are printed on the connection board as described in the table 15.

2. In order to prevent uncontrolled startup of the pump, bring the potentiometer knob to the null position by turning it clockwise to the limit stop.

3. Put the jumper JP1 on the connection board to the »AnalogPoti« position.

4. Connect the RS-232 interface of the connection board with a free serial interface of a PC. Use for that the delivered 9-pole null-modem cable.

5. Now install the delivered software as described in chapter 8 or chapter 9.

6. Connect the 24 VDC voltage supply with the plugs or the DIN connector.

Make sure that the polarity of the supplied direct current is correct, otherwise electronics will be damaged.

7. Provide for a steady liquid supply to the pump in order to avoid dry operation of the device.

8. The micro annular gear pump may now be put into operation with the available software (operating mode RS-232 see chapter 9.1).

Remarks:

– In case error occurs for example due to the motor overload - the green error LED on the connection board will extinguish.

7 Startup/shutdown of a mzr-pump

7.1 Preparing for operation

After the liquid supply system had been completed, please check once again the operating conditions of the micro annular gear pump as according to the following points:

- Are the inlet and outlet tubes correctly connected?
- Is the entire liquid supply system clean - that means free of particles, foreign bodies, pollution or swarf?
- Has a filter been installed on the suction side?
- Has a sufficient amount of the right liquid been supplied?
- The pump does not run the risk of a longer dry operation?
- The entire liquid supply system has been checked for leakage?
- Is it possible to stop the pump by an emergency switch if an unexpected malfunction occurs at the startup?

7.2 Startup of the micro annular gear pump

Switch on the voltage supply. The micro annular gear pump can now be put into operation by turning on the potentiometer knob or by sending a nominal external voltage signal.

Start the filling in of the pump at low or middle speed (1000 - 3000 rpm).

Warning Avoid dry operation of the pump over a longer time. The pump should be filled in before it is put to operation.

7.3 Flushing procedure after use

After each service the micro annular gear pump should be carefully flushed with a non-corrosive, filtered and particle-free flushing liquid (see table 16 and table 17). During flushing procedure the pump should operate at a speed of about 3000 rpm and if possible against a low pressure (that can be obtained by using a restrictor, a capillary or similar). The flushing liquid must be compatible with the delivered liquid and suitable for solving the remaining liquid rests. Depending on the application for example water, or isopropanol may be used. If you have doubts whether a particular liquid is suitable for this function or not, please ask the manufacturer of the liquid or HNP Mikrosysteme.

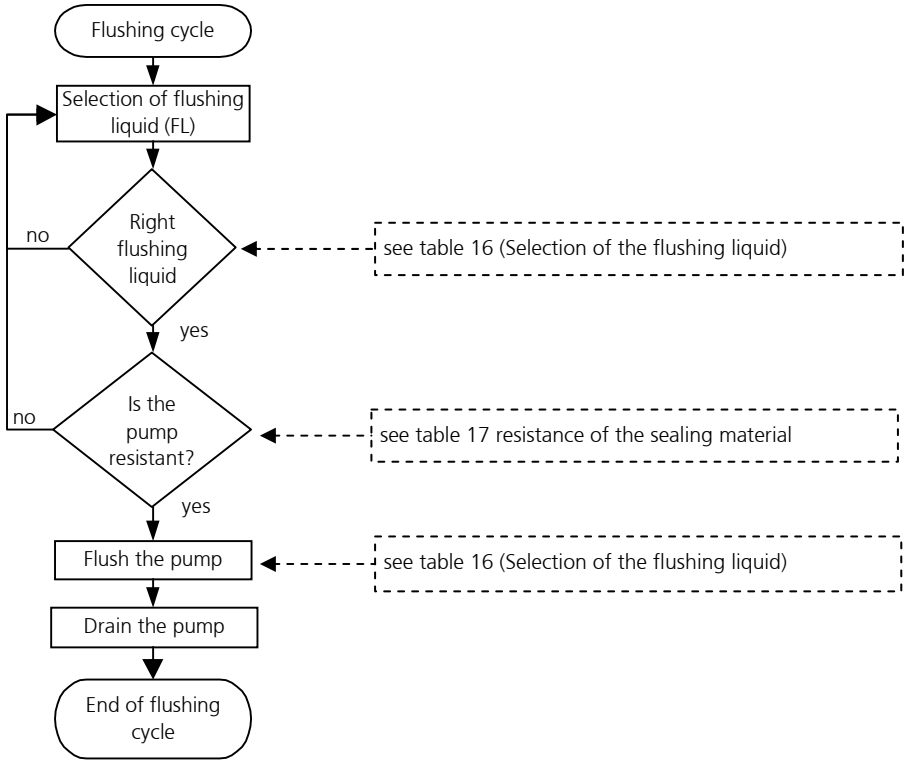


figure 28 Diagram of the flushing procedure

Warning Liquids that remain in the pump may crystallize, coagulate or lead to corrosion and as a consequence impair the work of the micro annular gear pump.

Warning Please make sure that the pump components and particularly O-rings and sealing are resistant to the employed flushing liquid. (see table 17).

Warning The flushing liquid (solvent) and the recommended duration of the flushing procedure depend on the delivered liquid (see table 17). The indicated flushing liquids are simple recommendations and should therefore be checked by the user as to their compatibility and suitability.

Regulations concerning use of substances dangerous to health should be followed!

	Nature of the delivered liquid	Flushing time [min]	Suitable flushing liquid
1	Oils, fats, plastifierss	15-20	isopropanol, ethanol, acetone, benzine/petroleum ether
2	Solvents (polar + nonpolar)	5-10	isopropanol, ethanol
3	Other organic liquids	10-15	isopropanol , ethanol
4	Refrigerating and cooling agents	15-20	isopropanol, ethanol
5	Neutral water/y solutions	20-25	isopropanol, ethanol
6	Basic solutions	25-30	DI-water (deionized water)
7	Organic acids	30-40	isopropanol, ethanol
8	Weak mineral acids	25-30	DI- water
9	Strong mineral acids	35-45	DI- water
10	Strong oxidizing liquids	35-45	DI- water
11	Paints, varnishes, adhesives	50-60	not specified - for further information please contact HNP Mikrosysteme.

table 16 Selection of the flushing liquid (solvent) and the duration of the flushing procedure depending on the delivered liquid.

