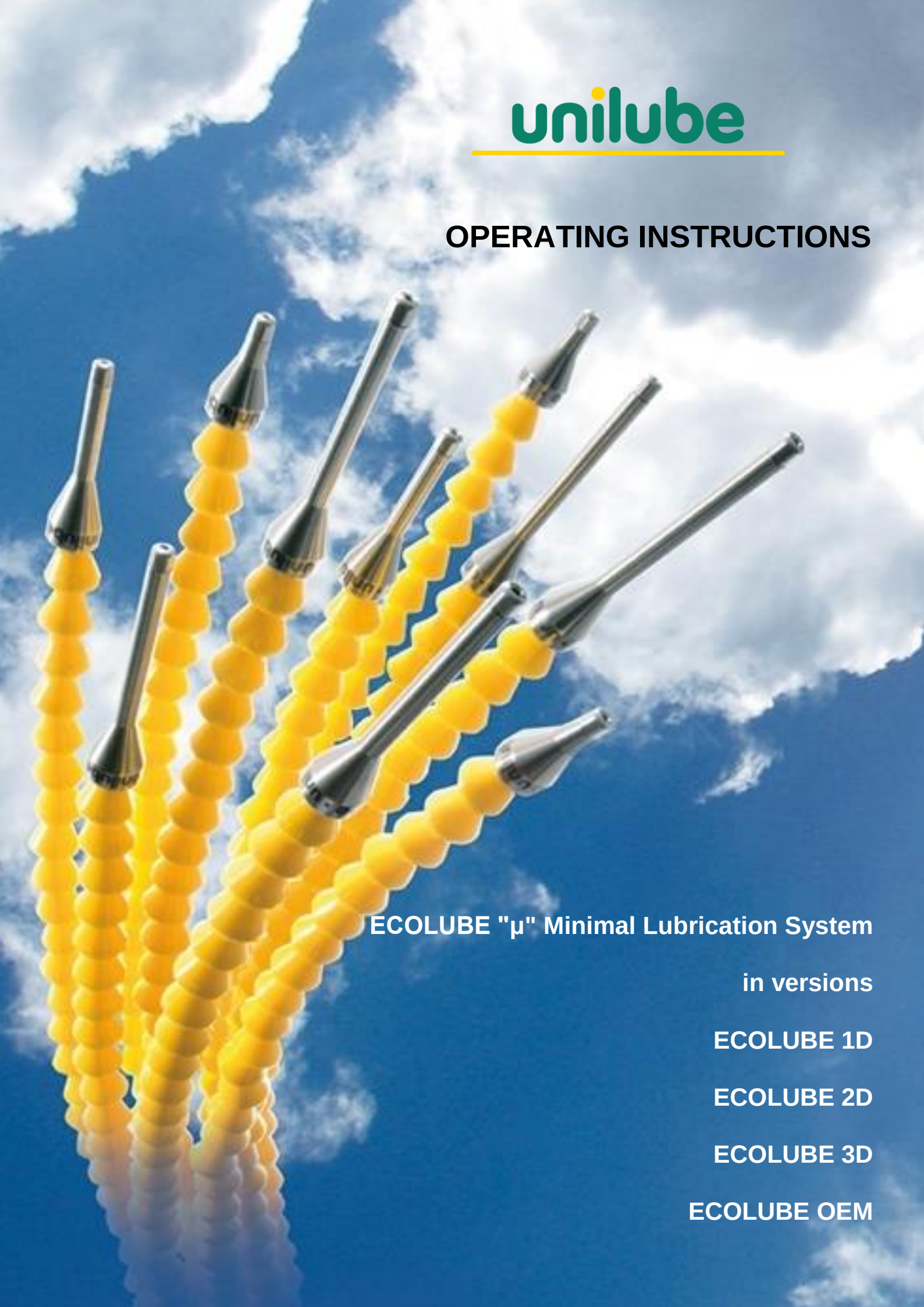
unilube

OPERATING INSTRUCTIONS



ECOLUBE "µ" Minimal Lubrication System

in versions

ECOLUBE 1D

ECOLUBE 2D

ECOLUBE 3D

ECOLUBE OEM

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Quick start-up:

SEE Chapter 9

Important note:

LAYOUT, TECHNICAL SPECIFICATIONS, SAFETY DATA SHEETS and HIGH-PERFORMANCE LUBRICANT INFORMATION SHEET are part of the OPERATING INSTRUCTIONS.

0. General information

0.1 Manufacturing and sales

UNILUBE LTD - MICRO LUBRICATION TECHNOLOGY
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Fig. 1: ECOLUBE "µ" Minimal Lubrication System Version 1D with options, e.g. main control valve with LED socket and level monitoring

1. Field of application and general safety instructions

1.1 The Minimal Lubrication System (MLS) is designed exclusively for applying a minimum quantity of lubricant (MQL) to a spatially limited point of need (e.g. tool, workpiece, bearing).

1.2 Specific warnings and operating instructions for the use of the MLS are given in the chapters of the operating instructions; these are marked with the following symbols and must be observed:

 General warning / Important note

 Fire / explosion hazard

 Danger from electricity

 Eye protection

 **Important note:**

The Minimal Lubrication System must not be started until it has been established that it has been connected in accordance with the operating instructions and associated specifications and that the machine and MLS are in a safe operating condition.

The manufacturer is not liable for damage to or caused by the Minimal Lubrication System resulting from improper installation or use, for example due to unsuitable equipment or settings.

Injury to people or damage to the MLS or the machine can occur due to lack of care or improper working methods; the operator is liable for this injury or damage.

2. Environmental regulations and "Greta"

2.1 The Minimal Lubrication System does not contain any components that fall under the restrictions of the REACH and RoHS directives and is manufactured so that it is CE compliant.

2.2 Correct use of the UNILUBE Minimal Lubrication System ensures that environmentally friendly consumption with highly efficient performance can be achieved because the quantity of lubricant can be matched exactly to requirements. For this purpose, it is absolutely essential that the information in the operating instructions, the technical specifications and information sheets is followed.

Incorrect metering leads to increased consumption, as well as lower performance, and harms the environment.

