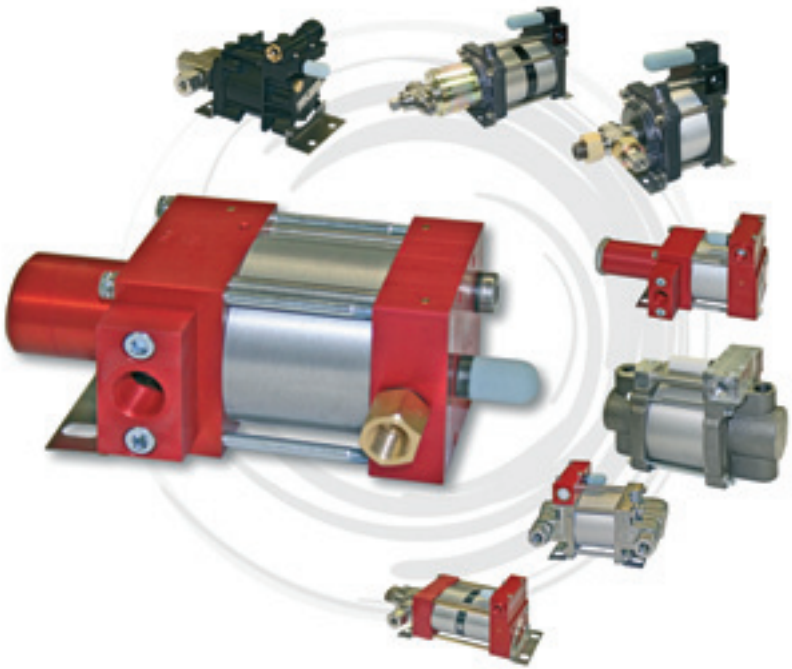
MAXIMATOR®

HIGH PRESSURE TECHNOLOGY · HYDRAULICS · PNEUMATICS · TESTING EQUIPMENT

Operating Instructions
High-pressure pumps



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MAXIMATOR®

MAXIMATOR GmbH
Walkenrieder Straße 15 · D-37449 Zorge · Germany
Telefon 0 55 86 / 803-0 · Telefax 0 55 86 / 8033040
e-mail: info@maximator.de
Internet: http://www.maximator.de

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1 Basic information

High-pressure pumps made by MAXIMATOR can be employed in large variety of applications. They serve to generate high pressures with oil or water.
The pumps are driven by compressed air in the range from 1 to 10 bars.

1.1 Notes on the Operating Instructions

These present Operating Instructions describe the configuration of pumps and provides information relating to their appropriate operation and maintenance. Please, thoroughly study the Operating Instructions prior to the first use of a MAXIMATOR pump. The Operating Instructions facilitate a swift understanding of all technical details and contain all necessary information for proper utilisation of our pumps.
The Operating Instructions include technical data, a technical description, and information regarding start-up, operation and maintenance. Each and any provided technical data as well as dimensions and weights are valid as at the printing date of these Operating Instructions. Such data may deviate for the actual pump model without fundamentally changing the material information and lose validity. Deviations from narrative and pictorial information depend on the respective specific technical features and accessories, which means that the customer may not derive any claims whatsoever from such. Please, make sure to comply with all maintenance, erection and operating notes provided in these present Operating Instructions to ensure full function and safety. The pumps may only be used for applications and purposes listed in these Operating Instructions. The manufacturer will not recognise any claims due to inappropriate operation and insufficient maintenance.

Please, make sure to note and observe all documentation regarding pump components and all other documents and records attached in the annex thereto.

All relevant accident prevention regulations and other generally accepted safety requirements must be observed and complied with.

1.2 Use to the intended purpose

The pumps may only be operated with media for which they are suitable according to the media endurance schedule. Any other media have to be tested by us for compatibility with pump material prior to their use. Pump drives are rated for compressed air up to 10 bars. In addition, any other drive media have to be tested for compatibility with pump materials. Changes and conversions at the pumps are not permitted for safety reasons. The pumps are not rated for longer dry running (without pumping medium). Dry-running for a longer period would result in a tear-off of the lubricating film in the high-pressure part. Dry running for shorter periods (e.g. during venting) gives no cause for concern.