Warning Please make sure that the pump components and particularly O-rings and sealing are resistant to the employed flushing liquid (see table 17).

	Shaft sealing		O-ring material		
Flushing liquid	PTFE (Teflon®), graphite-reinforced	UHMWPE	FKM (Viton®)	EPDM	FFKM
acetone	0	0	3	0	0
benzene	0	3	1	3	0
benzyl alcohol	0	-	0	2	0
butanol	0	-	1	0	0
dimethyl sulfoxide (DMSO)	0	0	3	0	0
ethanol	0	0	0	0	0
isopropanol	0	0	0	0	0
methanol	0	0	2	0	0
methylethylketone (MEK)	0	0	3	1	0
styrene	0	-	1	3	1
toluene	0	1	2	3	0
water	0	0	0	0	0
xylene	0	1	2	3	0
benzine/petroleum ether	0	0	0	3	0
oil / fine mechanics oil	0	0	0	3	0

Legend: 0 ... good suitability 1 ... suitability 2 ... conditional suitability 3 ... labile - ... not specified

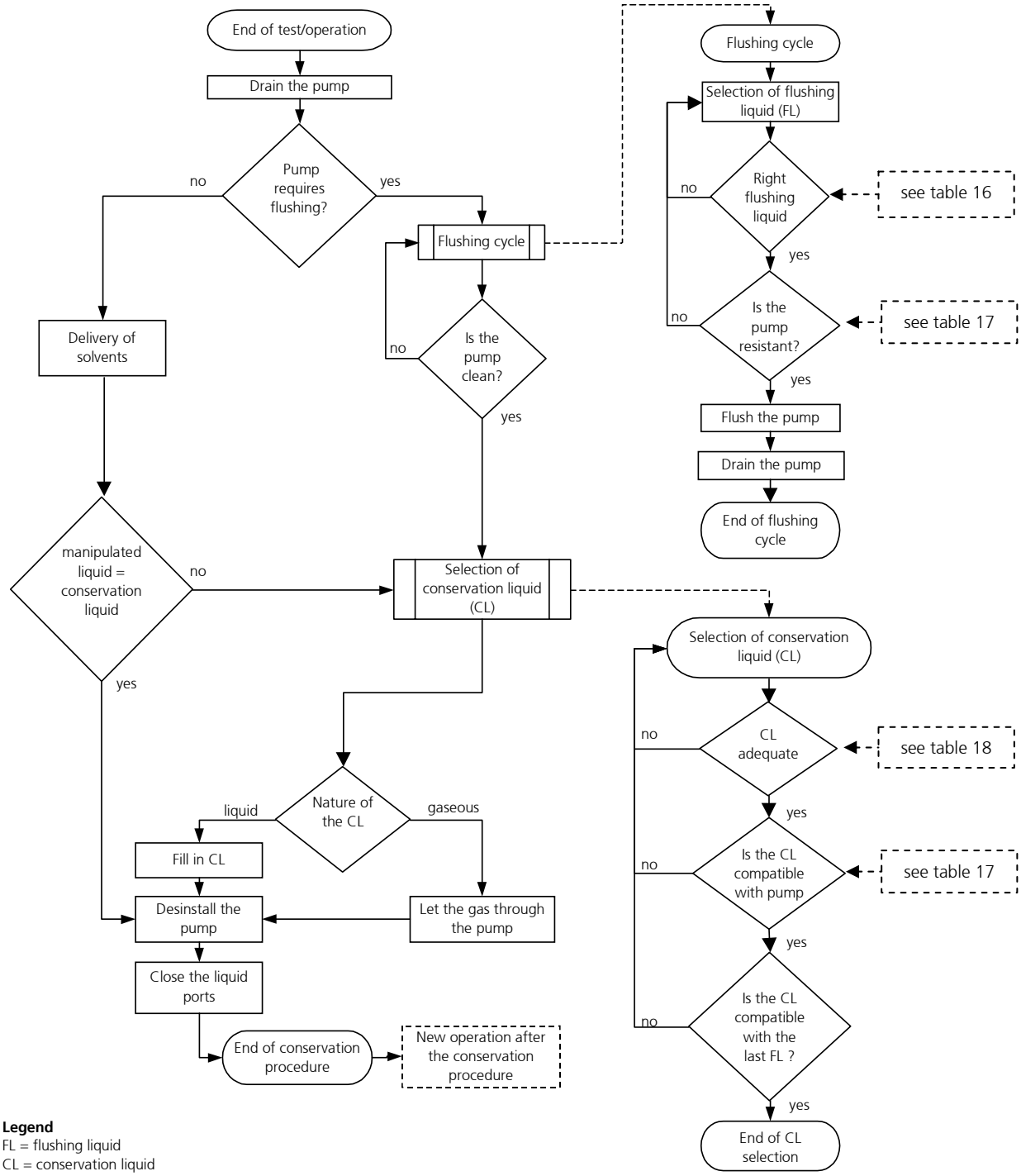
table 17 Resistance of the sealing materials depending on the flushing liquid (solvent)

7.4 Shutdown of the micro annular gear pump

In order to shut down a mzr-pump the following steps should be followed:

- Flush the pump with a filtered and particle-free flushing liquid (solvent) as described in the chapter 7.3.
- After the flushing procedure decrease speed of the pump to 0 rpm
- Fill the pump with a suitable conservation liquid (see chapter 7.4.1)
- Remove the pump from the system (see chapter 7.4.2)

By proceeding as shown in the diagram (see figure 30) you may prepare the pump for a longer standstill.