2.3 The raw materials used in the Minimum Lubrication System are recyclable:

- aluminium, untreated and anodised
- stainless steels
- brass
- plastics, PA, PU, NBR

2.4 When decommissioning and disposing of the MLS at end of life, national regulations must be observed.

3. Composition: Illustration of ECOLUBE 2D with equipment variants

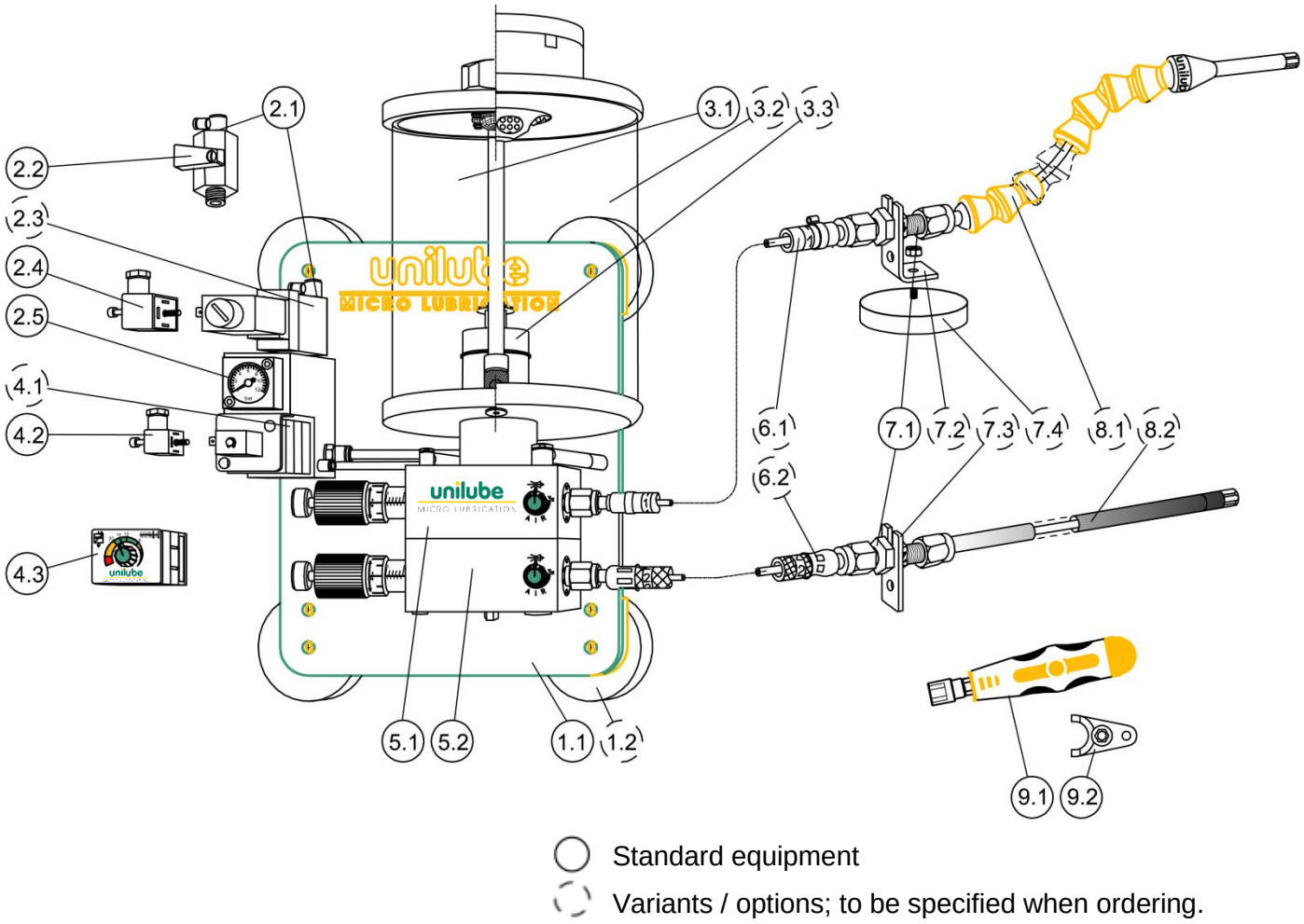

Fig. 2: ECOLUBE "µ" Minimal Lubrication System

1 Panel

1.1 Mounting plate with flange plates (basic dimensions 180 x 230 mm)

1.2 Magnetic base plate with rubberised contact surface, 4x Ø43 mm (option)

2 Connections and operation

2.1 Compressed-air fitting TUBO Ø 8-6, or G 1/8"

2.2 Manual shut-off valve (MSV, 2/2-way, delivered as standard, without option of item 2.3)

2.3 Electric main control valve (MCV, option, instead of item 2.2)

2.4 Cable socket with LED power indicator for item 2.3 (size 30x30 mm DIN 43650-A)

2.5 Pressure gauge for indicating the operating pressure (MLS working range 5 ÷ 8 bar, optimally 8 bar)

3 Lubricant system

3.1 Reservoir with fine filter and twist lid, 0.8 litre version
3.2 Reservoir with fine filter and swivel lid, 1.5 litre version (option)
3.3 Level monitoring (option) with 2-core electric cable (3m)

4 Metering pump control system

4.1 Electric pump control valve (PCV, option, instead of item 4.3)
4.2 Cable socket with LED power indicator for item 4.1 (size 16x16 mm CI-MIKRO - pin 9.4)
4.3 Pneumatic time relay with control valve (PPG, delivered as standard, without option of item 4.1)

5 Lubricant metering

5.1 Combi metering block - initial block with integrated micro metering pump
5.2 Combi metering block - follow-up block with integrated micro metering pump

6 Coaxial feed line

6.1 Nozzle #1 line (transparent plastic hose variant)
6.2 Nozzle #2 line (resistant metal protective hose option)

7 Nozzle attachment and capillary coupling

7.1 Bulkhead nozzle support (with clamping length s $\leq$ 10 mm)
7.2 Retaining bracket (option)
7.3 Retaining clamp (option)
7.4 Magnetic base plate with rubberised contact surface, Ø43 mm (option)

8 Coaxial nozzle arm

8.1 Nozzle # 1 (variant with flexible plastic links with stainless steel tip)
8.2 Nozzle # 2 (variant with rigid stainless steel tube with nozzle head)

9 Service tool

9.1 Socket spanner for swivel lid and vent screw
9.2 Plastic tool for vent screw

4. Structure, mounting and connection

4.1 The specific structure of the MLS and the components can be seen in the (separate) LAYOUT.

4.2 The MLS is fixed vertically to the 4 holes (Ø 6.4 mm) of the mounting plate (see LAYOUT). Attachment using 4 magnetic base plates is recommended only when there is a change in use for the workstation.