1.3 Warranty and liability

As a rule, the „General Conditions of Sale and Delivery" provided by the pump manufacturer are valid.

Warranty and liability claims in case of personnel injury and/or property damage shall be excluded when such are attributable to one or more of the below causes:

- ❒ Use of a pump to other than the intended purpose.
- ❒ Inappropriate start-up, operation and/or maintenance of a pump.
- ❒ Changes at a pump.
- ❒ Operation of a pump with defective safety installations or improperly mounted safety and protection installations.
- ❒ Non-observance of notes and advices given in these Operating Instructions regarding pump start-up, operation and maintenance.
- ❒ Insufficient monitoring of pump components that are subject to wear and tear.
- ❒ Inappropriate repair work.

2 Safety notes

2.1 General safety directives

Safety of the machines is governed by the below EC Directives:

- ❒ Directive 89/655/EEC
- ❒ Accident prevention regulations VSG 1.1, VSG 3.1
- ❒ Machine Directive 98/37/EC, Annex II A

as well as the applied harmonised standards

- ❒ EN ISO 12100-1 and 12100-2, EN 294, EN 349, EN 418, EN 693, EN 574
- ❒ VBG [Accident Prevention Code] 7n5.2
- ❒ Accident prevention regulations of German Employers' Liability Insurance Association [*Berufsgenossenschaft*]

Pumps may emanate hazards when used by non-skilled personnel, inappropriately or for any other than the intended purpose.

Every person that is ordered to operate or maintain the pumps must have read and understood the complete Operating Instructions prior to carrying out any of such operations. This applies also when the person already with the pumps or received training on pumps.

The owner is advised to request its personnel to verify perusal of the contents of these Operating Instructions in writing. Knowledge of the contents of the Operating Instructions is one prerequisite to protect operatives from hazards as well as avoid faults and thus operate the pumps safe and without disturbances or malfunctions. The Operating Instructions shall be accessible to operating and maintenance personnel at any time! Responsibility for accident-free operation of pumps is the owner or its authorised personnel that is employed in operating or maintaining the pumps.

All notes regarding labour safety refer to the currently valid regulations in the European Community. The applicable laws and national regulations have to be kept in other countries. Both in the European Community and in non-EU countries, the owner is obliged to determine the present status of codes and regulations. Beside the labour safety notes in these Operating Instructions, the generally valid safety and accident prevention regulations must be observed and complied with.

All information provided in these Operating Instructions has to be observed without any restrictions!

2.2 Symbols and signal words

HAZARD

Types and sources of hazards that may result in serious personal injuries or death.
Measures to avert such hazards.

CAUTION

Types and sources of hazards that may result in personal injuries or property damage.
Measures to avert such hazards.

NOTE

Advice for users and useful information.

NOTE

Environmental impacts

2.3 Fundamental Safety measures

2.3.1 Technical condition

Please, observe the following:

- ❒ In order to avoid hazards and ensure optimal performance, do not carry out any changes or modifications at the pumps.
- ❒ The user is obliged to operate the pumps in an appropriate and safe operating condition. The technical condition must conform to all statutory requirements and regulations.
- ❒ Inspect the pumps prior to each start-up for damage and appropriate condition.
- ❒ Any changes at the pumps that have an impact on their safety have to be reported by personnel at once to the owner.

2.3.2 Safety notes relating to pump operation

Check the pumps for operating safety prior to each start-up!

Observe the following safety notes during pump operation:

- ❒ All generally valid safety and accident prevention regulations have to be observed!
- ❒ Make sure to know all installations, actuators and controls as well as their functions prior to starting the pumps!
- ❒ Caution at all hydraulic actuated parts!
- ❒ Make sure during the entire operation that on-site conditions are conducive to the application of the pumps.
- ❒ Stop the pumps at once when any changes are noticed during their operation.