Legend
FL = flushing liquid
CL = conservation liquid

figure 29 Diagram of the shutdown procedure

7.4.1 Conservation

If the micro annular gear pump operates at irregular intervals or for other reasons should be put out of operation for a longer period, it should, after service and flushing procedure (see chapter 7.3), be filled in with a suitable conservation liquid.

The conservation liquid may be selected from the table 18 depending on the duration of the standstill and the resistance of the pump to the manipulated liquid. The indicated conservation liquids are simple recommendations and should therefore be checked by the user as to their compatibility and suitability. The figure 30 presents a diagram of conservation agent selection.

Remark: This diagram is repeated as a part of the figure 29 (shutdown procedure of the micro annular gear pump).

After the cleansing procedure the pump should be filled with a suitable conservation agent. You will find a choice of possible conservation agents in the table 18.

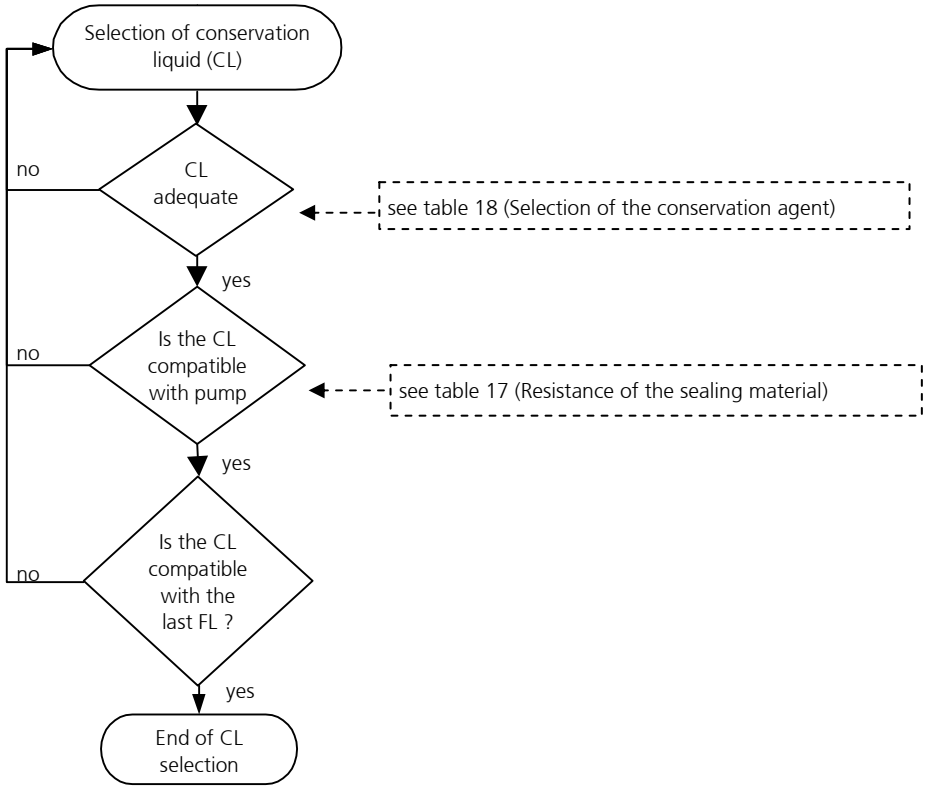


figure 30 Diagram - selection of conservation liquid (CL)

Liquids	Solubility in water	Compatibility with the delivered liquid	Duration of storage	Breakaway torque	Toxicology	Viscosity	Description
isopropanol	+	+	o	o	o	+	solvent for organic compounds, cosmetics, essential oils waxes, and esters, antifreezers, antiseptic agents
acetone	+	+	o	o	o	+	solvent for a number of organic compounds, unlimited solubility in water, dissolves natural and synthetic resins, fats, oils and commonly used plastifiers
ethanol	+	+	o	o	o	+	solvent for organic compounds, fats, oils and resins
DI-water	+	+	-	-	+	+	solvent for many organic and mineral liquids
fine mechanics oil	-	-	+	+	+	+	cleansing and protective action (dissolves fats, tar, rubber or adhesive substances, protects against corrosion).
hydraulic oil	-	-	+	+	+	-	lubricating and preserving properties (*Warning*: may resinate or deteriorate with time)
nitrogen	-	+	+	+	o	+	is not a solvent, may leave deposits after drying out
air / compressed air		+	+	+	+	+	is not a solvent, may leave deposits after drying out

Legend: + ... good/suitable o ... satisfactory; - ... bad/inadequate

table 18 Selection of the conservation agent

In order to prevent dust particles and foreign bodies from penetrating into the pump or the conservation agent from leaking out, please secure the liquid input and output openings with the delivered protective plugs or screws.

Warning Water or DI-water should not be used as conservative liquids. They germinate already after a few days and build a biofilm which can later block the pump.

7.4.2 Dismantling of the system

- Put the drive out of operation by turning down speed to 0 rpm and by switching off the voltage supply. Make sure that the procedure described in the chapter 7.3 has been completed.
- Now that the pump has been stopped you may remove it from the system.
- Protect the inlet and outlet openings of the pump with adapted protective plugs or screws.

7.5 Problem shooting

If the pump stops operating abruptly or has difficulties with starting operation, please undertake the following steps:

Try to liberate the micro annular gear pump:

- by turning the potentiometer knob back and forth or by connecting an analog voltage
- via the control software
- by pressing with a syringe a suitable flushing liquid (see table 16 and table 17) through the micro annular gear pump
- by changing the operating direction of the pump.

If these measures turn out to be ineffective, please contact the service staff of HNP Mikrosysteme (see chapter 15) and send the pump back to the manufacturer for inspection.

Warning *You should under no condition* try to disassemble the pump by yourself. This may cause damage to the pump components and consequently annul your warranty claims.