Fig. 3: ECOLUBE "µ" Minimal Lubrication System

4.3 The MLS must be positioned in such a way that the reservoir is protected from impact – e.g. by foreign parts – (risk e.g. of breakage and leakage) and that the lubricant can be topped up without any risk of spillage.

Important note:

Avoid mounting on rapidly accelerating axles as there is a risk of overspill or air entering the hydraulic system.

4.4 When installing the coaxial feed line *(Fig. 4* consisting of ring line ② with integrated capillary line ①*)*, make sure that neither kinking nor cracking (e.g. over sharp-edged sheet metal) can occur and that the line is not routed through the chip area (risk of destruction). The minimum bending radius of 35 mm *(Fig. 4)* must be observed. Due to the low weight, the coaxial feed lines should be routed in cable ducts as the top layer where possible.

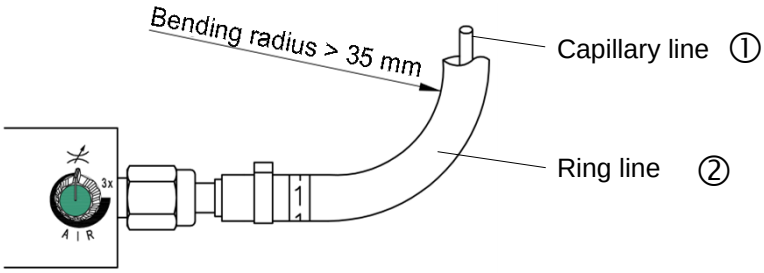

Fig. 4: Coaxial feed line with minimum bending radius

Important note:

Only disconnect the coaxial feed line if absolutely necessary, e.g. to install it in a cable carrier. If possible, only disconnect at the support for the nozzle arm.

If the coaxial feed line or the nozzle arm need to be detached more frequently, it is recommended to use the UNILUBE RAPID coax coupling (option).

4.5 The bulkhead nozzle support *(Fig. 5* ① M10x1, clamping length s ≤ 10 mm*)* is fixed by the bulkhead nut (*Fig. 5* ②) close to the place of use, e.g. in a spindle plate (*Fig. 5* ⑤ supplied by the customer) or fastened by means of a retaining clamp (*Fig. 5* ③ option) or retaining bracket (*Fig. 5* ④ option), so that the nozzle can be oriented in the optimal direction and at the shortest possible distance from the lubrication point or point of need (e.g. at the tool) (see separate TECHNICAL SPECIFICATIONS "Nozzle support" and "Lubricant film application").

A magnetic base plate (option) is only advisable when the place of use changes and must be fitted with good adhesion (risk of the nozzle arm shifting or slipping off).

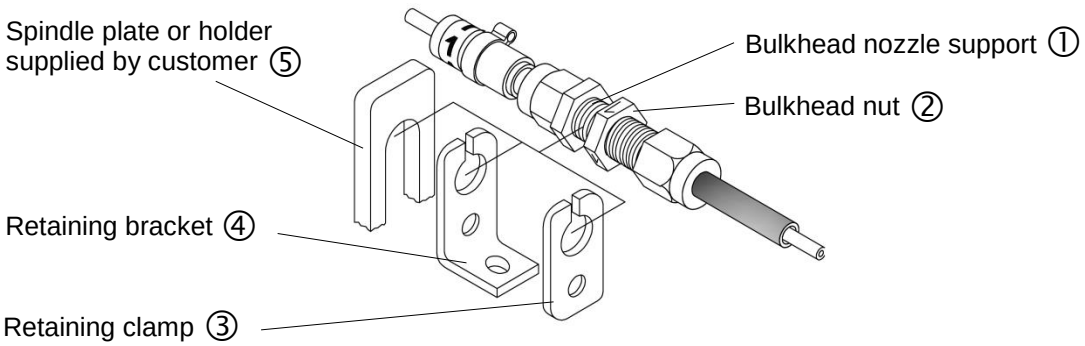

Fig. 5: Bulkhead nozzle support

4.6 The compressed-air line is connected via the push-in screw fitting (TUBO Ø 8x6 mm) or the internal thread (G 1/8") of the Manual Shut-off Valve *(Fig. 6* ①) or the Main Control Valve (MCV, *Fig. 7* ①, option). When the valve is closed *(Fig. 6* ② "Closed" position), the MLS is depressurised; when the valve is open *(Fig. 6* ③ "Open" position*)*, compressed air is supplied to the MLS.

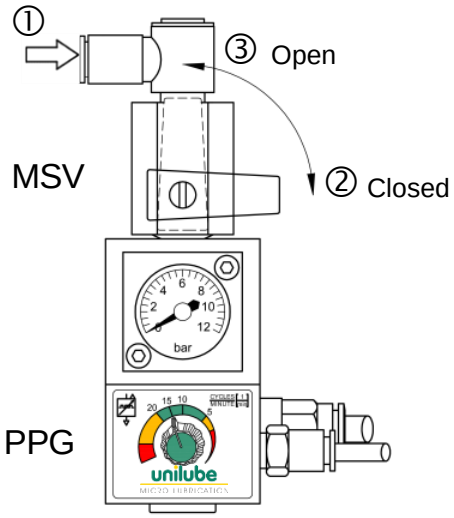

Fig. 6: Manual Shut-off Valve and Pneumatic Pulse Generator – connection and emergency actuation

The supplied compressed air must be absolutely oil-free and dry (ISO 8573 – class 4), and the required operating pressure must be between a minimum of 5 bar and a maximum of 10 bar; the optimum working range is between 6 and 8 bar.