CAUTION

Make sure to depressurise the drive and high-pressure sides of pumps prior to starting any work on the units.

CAUTION

Setting and repair work may only be carried out by certified workshops!

2.3.3 Safety notes relating to maintenance and repair

Operating disturbances that are caused by insufficient or inappropriate maintenance may result in very high repair costs and long downtimes of the pumps.
The manufacturer will not assume any liability for damage that is due to inappropriate maintenance and care!

Required maintenance intervals are specified in a maintenance schedule.

Please, observe the following:

- ❒ The pumps may only be serviced, maintained and repaired by service personnel of the manufacturer or specifically trained and instructed skilled personnel.
- ❒ Each and any maintenance and repair work at the pumps may only be carried out when the pumps have been switched off and depressurised.

2.3.4 Requirements to owner's personnel

- ❒ The hazards that may emanate from the pumps have to be pointed out to personnel before starting any work.
- ❒ Hazards of injury may emanate from the pumps when not operated by properly skilled persons.
- ❒ Each person that is instructed to start up, maintain or repair the pumps must have completely read and understood these Operating Instructions.
- ❒ The Operating Instructions must be accessible to the personnel at any time. It is recommended that taking note of the contents of the Operating Instructions be documented in writing.
- ❒ Upon instruction of the owner personnel has to wear protective clothing.
- ❒ All Safety notes in these Operating Instructions and in all pertaining documents must be observed and complied with at any time and without any restrictions.
- ❒ A pump has to be immediately switched off when hazards are detected that may result in personal injury.
- ❒ Personnel must have well-founded knowledge of the following operational sequences, in-house regulations and behaviours:

  - Operating sequences of the pumps
  - Limitation, safeguarding and marking of hazard zones
  - Behaviour and measures in cases of hazards or emergency

2.4 Specific safety notes

2.4.1 Safety in case of emissions

Depending on the specific type of application, expanding compressed air will generate a certain noise level. Air leaving the silencer may be soiled with water, oil or grease. It is also possible that small ice crystals form at the silencer that may come loose and hurl away. Persons near running pumps may have to wear protective goggles and, as the case may be, ear protection.

2.4.2 Safety in case of defective pumps

During operation of the pumps, both the drive part and the high-pressure part are under pressure. Exiting gases or fluids re under high pressure after a defective but also during normal operation and must not be caught or deflected by objects or body parts. It must be ensured that upon a defect, the pump concerned is immediately depressurised and repaired.

HAZARD

Maintenance and repair work may only be carried after the pumps were depressurised.

2.4.3 Safety at the place of installation

The pumps must not be operated in confined containers. Drive air flowing out may burst the container. Hydraulic bolted unions at suction and pressure nozzles must not be loosened. Bolted unions must be firmly tightened to avoid leakages and damage. Pumps must be installed so that controls and actuating elements as well as bolted unions are freely accessible at any time.

3 Technical Description

MAXIMATOR pumps operate according to the pressure intensifier principle. Large areas are charged with a low pressure (air piston) and generate via the small surface areas a high pressure (plunger piston). Continuous delivery is achieved by means of sustained pulsation that is induced by a pulse-operated 4/2-port directional control valve (main block valve). The main block valve admits alternately the top and bottom side of the air piston. The main block valve is selected via two 2/2-port directional control valves (pilot valves) that are actuated mechanically by the air piston in its stop positions. The pilot valves aerate and vent the operating chamber of the main block valve. The restoring force for the main block valve depends on the driving air. The main block valve has a higher effective surface in the operating chamber than in the drive chamber to which compressed air is continually admitted. The plunger piston generates a volume flow by means of check valves (suction valve, pressure valve). The outlet pressure is calculated by the transmission ratio between air piston and plunger piston multiplied by the drive pressure.
That is, the static ultimate pressure of the hydraulic can be adjusted by regulation of the supply pressure. Upon reaching the ultimate pressure, the pump comes to a standstill and also ceases to consume air. Only a pressure drop on the hydraulic side or a pressure increase on the drive side will re-start the pump. Pumps for manual emergency operation are an exception. The suction stroke in these pumps is performed by a spring (only with pumps M22 to M189). All pumps are single acting. The pumps are equipped with a high-pressure part and an air piston. Liquid is not pumped when the pump carries out a suction stroke but a pulsating pumping flow is generated. Almost all of our pumps can also be built with two high-pressure parts as double acting models. Thus, the pumping capacity is increased and pulsation reduced. Several single acting pumps can be fitted with two or three air pistons to double or triple their nominal pumpage ratio and a higher hydraulic pressure is achieved with a lower drive pressure.