7.6 Return of the micro annular gear pump to the manufacturer

For the return of a micro annular gear pump and components that have already been employed, please follow the instructions:

- drain any remaining rests of the delivered liquid from the pump
- flush the pump with an adapted solvent
- remove the filter elements from integrated or loosely delivered filters
- protect all openings against dust with the delivered protective plugs or screws
- return the pump in its original packing

The service personnel which carries out the repair should be informed about the condition of the already used micro annular gear pump. This is done by means of the "Declaration of media in contact with the micro annular gear pump and its components" (see chapter 18). This form may also be downloaded from the web site *www.hnp-mikrosysteme.de/download*.

The "Declaration of liquids in contact with the micro annular gear pump and its components" must imperatively be filled in. The nature of liquid which entered into contact with the micro annular gear pump and its components must be specified.
In case of non-compliance, the sender will be liable for any resulting injure to persons or any object damage.

8 Software »mzr-pump control«

Install the delivered software »mzr-pump control« from both diskettes by starting the program »Setup« on the diskette »Disk 1«. The delivered software is compatible with Windows 95®, Windows 98®, Windows NT, Windows 2000® and Windows XP®.

After a successful installation the program »mzr-pump control« can be found in the start menu under »Programs - HNP Mikrosysteme«. After the program has been initiated, data such as the pump type »mzr-2905«, »mzr-4605«, »mzr-7205« and the gear reduction should be set.

The program enables to coordinate metering or continuous delivery tasks. The operating parameters of the micro annular gear pump are set via included user interface.

The »Dosage« operating mode (see figure 31) enables to set constant volumes in units such as ml, mg or rpm as well as pauses for a fixed number of sequences or for continuous operation. Each metering procedure will be configured according to the speed profile which is set for such values as »Max. velocity« and the »Acceleration«. The allowable speed values extend from 1 to 6000 rpm and the acceleration values from 1 to 2000 rotation/s².

The metering procedure can be initiated with the »Start« button or by pressing the enter key. The task may be stopped either with the »Stop« button or by pressing once again the enter key.

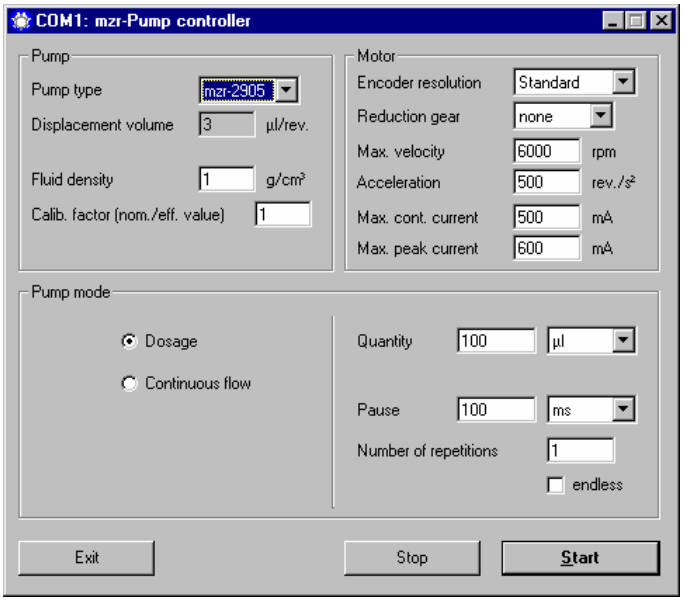


figure 31 Setup window of the »Dosage« operating mode

In the »Continuous flow« operating mode (see figure 32) continuous flow rates in units such as ml/min, g/min and rpm may be set. Operation of the micro annular gear pump may be initiated with the »Start« button or by pressing the enter key for the indicated »Duration« value. Checking of the »endless« box will put the pump to continuous operation. The »Stop« button or pressing of the enter key once again will stop the delivery. If you check the »Potentiometer« box, speed may be set by turning the potentiometer knob in the front of the control module or on the terminal box.

The input of the »Fluid density« enables to convert units of weight to the given volumes or to the given flow rates expressed in volume units. *Remark*: if you are only working with volumes, the indication of the fluid density will not be necessary and the standard value »1« can be left.

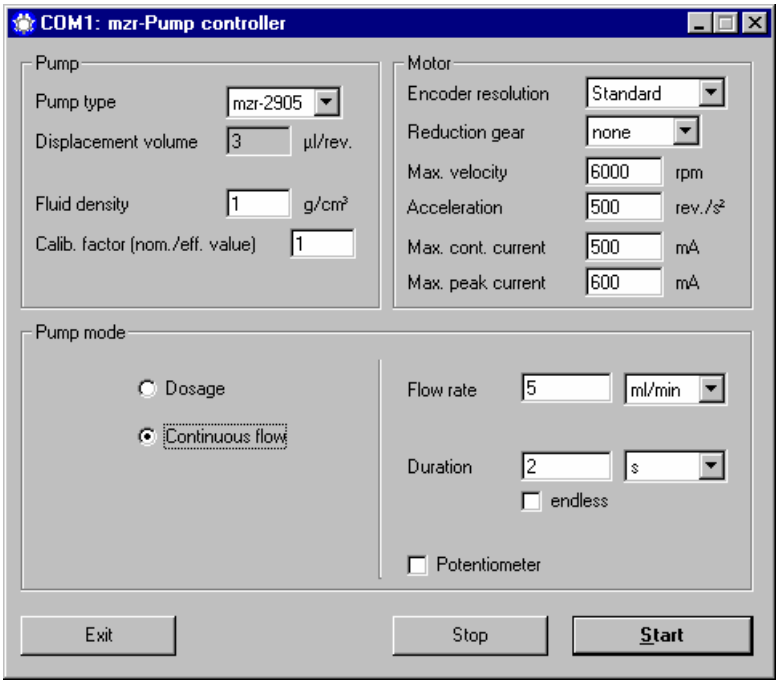


figure 32 Setup window of the »Continuous flow« operating mode

The »Calibration factor« enables to find the relation between the actually delivered quantities or flow rates (= actual value) and the set up quantities or flow rates (=nominal value). The calibration factor is specific to every pump and each application case and therefore should be determined by the user as according to the volume or weight of the delivered fluid. The calibration factor may be calculated according to the following formula:

$$\text{Calibration factor} = \frac{\text{Desired quantity}}{\text{Actual quantity}} = \frac{\text{Desired delivery value}}{\text{Actual delivery value}}$$

In practice, due to the high precision of the system the calibration factor value will only slightly exceed 1.