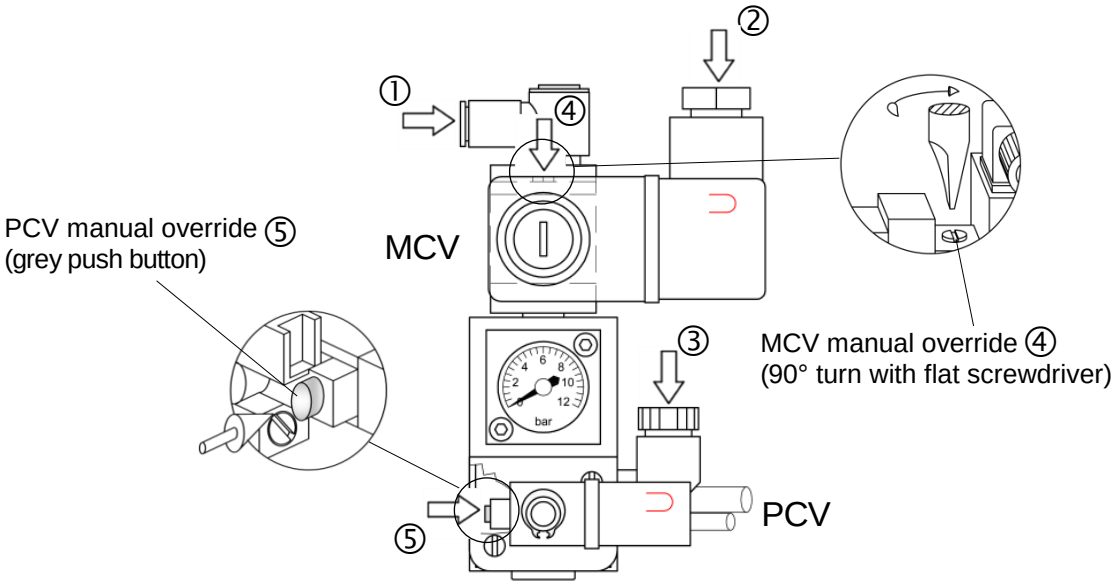

Fig. 7: Electric Main and Pump Control Valve, connections, LED and manual overrides

Important note:

Before any maintenance work, e.g. on the nozzles, the MLS must be depressurised (electric Main Control Valve switched off on the machine side or Manual Shut-off Valve closed, *Fig. 6* ② "Closed" position).

4.7 The MLS is coupled to the machine via the electric 3/2-way Main Control Valve with 24 VDC *(Fig. 7* MCV). A cable socket with LED power indicator *(Fig. 7* ②) is provided for connection to the machine control system; likewise for connection of the electric Pump Control Valve (option PCV, *Fig. 7* ③, for setting the delivery cycles, see Chapter 6.4).

When the machine is at a standstill, overrides are provided for maintenance purposes by means of the manual overrides on the electric Main Control Valve via a screw slot *(Fig. 7* ④) and on the electric Pump Control Valve by pulses via the grey push button *(Fig. 7* ⑤ *& Fig. 15*). If a Manual Shut-off Valve *(Fig. 6*) is fitted, it is activated e.g. via a control valve on the machine side (MLS On – MLS Off).

Important note:

Installation may only be carried out by qualified personnel (e.g. industrial electrician)! Before carrying out repairs, the Minimal Lubrication System must be depressurised and de-energised; do not spray or clean it with water.

5. Filling with high-performance lubricant and operating conditions

5.1 Fill the reservoir with ***UNILUBE high-performance lubricant*** and the MLS is ready for operation (see Chapter 8 "Venting, maintenance and cleaning").

Spilled lubricant must be wiped up immediately.

Dirt particles, e.g. chips or metal dust, must be strictly prevented from entering the reservoir and the hydraulic and pneumatic system (risk of destruction of the micro metering pump).

- 0.8 litre reservoir : Open twist lid (coarse thread and O-ring seal) and place lid on upper flange *(Fig. 8*, protection from loss)
- 1.5 litre reservoir : Open the reservoir lock of the swivel lid with the socket spanner (*Fig. 9*) and swivel the lid open by 180°

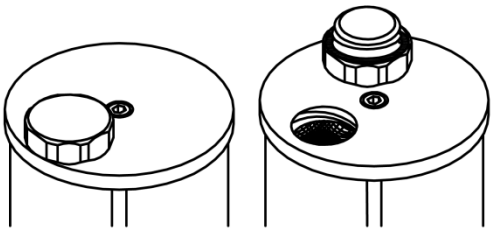

Fig. 8: 0.8 litre reservoir with twist lid

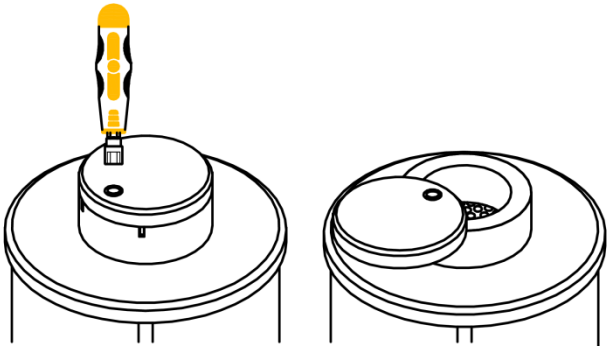

Fig. 9: 1.5 litre reservoir with swivel lid

Important note:

The functionality and efficiency of the Minimal Lubrication System can only be guaranteed when *UNILUBE high-performance lubricants* are used. The safety data sheet and information sheet must be strictly observed.

The use of lubricants from other sources voids all warranties. There is a risk of decomposition (e.g. reservoir glass, seals) or the formation of deposits (e.g. in the micro metering pump). Furthermore, the composition of the products can result in a loss of performance, with the risk of e.g. tool breakage or workpiece destruction or even a risk of damage to health.

5.2 In order to ensure an even application of lubricant, it is recommended, especially after a standstill of longer than 24 hours, to operate the MLS for a few seconds without a consumer (avoid dry running).

Important note:

Check the settings of the Minimal Lubrication System at intervals and ensure sufficient ventilation of the working area. Avoid high lubricant concentrations and the formation of oil mist. It is prohibited to use explosive, corrosive or flammable liquids – risk of injury and fire!

6. Setting tasks

6.1 Setting the metering quantity: The micro metering pump meters the lubricant precisely and at high pressure. The piston stroke and thus the delivery rate can be steplessly varied by turning the micrometer screw *(Fig. 10* ①), the total adjustment range being 5 turns.

Important note:

Adjust the micrometer screw gradually and not beyond the two end stops (minimum and maximum) (risk of destroying the micro metering pump).

The set values can be read off precisely from the two scales on the micrometer screw *(Fig. 10* ② and ③), each mark on the scale representing a 2% change in the piston stroke. Experience has shown that the optimum working range is between 0.1 and 0.5 turns (corresponding to 2% and 10% delivery rate, see *Fig. 19*).