3.1 Functioning of a high-pressure pump

Drive air flows from the port (8) through the main block valve (10) to the bottom side of the air piston (11). The pump carries out a suction stroke. The intake valve (3) opens. The plunger piston (4) sucks the fluid through the intake port (2) into the pump's HP part. In the top end position, the air piston (11) actuates the pilot valve (12). Control air gets from the port (7) to the main block valve (10) and forces the latter into the other switching position.

The space below the air piston (11) is connected with the silencer (9) via the main block valve (10). Simultaneously, drive air is charged to the top side of the air piston (11). A pressure stroke is carried out. The intake valve (3) shuts. The pressure valve (5) is opened and the plunger piston (4) forces pumping medium out of the pressure outlet 86). Both pilot valves (1) and (12) are shut during the pressure stroke. The main block valve (10) is being held in its front position by the pressure entrapped on the large side of the main block valve. When the air piston (11) reaches its lower end position, it actuates the pilot valve (1). The large surface area of the main block valve is vented through a port (Y). The main block valve (10) is pressed by drive air into the outlet position. A new suction stroke commences.

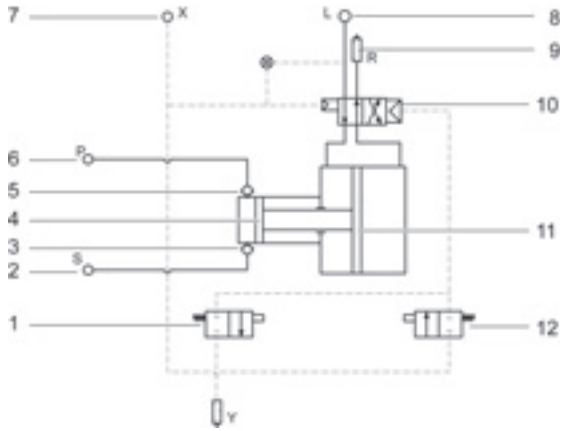


Fig. 1: Functioning principle of a high-pressure pump

1 Pilot valve venting
2 Intake port
3 Inlet valve
4 Plunger piston
5 Outlet valve
6 Pressure outlet
7 Inlet Control air
8 Air port
9 Exhaust air outlet
10 Servo-valve
11 Air piston
12 Pilot valve charged