9 »Motion Manager« software

The »Motion Manager« software enables operation and configuration of the drive and offers a possibility of an online graphic analysis of the operating data. The software is delivered on two diskettes. The program may be installed on a PC running under Windows 95®, Windows 98®, Windows NT®, Windows 2000® or Windows XP® operating systems.

If the »Motion Manager« diskettes are not available, and you have received for example the »mzr- pump control« software, you may still download this program from the following web site: *www.faulhaber.de*. Here, the latest version is always available in German and English. (*Download - Motion Manager*).

Install the software »Motion Manager« by starting the program »Setup« on the »Diskette 1«.

After the installation the »Motion Manager« program may be loaded from the »Faulhaber Motoren« folder from the Windows start menu.

In order to program the drive the micro annular gear pump should be put into operation. The drive and the PC should be connected with the delivered null-modem cable.

9.1 Direct drive control

In the »Motion Manager« software the input commands may be sent directly to the drive. This enables to execute the movement commands and to modify the drive parameters.

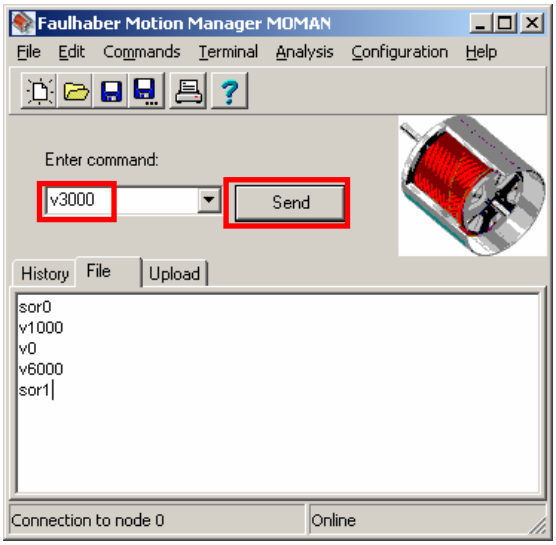


figure 33 Motion Manager software for direct control of the drive

The commands are entered in the field »Enter command:«. The button »Send« will send the command to the drive for execution (see figure 33). The commands may be given alternatively in capital letters or low case. The drive will ignore excess space characters.

An example for continuous delivery

Commands	Description
SOR0	Operating mode RS-232: Set the nominal speed via the RS-232 interface
V1000	Rotation speed of 1000 rpm
V0	Standstill of the pump (speed 0 rpm)
V6000	Speed value 3000 rpm
SOR1	Analog input of the operating mode: setup of the nominal speed with the potentiometer knob or by connecting an external voltage signal to the analog input

An example for discrete dosage

Command	Description
SOR0	Operating mode RS-232: set the position via RS-232 interface
LR10000	Load a relative position of 1000 to the control unit 10,000 = 10 rotations (*Remark: 1000 steps = 1 rotation)*
M	Execute the task / start positioning
LR20000	Load a relative position of 2000 to the control unit 20,000 = 20 rotations
M	Execute the task / start positioning
SOR1	Analog input operating mode: Set nominal speed with potentiometer or by connecting a voltage signal to the analog input

In case of the mzr-2905, mzr-4605 and mzr-7205 micro annular gear pumps 1 revolution of the rotor corresponds to 1000 steps. The gear reduction is to be considered while using a gear reduction module.

For more details concerning the operation of the Motion Manager, please read the online program help.

9.2 Programming of the control

The control of the micro annular gear pump may be adapted by the user to a specific task by means of an easy programming language. The program files are available in the ASCII code and have by default the »mcl« extension which stands for "*m*otion *c*ontroller *l*anguage". Various parameters of the drive such as the maximal speed, the acceleration, the number of rotations, the allowable current load and the parameters of the PI-controller may be programmed with this language. Furthermore, it is possible to program short movement sequences which will be saved in the internal memory of the drive and then autonomously executed.

9.3 Transfer of a mcl file to the drive

The existing mcl files may be loaded to the file editor window using the menu command *File - Open…* (in the program window).

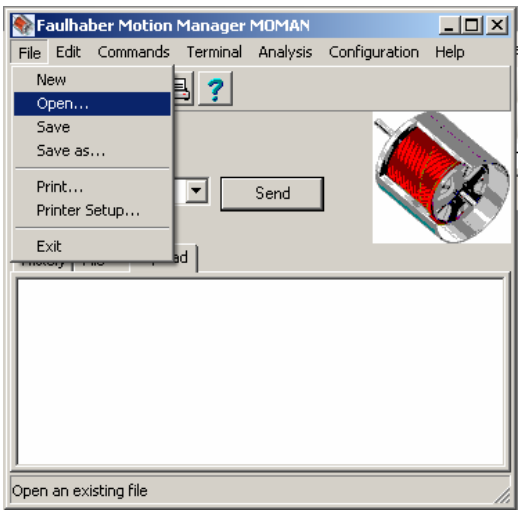


figure 34 Menu file- open

The required mcl file may be selected and loaded via the file selection window (see figure 34). By using the menu command *Terminal - Transfer configuration file* the mcl file will be transferred to the drive (see figure 35).