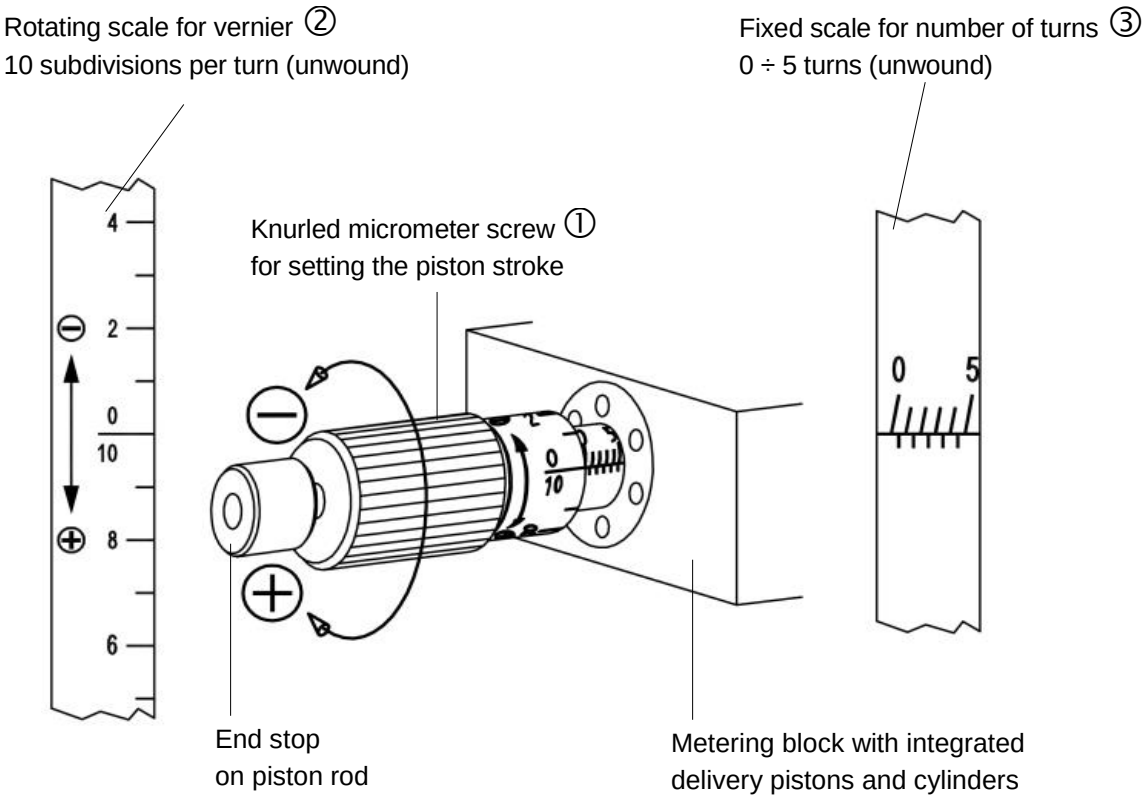

Fig. 10: Metering pump – regulating knob, metering stroke setting with micrometer display for stepless adjustment 0 ÷ 5 turns (0 ÷ 100% delivery rate)

6.2 The function of the Minimum Lubrication System and especially of the nozzles can be checked and visualised e.g. with a paper strip or ideally with a plastic disc. These are moved past the nozzle tip at a distance of about 10 mm. The applied lubricant leaves a fine and even pattern – corresponding to the delivery setting selected – without any drops being formed. This check should be done at regular intervals.

A perfect micro-film of lubricant is just visible by eye on the plastic disc when held up to the light.

6.3 Setting the number of cycles: The Pneumatic Pulse Generator (PPG *Fig. 6 & 14*) determines the cycling of the micro metering pump; the setting is steplessly variable from 0 to approx. 60 pulses/minute by turning the toggle knob (optimum working range: 5 ÷ 20 pulses/minute, *Fig. 14* green). The adjustment range has no stop and the toggle knob can be turned in either direction as desired.

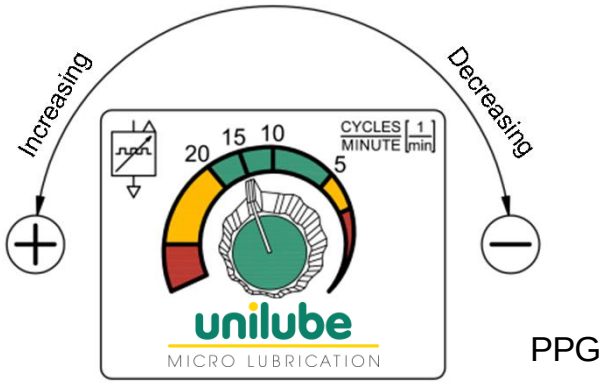

Fig. 11: Pneumatic Pulse Generator – setting number of cycles (5 ÷ 20 pulses/min)

When the electric Pump Control Valve (PCV option, *Fig. 7*) is used, the cycling of the micro metering pump is determined via the machine control system. With a fixed switch-on time (approx. 0.5 seconds), the quantity of lubricant required for the respective process is set by varying the switch-off time (see separate CONTROL DIAGRAM "Minimal Lubrication System with programmable delivery rate").

6.4 When using the MLS as an "air nozzle" without the application of high-performance lubricant, it should be noted that:
By reducing the piston stroke to 0 turns and/or the number of cycles to 0 (see Chapter 6.1 and 6.3), the effect of pure air delivery is achieved. Here and with subsequent reuse of the MLS with ***UNILUBE high-performance lubricant***, run-in phases (with no consumer) are necessary to achieve constant conditions:

- For operation with pure air : The run-in phase discharges lubricant residues from the nozzle.
- For operation with lubricant : After the run-in phase, dry running (lack of microlubrication) is prevented by a constant discharge of lubricant.

6.5 Mixing air setting: The mixing air creates a microfine film of lubricant from the droplet particles and influences the degree of aerosol formation with a mixing ratio of lubricant to air of about 1 : > 1 million, as well as chip removal, etc. Each nozzle is set individually using the associated toggle knob ***(****Fig. 12*, labelled "AIR"). The adjustment range has an almost linear characteristic curve and is limited to 3 turns (max. 150 Nl/min per nozzle at 6 bar operating pressure). The optimal working range when using the standard nozzle is between 0.5 and 1.5 turns.