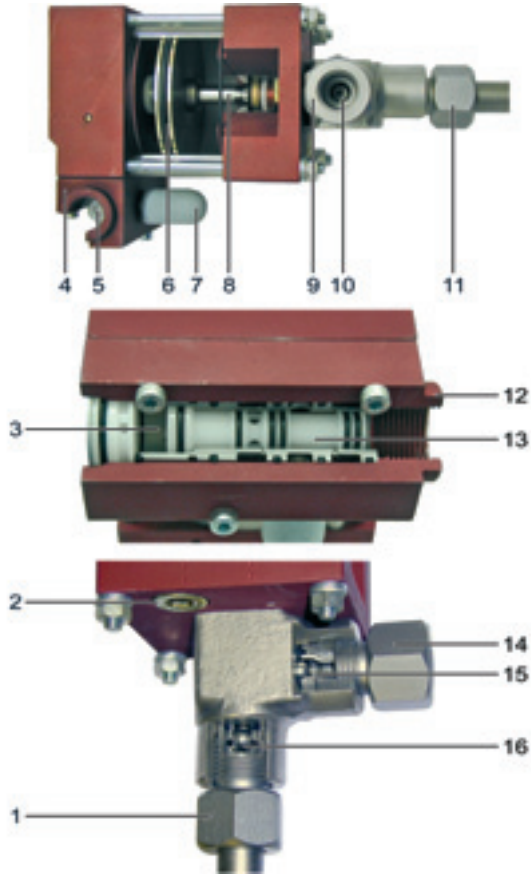
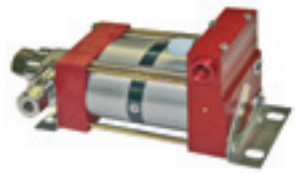
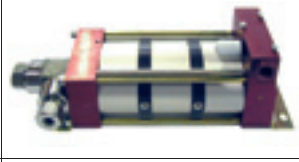


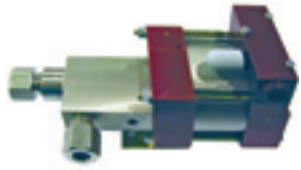
Fig. 2: **Components of a high-pressure pump (Example)**

1 Intake port
2 Pilot valve
3 Actuation space
4 Air port
5 Main block valve
6 Air piston
7 Drive air outlet
8 Plunger piston
9 Pressure outlet
10 Outlet valve
11 Intake port
12 Air port
13 Main block valve
14 Pressure outlet
15 Outlet valve
16 Intake valve

3.2 Overview of high-pressure pumps

Designation	Figure	Field of application
Mini-pumps MP		Pumps for oil up to 1000 bars. ❑ Hoisting and clamping Hydraulic systems for lifting and shifting loads, lifting tables, scissor-type jacks. ❑ Hydraulic applications Clamping devices, stamping machines and presses, clamping chucks, actuation of hydraulic cylinders. ❑ Presses Cold isostatic presses, filter presses, hydraulic presses, pressure generation for presses and press overload protection. ❑ Tools Actuation of cutting and folding devices, cable scissors, tube bending devices, clamping of cylinders, actuation of torque wrenches. ❑ Testing Test machines for pressure and tensile strength tests. ❑ Lubricating systems
Mini-pumps MO		
		
Standard pumps S		
		

Designation	Figure	Field of application
Mini-pumps M		Pumps for water and oil up to 5500 bars. Models: Single- and double-acting, One-, two- and three-stage. ❑ Hydrostatic testing of: Valves, tanks, accumulators, pressure switches, measuring transducers, pressure gauges, shut-off devices for boreholes, components for space and aviation systems. ❑ Burst pressure and life test at the components listed above. ❑ Calibration of pressure gauges and measuring transducers ❑ Water-jet cutting and cleaning ❑ Leakage testing ❑ Emergency-Stop systems for oil and gas platforms ❑ Pressure admission to pressure accumulators
		
		
High-output pumps G		
		

Designation	Figure	Field of application
Pumps MSF		Pumps for chemical and offshore industries up to 1450 bar. Models: With intermediate chamber, leakage boring and PTFE sealings. ❑ Injection of protection agents into pipe systems ❑ Injection of coolants ❑ Testing in aviation and automotive industries ❑ Exchange of chemical fluids and pressure admission.
High-output pumps GSF		
High-output pumps GX		

3.3 Pump designs

Technical characteristics	Design
L	Air recuperation ⇨ Suction stroke
01	Spring recuperation ⇨ Only possible with pump model M22 – M189
D	Double-acting ⇨ higher output capacity, lower pulsation
-2	Two air pistons ⇨ higher pressure ratio (2* Standard)
-3	Three air pistons ⇨ higher pressure ratio (3* Standard)
S	Side-mounted intake socket
VE	Special sealing for operation with water.
DIR	Direct pilot valve air ⇨ at low drive pressures
436	Code number for special models (customised)

3.4 Type ordering code

NOTE

Type ordering codes are required for ordering high-pressure pumps.