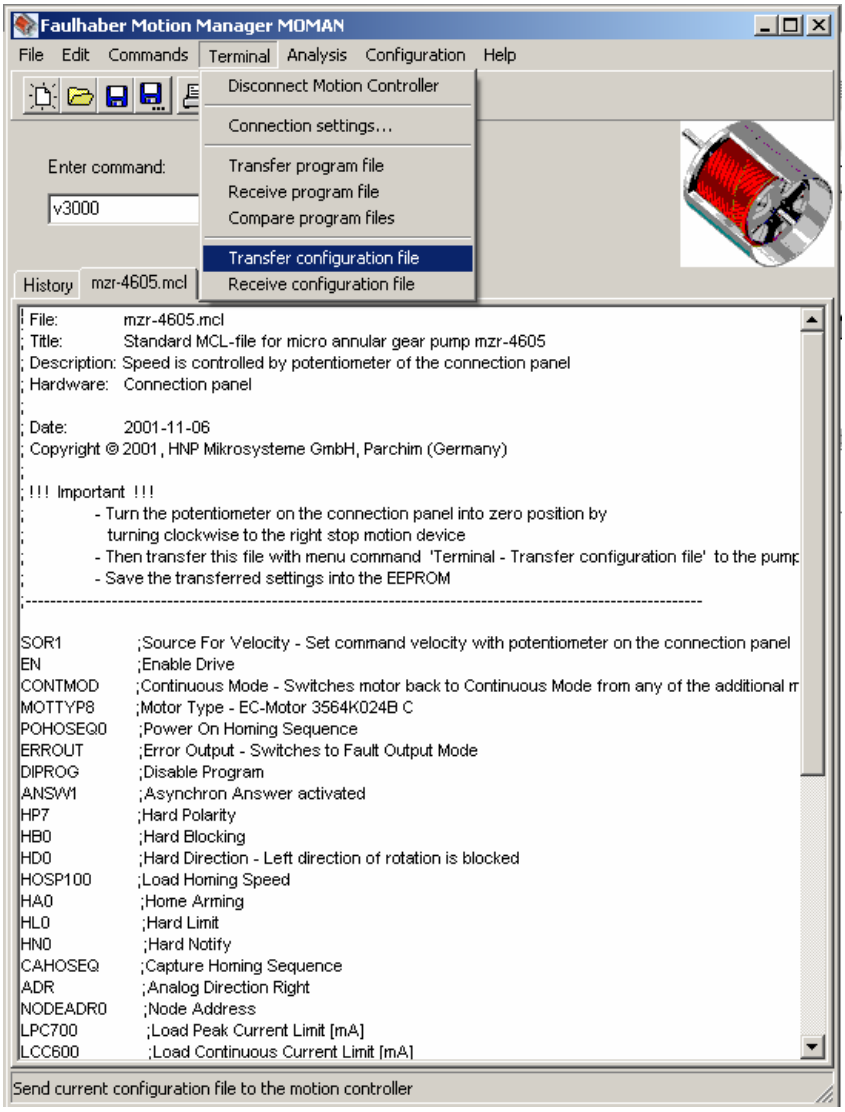


figure 35 Transfer of the mcl files as parameter data

When a window appears with the enquiry if the mcl files should be transferred to the »Motion-Controller«, answer by clicking on the »Yes« button.

In order to save the configuration and the programmed operation files in the EEPROM, confirm the dialogue window with »OK« (see figure 36). By this confirmation the program will be saved in the memory with a resident status and will be available for future operation.

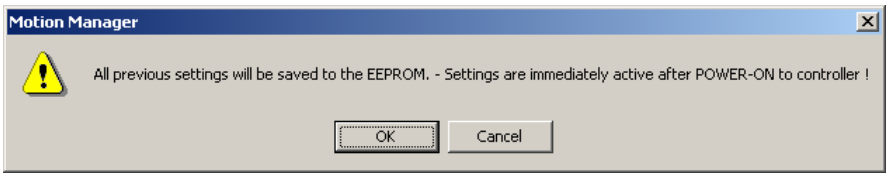


figure 36 Storage confirmation

A diskette with sample mcl programms is delivered along with the Motion Manager. At the delivery the pump has a standard program configuration. Moreover, a sample program that may be started with an external switch is available for discrete dosage tasks.

Pump type	Standard program	Sample program for dosage tasks
mzr-2905	mzr-2905.mcl	dosage_2905_e3.mcl
mzr-4605	mzr-4605.mcl	dosage_4605_e3.mcl
mzr-7205	mzr-7205.mcl	dosage_7205_e3.mcl

table 19 Overview of mcl sample programs

10 Accessories for microfluidic systems

The accessory range for the liquid delivery systems of HNP Mikrosysteme comprises complementary equipment such as hoses, tubes, fluid fittings, filters and non-return valves that are best adapted to your micro annular gear pump. We will eagerly share our long date experience as far as component selection is concerned.

11 Non-liability clause

HNP Mikrosysteme GmbH shall not be liable any damage resulting form the non-respect of instructions comprised in this operating manual.

It belongs to the user to check the integrity, the correct choice and the suitability of the product for the intended use.

It remains at the responsibility of the user to conform to all laws, rules and regulations in force. This applies above all to the treatment of aggressive, poisonous, corrosive and other dangerous liquids.

12 Electromagnetic compatibility (EMC)

The servo motor with sinus commutation and integrated motion controller 3564K024B C(S) has been evaluated and checked in conformity with the Electromagnetic Compatibility Directive 89/336/EEC. In order to help you comply with the EMC-protection measures restrictions concerning the electrical interface have been listed in the enclosed manual »Servomotors with sinus commutation and integrated motion controller«.

An optional adapted EMC protection module may be delivered on demand by HNP Mikrosysteme.