Fig. 12: Regulating knob with toggle – flow rate of mixing air

7. Factory settings

7.1 After testing, the Minimal Lubrication System is delivered with the following factory settings:

7.1.1 Piston stroke of the micro metering pump
Micrometer screw turned up 0.5 turns
(≙10% delivery rate, *Fig. 10*)

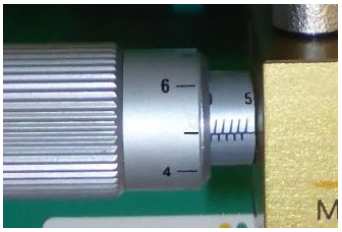

Fig. 13: Micrometer screw – factory setting 0.5 turns

7.1.2 Number of cycles
- Version with Pneumatic Pulse Generator
20 pulses/minute (≙ 20 piston strokes/min, *Fig. 6*)

Fig. 14: Pneumatic Pulse Generator – factory setting 20 cycles / min

- Version with electric Pump Control Valve
  Programmed pulses (≙ CNC machine control system *Fig. 7)*
  (depends on what the customer has programmed)

Fig. 15: Electric Pump Control Valve – cycles from control system

7.1.3 Mixing air
Toggle knob opened by 1.0 turn
(≙ 50 Nl/min, *Fig. 12)*

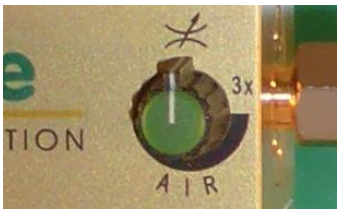

Fig. 16: Air regulation – factory setting open by 1 turn

The setting data listed above apply as general guide values for many applications using ***UNILUBE high-performance lubricants***. However, each use case requires individual adjustment to the conditions; experience has shown that the delivery rate of the micro metering pump can still be significantly reduced under optimised operating conditions (see Chapter 10 "Lubricant consumption values").

Important note:

Check the settings of the Minimal Lubrication System at intervals and ensure sufficient ventilation of the working area. Avoid high lubricant concentrations and the formation of oil mist. It is prohibited to use explosive, corrosive or flammable liquids – risk of injury and fire!

8. Venting, maintenance and cleaning

8.1 Before starting up for the first time and after any maintenance work on the coaxial line or nozzle, the MLS must be vented. As long as the quantity of high-performance lubricant in the reservoir does not fall below a minimum level (intake opening covered, fine filter), no further venting is usually necessary.

A level monitoring system *(Fig. 1 & 2 item 3.3*, option for reservoirs with a nominal volume of 0.8 or 1.5 litres), which can be supplied separately, prevents unintentional emptying because a

signal has been emitted prematurely (refer to separate TECHNICAL SPECIFICATION "Level monitoring").

8.2 The Minimal Lubrication System is vented as follows:

8.2.1 Fill the reservoir with ***UNILUBE high-performance lubricant*** (Chapter 5.1) and do not close the lid during the venting phase to ensure unobstructed air equalisation.

8.2.2 Open the vent screw (*Fig. 17* ①) on the underside of the metering block by hand or with the service tool (*Fig. 17* ② SW 6.35) by approx. 2 turns and drain the lubricant until it comes out without any bubbles (duration: approx. 5 seconds); then close it fully again. Tightening by hand is sufficient (O-ring locking). To flush out the hydraulic system or to empty the reservoir, the vent screw can be unscrewed completely.

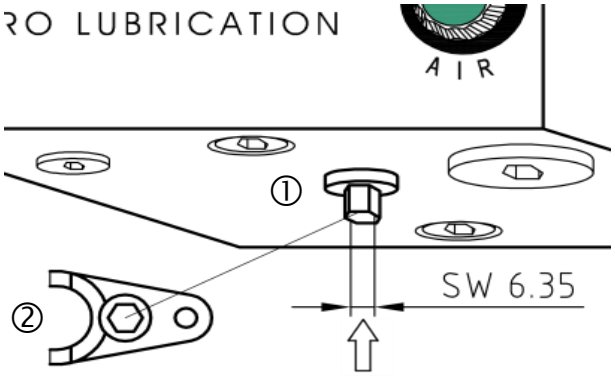

Fig. 17: Vent screw ① on underside of metering block – tool ② with hex socket

8.2.3 Increase the piston stroke of the metering pump to its maximum (open by 5 turns *Fig. 10* ① and Chapter 6.1).

8.2.4 Increase the number of cycles of the PPG to approx. 60 (-120) pulses/minute (*Fig. 11* and Chapter 6.3). For versions with an electric Pump Control Valve (option) in the machine control system, select the setting for venting (depends on what the customer has programmed).

8.2.5 Reduce the air volume of the nozzle via the air regulating screw *(Fig. 12*) to 0.5 turns.

8.2.6 Operate the piston rod by hand. To do this, press the end stop of the micro metering pump *(Fig. 10*) against the micrometer screw approx. 20 times. With no lubricant in the capillary line *(Fig. 18* ① inner pressure hose of the coaxial feed line), lubricant can be seen to enter the capillary line after approx. 18 strokes and air is removed from the hydraulic system.

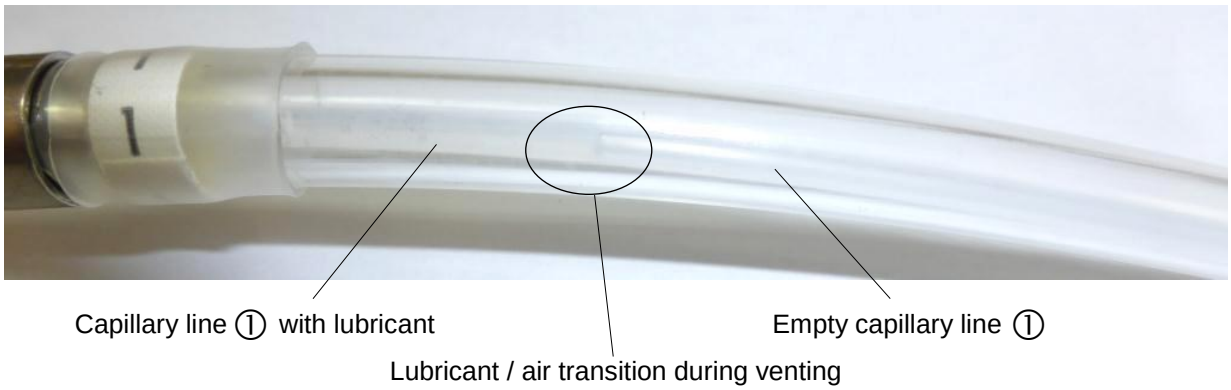

Fig. 18: Capillary line ① filling with lubricant during venting

8.2.7 Switch on the compressed air (e.g. by overriding the MCV *Fig. 7* ④) and watch the air bubbles move through the capillary line until the line is free of bubbles over its entire length up to the nozzle head (duration: approx. 1.5 minutes / 1 metre coax line length).