13 Problem shooting

Disturbance	Cause	Solution
1 The pump does not work.	No power supply	Check the power supply.
2 The pump does not pump the liquid.	No liquid in the primary tank	Fill the recipient/tank with liquid.
	Presence of air or gas in the pump	The pump cannot run dry against the system pressure. Fill in the pump at no pressure or at reduced system pressure.
	Malfunction of the liquid supply components (such as in the delivery tube, the needle or external non-return valve)	Check the components for possible disturbances to be eliminated. Cleanse the accessories where needed.
	Failure of the electric installation	Check the electric installation for the correct cable configuration, loose contacts, etc.
	The pump did not receive the start signal or start conditions are not fulfilled.	Check if the start condition have been fulfilled start signals (software control, PLC, start signal) and the programs.
	Motor disturbance: the red error LED is on.	Check the failure condition of the motor control with the Motion Manager software.
3 The pump does not start to operate.	The pump does not take in the liquid.	The tubing on the induction side is too long or has a too small internal diameter (a too low NPSHA value).
		The tubing or the fluid connection on the induction (suction) side are not tight. Please check the intake connection and the tubing.
		Air bubbles in the fluid system (tubes, valves, ...)
		If the viscosity of the liquid is too high, apply pressure on the suction side.
		Check the pressure exerted on the primary liquid tank.
		An external non-return valve does not open. Check the non-return valves.
		Submit the non-return valve to a higher pressure, so that the pump may fill in.
4 The motor turns, but the pump does not operate.	No liquid in the pump	Fill the pump with liquid.
	Air bubbles in the liquid supply system (tubing, valves, ...)	Fill the pump and the liquid supply system with liquid.
	The non-return valve does not open.	Rinse the non-return valve.
	Blocked delivery tubing or needle	Cleansing, flushing or exchange of the delivery tubing or dosage needle
	The coupling between the motor and the pump is out of position.	Return the pump to the manufacturer.
	The pump shaft is broken.	Return the pump to the manufacturer.
5 The pump is filled with liquid, but does not pump it.	Error indicator (the red status LED on the terminal box is on and the motor control has set the error output).	Check the motor error status with the Motion Manager software (command GFS). Try to liberate the pump by making it operate for 1 s in a reverse direction with -1000 rpm.
		Adapt the motor current to the control. Contact the manufacturer of the pump.
	Presence of particles in the delivered liquid or blockage of the pump.	Check the motor error status with the Motion Manager software. Try to liberate the pump by making it operate for 1 s in a reverse direction with -1000 rpm.
		Return the pump to the manufacturer for cleansing. Use a filter, flush the liquid delivery

Disturbance	Cause	Solution
		system.
		Flush the pump with a syringe.
	The non-return valve does not open.	Rinse the non-return valve.
	Blockage of the delivery tubing or the needle.	Cleanse, flush or exchange the delivery tubing or the needle.
	Air bubbles in the liquid delivery system, (tubing, valves)	Fill in the pump and the delivery system with liquid.
6 Dosage volume does not correspond to the set values.	Air bubbles in the liquid delivery system, (tubing, valves ,...) and the pump	Vent the liquid delivery system and check for untight fluid connections.
	Pump shows cavitation.	Too long or too narrow intake tubing. Shorten the intake tubing or change the position of the pump.
	Polluted or too small filter	Change the filter to a new or bigger one.
	The non-return valve does not open.	Rinse the non-return valve.
7 Speed of the pump cannot be adjusted.	Defective electric installation	Check the electric installation for correct cable configuration and loose contacts.
	Defective drive control	Return the drive control to the manufacturer.
8 Liquid drops from the dosing needle.	The non-return valve does not close.	Rinse the non-return valve.
	Too high pressure on the primary liquid tank	Stop the delivery of compressed air on the primary liquid tank.
	The liquid tank is placed at a higher level than the dosing needle.	Place the liquid tank at the same or slightly lower level than the pump.
9 Liquid leaks from the fluidic seal.	The connection kit of the fluidic seal module is untight.	Check the assembly, tighten the threaded connections.
	Pressure on the induction tank of the fluidic seal liquid	Stop the delivery of compressed air on the sealing liquid tank Defective sealing - if necessary return the pump to the manufacturer.
10 The dosage volume decreases with time.	Polluted filter.	Exchange the filter.
	Deposits in the pump.	Flush the pump or return it to the manufacturer for dismantling and cleaning.
	The pump is worn after a long operating period or after use with abrasive liquids.	New definition of the calibration factor of the pump, by modifying the pump characteristics graph necessary.
11 Leakage from the pump	The sealing does not function correctly.	Return the pump to the manufacturer.
12 Leakage from the coupling assembly	Defective shaft seal	Return the pump to the manufacturer to change the shaft sealing.
13 Leakage from the fluid connections	Untight lock rings	Exchange or tighten the fluid connections, exchange the fluid connection fittings.
14 Air bubbles on the delivery side	Loose fluid connections (particularly on the induction side)	Check and tighten the fluid connections.
	The shaft seal is untight or worn.	Return the pump to the manufacturer.
15 Minimal leakage during standstill	No error, cause relative to the operating principle	Employ a non-return valve. Place the liquid tank at the same or slightly lower level than the pump
16 Excess temperature	The surface of the pump is hot.	Clean the surface of the pump, rinse the pump
	The pump operates with difficulty.	The pump should be flushed.
	Particles in the delivered liquid or deposits in the pump	The operation of the pump should immediately be stopped! Return the pump to the manufacturer for cleansing.
	Noise of beveling	The operation of the pump should immediately be stopped! Return the pump to the manufacturer for cleansing and repair.
	The motor surface or the motor interior are too hot.	High temperature indicator in the drive is on. The motor has been shut down by the