8.2.8 After the venting process is complete, restore the piston stroke, number of cycles and air volume to the operating values (Chapter 7) and fully close the reservoir.

8.2.9 The functioning of the Minimal Lubrication System and especially of the nozzles can be checked and visualised e.g. with a paper strip or ideally with a plastic disc. These are moved past the nozzle tip at a distance of about 10 mm. The applied lubricant leaves a fine and even pattern corresponding to the delivery setting selected. This check should be done at regular intervals.

8.3 Each time before the reservoir is filled with ***UNILUBE high-performance lubricant***, check the Minimal Lubrication System for leaks or defects; if necessary, remove dirt, chips, etc. with a neutral cleaning agent.

Important note:

When working on the nozzles, make absolutely sure that the tools are at a standstill and the machine is switched off; for maintenance purposes, simulate operation with manual override (see *Fig. 7* and Chapter 4.7). Do not point the nozzle tip at people, especially not at their eyes – risk of injury!

9. Quick start-up guide

9.1 Mount the MLS, fix the lines and nozzles, connect the MLS electrically and pneumatically
Detail: Chapter 4

9.2 Fill reservoir with UNILUBE high-performance lubricant
Detail: Chapter 5.1

9.3 Open the drain and vent screw until lubricant is discharged without any bubbles, then close it
Detail: Chapter 8.2.2

9.4 Turn up the delivery rate of the micro metering pump to its maximum (5 turns) using the micrometer screw
Detail: Chapter 8.2.3

9.5 Set the PPG to approx. 90 pulses/min or the setting in the machine control system for PCV to vent and set the air regulating screw to approx. 0.5 turns
Detail: Chapter 8.2.4 and 8.2.5

9.6 Operate the metering pump manually until lubricant / bubbles can be seen to move in the capillary line
Detail: Chapter 8.2.6

9.7 Operate the MLS mechanically or electrically
Detail: Chapter 4.7 & 8.2.7

9.8 Shut off the MLS mechanically or electrically when the capillary line has no air bubbles in it

9.9 Set factory settings or individual required values (micro metering pump, air regulating screw, Pneumatic Pulse Generator or Pump Control Valve)
Detail: Chapter 7

10. ECOLUBE "µ" consumption values

10.1 The following diagrams *(Fig. 19 & 20*) and calculations allow the lubricant consumption to be determined for different settings. The values are based on continuous operation; when coupled with the work process (e.g. feed rate), reductions in consumption of 50% or more can be achieved. The settings are made according to Chapter 7.

10.2 Example with "factory setting" (heavy chip removal):
Consumption with 0.5 turns of micrometer screw and 20 pulses/minute (***Fig. 19 & 20***)

Calculation:

Maximum delivery rate		0.0155	ml/stroke	(100	%	piston stroke of micro metering pump "µ")
Piston stroke setting	x	0.1		(10	%	delivery rate = 0.5 turns)
Setting for number of cycles	x	20	pulses/min	(20		strokes of micro metering pump "µ")
Operating time	x	60	min	(1		hour)
Consumption per process hour	=	**1.86**	**ml/h**	(continuous operation with **"Factory setting"**)		

10.3 Example with "micromachining" (light machining):
Consumption with 0.2 turns of micrometer screw and 5 pulses/minute (***Fig. 19 & 20***)

Calculation:

Maximum delivery rate		0.0155	ml/stroke	(100	%	piston stroke of micro metering pump "µ")
Piston stroke setting	x	0.04		(4	%	delivery rate = 0.2 turns)
Setting for number of cycles	x	5	pulses/min	(5		strokes of micro metering pump "µ")
Operating time	x	60	min	(1		hour)
Consumption per process hour	=	**0.19**	**ml/h**	(continuous operation with **"Micromachining"**)		

Important note:

The Minimum Lubrication System is delivered with the factory settings according to Chapter 7. The parameters required for individual use cases depend on various factors (e.g. the process, material, tool) and must be optimised individually during operation.