Disturbance	Cause	Solution
		thermistor. Return the pump to the manufacturer.
17 The pump is noisy	Wearout of the pump or defective components	Do not continue to operate the pump, return it to the manufacturer for maintenance.
18 Lack of connection with the RS-232 interface	The pump is not connected.	Check the power supply 24 VDC.
		Check the connection of the interface and the null-modem cable. Change the cable if necessary.
	The drive control does not respond.	Interrupt the voltage supply for about 10 s, connect the voltage supply again. Automatic start of the integrated drive control
19 Overcurrent	Particles in the delivered liquid	Rinse the pump.
	The pump operates with difficulty.	Dosing needle is damaged. Needle should be cleansed, flushed or exchanged.
		Tubing on the delivery side, dosing needle or non-return valve are blocked. Cleanse, flush or exchange the components.
	Deposits inside the pump.	Flush the pump. If necessary return the pump to the manufacturer.
20 Undervoltage	Voltage supply < 12 VDC	Check the power supply 24 VDC.
21 Overvoltage	Voltage supply > 28 VDC	Check the power supply 24 VDC. The drive control may be damaged. Return the pump to the manufacturer.

table 20 Problem shooting - causes and solutions.

If a disturbance that has not been mentioned in the above list, or that makes the use of the micro annular gear pump unsafe appears, please stop the operation of the pump without delay and contact the manufacturer.

14 Service, maintenance and warranty.

The maintenance of the micro annular gear pump should be carried out depending on the delivered liquid

– *for lubricating liquids* after 12,000 h working hours, but not later than 24 months after the initial operation

– *for non-lubricating liquids, crystallizing liquids or liquids containing particles,* after 5000 h working hours but not later than 12 months after the initial operation. If during the first inspection no substantial wearout of the pump is observed, the following inspection under the same working conditions should be performed after 8000 h working hours, yet not later than 15 months following to the last inspection.

If during the first inspection the pump shows a particularly strong wearout, the maintenance intervals should be readapted to the operating parameters.

In order to prevent a strong wearout of the pump, the pump should be shut down properly after every application as described in the chapter 7.4. A supplementary flushing procedure with a neutral flushing liquid (see chapter 7.3) also slows down the wearout process of the pump.

It is not allowed to open the micro annular gear pumps. The warranty extincts with the expiry of the legal warranty period or with the opening of the pump. Furthermore HNP Mikrosysteme cannot give any warranty of exchange for parts whose damage result from incorrect use.

For service and maintenance please return your micro annular gear pump to HNP Mikrosysteme (You will find the address on the cover of the present operating manual).

The declaration of liquids having had contact with the micro annular gear pump and components must imperatively be completed. The nature of the liquids must be specified. In case of non-compliance the sender will be liable for any resulting injure to persons or any object damage.

Sealings, rotors and shaft are parts that undergo wear and will be replaced by HNP Mikrosysteme GmbH during maintenance depending on their degree of wear.

15 Contact person

Development and application assistance , service and accessories

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16 Legal information

Marks

Teflon® is a registered trademark of DuPont.

Viton® is a registered trademark of DuPont Dow Elastomers.

Microsoft®, Windows® are registered trademarks of Microsoft Corporation in the USA and in the other countries.

mzr® is a registered trademark of HNP Mikrosysteme GmbH.

Other product names or descriptions not mentioned above are possibly registered trademarks of related companies.

Patents

Micro annular gear pumps (and housings) are protected by assigned patents: DE 198 43 161 C2, EP 1115979 B1, US 6,520,757 B1, EP 852674 B1, US 6,179,596 B1, EP 1354135. Patents pending: DE 101 46 793, US 10,466,792, DE 10 2004 052 866. In the US, Europe and Japan additional patents are pending.

17 Safety information for the return of already employed micro annular gear pumps and components

17.1 General information

The operator carries the responsibility for health and safety of his/her employees. The responsibility extends also to employees not belonging to the company that have a direct contact with the micro annular gear pump and its components during repair or maintenance works. The nature of media (liquids) coming into contact with the micro annular gear pump and its components must be specified in the corresponding declaration form.

17.2 Declaration of liquids in contact with the micro annular gear pump

The staff performing the repair or maintenance works must be informed about the condition of the micro annular gear pump before starting any work on the device. The »Declaration of media in contact with the micro annular gear pump« should be filled in for this purpose.

The declaration should be sent directly to the supplier or to the company designated by the supplier. A second copy of the declaration must be attached to the shipment documents.

17.3 Shipment

The following instructions should be observed for the shipment of the micro annular gear pump.

- drain any remaining liquid from the pump
- flush the pump with an adapted flushing liquid
- remove the filter elements from the integrated or loosely delivered filters
- all the openings should be air-tight plugged
- return the pump in the original packing

18 Declaration of media in contact with the micro annular gear pump and its components

Type of the device

Pump type/serial number/article: .....

Operating hours/running time: .....

Bill of delivery-number and delivery date: .....

Reason of the return: .....

.....

.....

Contact with media (liquids)

The micro annular gear pump has entered into contact with: .....

.....

and has been cleansed with: .....

.....

The safety specification of the liquid has been attached (Yes / No): .....
or is available on the following web site: www.....

If a pump which had contact with dangerous substances could not be properly cleansed prior to the shipment, we reserve the right to entrust a specialized company with the cleansing of the device. The return of the pump in the original packing is purposive. This measure is necessary in order to protect the employees and the delivery staff.

Nature of the delivered liquid:

- ☐ explosive
- ☐ toxic (toxic byproducts)
- ☐ carcinogenic
- ☐ caustic
- ☐ oxidizing
- ☐ radioactive
- ☐ microbiological
- ☐ corrosive
- ☐ susceptible to moisture
- ☐ pH-value: .....
- ☐ other: .....

Declaration

I/we certify herewith that the stated information is exhaustive and correct. The micro annular gear pump and corresponding liquid supply components are shipped in conformity with the applicable regulations.

Company/Institute: .....

Street: ..... Zip code, location: .....

Telephone: ..... Fax: .....

Contact person (in printed characters): .....

Date: ..... Company stamp: .....

Obligatory signature: .....