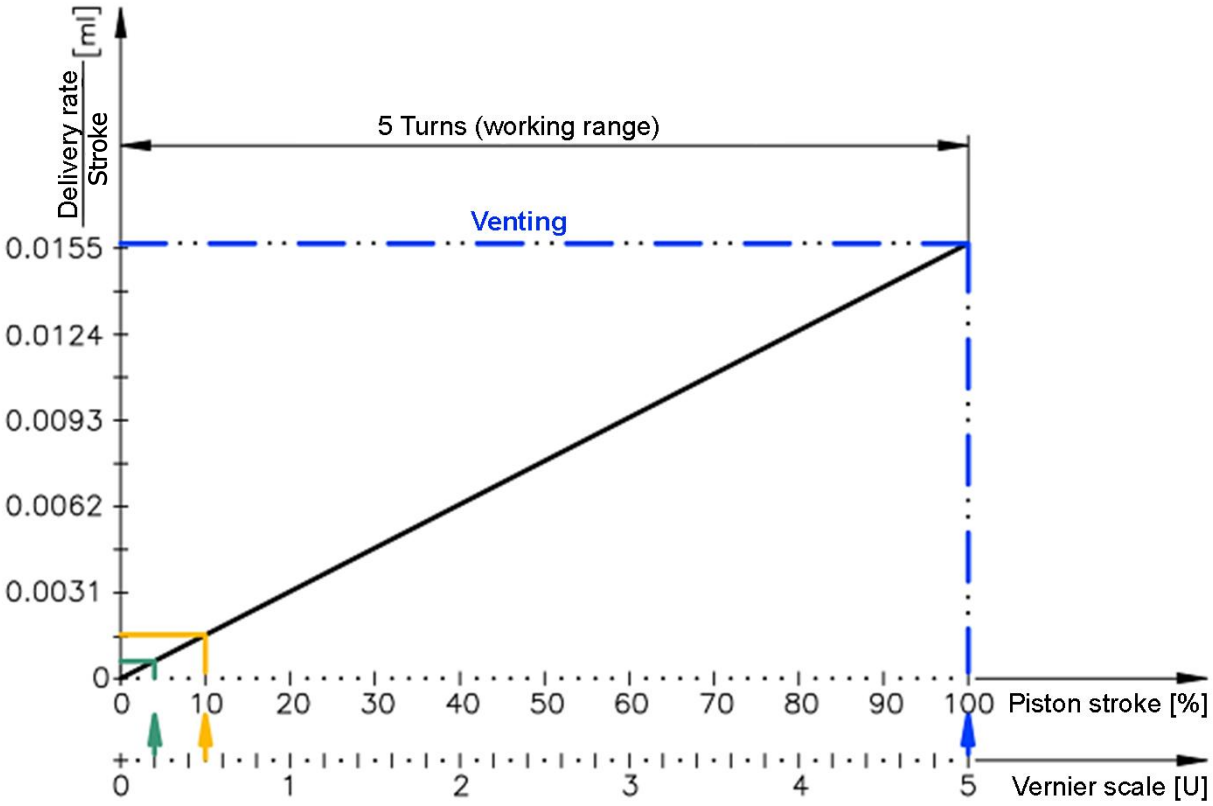

Fig. 19: Delivery rate as a function of the piston stroke

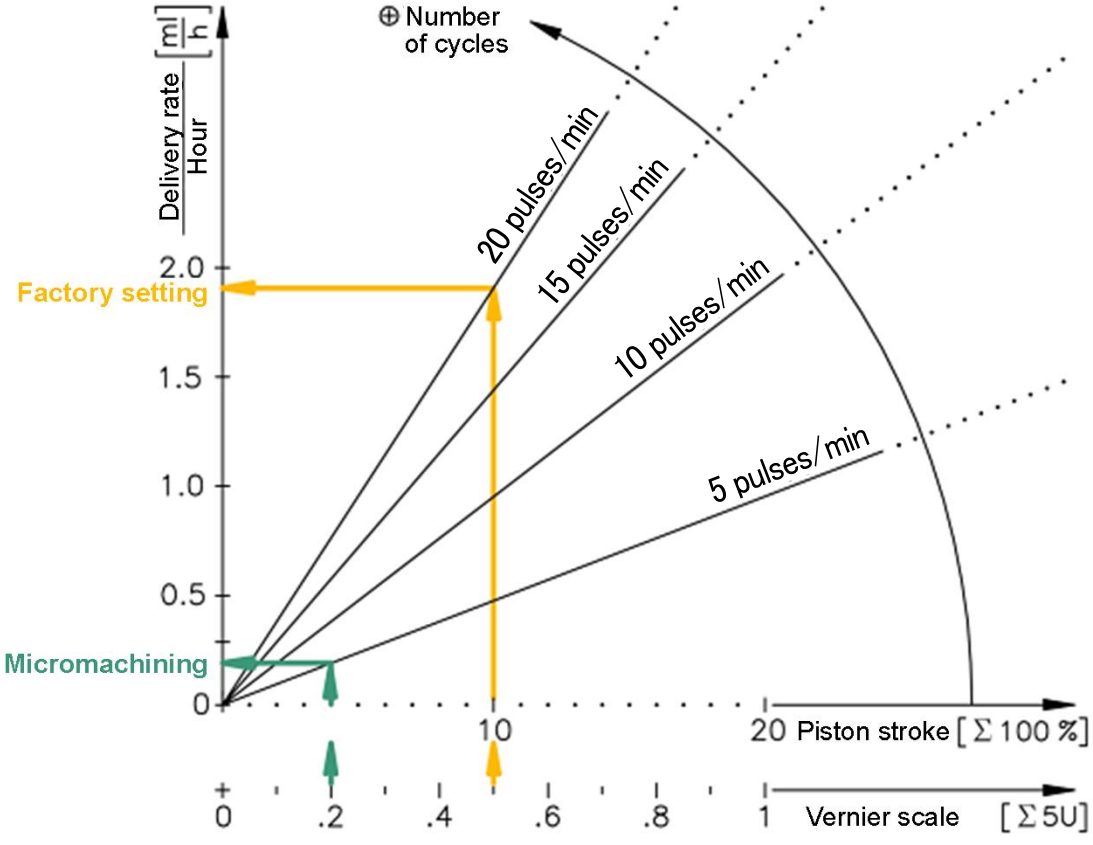

Fig. 20: Consumption as a function of the piston stroke and at different cycle rates (pulses/min)

11. Supplementary documentation

11.1 Available on request:

	Document number
Layout: ECOLUBE 1D, 2D, 3D	SP 9263
Technical specification: main control valve	TS 3006
Technical specification: pump control valve	TS 3037
Control diagram: MLS with programmable delivery rate	SP 9093
Technical specification: level monitoring	TS 3011
Terminal diagram: pin assignment	SP 9166
Nozzle support: design variants	SP 9107
Technical specification: universal nozzle support	TS 3010
Technical specification: RAPID coax coupling	TS 3046
Technical specification: coax standard nozzle	TS 3024
Mounting recommendation: nozzles oriented at saw blade 1D, 2D, 3D	SP 9157
Technical specification: Flexline coax nozzle	TS 3047
Technical specification: spray patterns	TS 3013
Technical specification: circular saw support	TS 3040
Technical specification: band saw support	TS 3023
Project outline: ring nozzle	SP 9271
Technical specification: TIMJET	TS 3038
UNILUBE 2032 safety data sheet	TS 3029
UNILUBE 9107 safety data sheet	TS 3030
Information sheet on UNILUBE high-performance lubricants	TS 3036

11.2 Further drawings of applications and projects available on request.

12. Abbreviations used

MSV	Manual shut-off valve
MCV	Main control valve
ISO	International Organization for Standardization
LED	Light-emitting diode
coax	Coaxial (e.g. nozzle arm, feed line)
MLS	Minimum Lubrication System
NBR	Nitrile butadiene rubber
PA	Polyamide
PPG	Pneumatic pulse generator
PU	Polyurethane
PCV	Pump control valve
TIM(JET)	Tool-integrated microlubrication
VDC	Volts of direct current

Subject to technical changes, Date: August 28, 2023

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