The type ordering code for individual high-pressure pumps is composed as follows:

1. Design
2. Pressure ratio
3. Model

Example		
1	2	3
M	37	LVE

NOTE

Explanation of the example:

M Mini-pumps
37 Pressure ratio
L Air recuperation
VE Special sealing for operation with water

4 Erection and start-up

4.1 General notes on erection

Our pumps can be installed in any desired position.
A vertical position entails certain advantages for the durability of sealings because the weight of pistons will not have to be absorbed by the sealings.
Fixing angles are provided for fastening the pumps.

When fastening at intake and pressure sockets, please, make sure that the connections used withstand the pulsating loads applied by the pumps.
Make sure to avoid ingress of any foreign matter into the pump ports during erection (e.g. drilling dust during wall mounting). Remove the blind plugs from pump ports only just prior to fastening the respective ports.
Typical operating temperatures for high-pressure pumps are between –20 °C and +80 °C. Pumps with sealing version –VE for water operation can only be employed up to +60 °C; for short operating periods temperatures up to +80 °C are possible. Special pump models have to be used for outdoor pump applications at temperatures of 0 °C and lower.

4.2 Compressed air system

The compressed-air port requires mounting of a compressed air control unit made by MAXIMATOR downstream of the pumps. The compressed air control unit consists of pressure filter, water separator, shut-off valve, pressure controller, pressure gauge and, if need be, safety valve.

Fig. 3: Compressed air control unit

If the owner of the pumps does not install a compressed air control unit, compressed air quality has to be ensured according to the requirements of the manufacturer.

Requirements to compressed air quality:

- ❑ Solid matter
  Maximum particle size 5 µm
  Maximum particle concentration 5 mg/m³
- ❒ Dew point
  Up to +10 °C, water content of 9.4 g/m³
  Up to + 2 °C, water content of 5.6 g/m³

4.2.1 Compressed air lubrificator

A compressed air lubrificator is not necessarily required. All moving in the pumps parts are treated with special grease during erection.
The grease may become gummy when the pump is operated with extremely dry air for a longer period of time. Use of a compressed air lubrificator is recommended in such cases.

CAUTION

After use of a compressed air lubrificator the pump must never be operated without this oiler. The oil of the compressed air lubrificator purges grease from the pumps so that permanent lubrication cannot be ensured. Special grease made by the manufacturing company may be used for re-lubrication. When employing a compressed air lubrificator, the oil content of compressed air should be 1 mg/m³ to 5 mg/m³.

4.2.2 Pipe cross sections

The compressed air port must not be specified smaller than the port thread. Reduction to smaller port threads may result in performance losses and malfunctions of the pumps. Excessively long supply pipes may give rise to problems due to pressure drop in smaller pipes.

4.2.3 Direct pilot-valve air

In pumps with direct pilot air, the pilot valve air has to be connected upstream of a pressure controller. The pumps can reverse better at lower drive pressures. The pumps will not work when direct pilot valve air is not connected.

NOTE

Direct pilot valve air is available for M and S pumps as a special option.
Double-acting S pumps and G pumps are provided with direct pilot valve air as a standard feature. The respective port is marked with „X".

4.3 Hydraulic system

Hydraulic pipes and accessory parts have to be matched to the pumps in terms of pressure and cross-section otherwise the output capacities and safety of the pumps may be impaired.

4.3.1 Intake pipe

Intake pipes have to be under-pressure tight in order to achieve optimal pump performances. Cutting-ring bolted unions are not suitable.
Intake pipes must not be specified larger or smaller then the pump's intake port.

Pump type	Maximum intake height (in m)
M4 - M12, S15 - S35, G10 - G35	2.0
M22 – M72, S60 – S150, G60 – G150	1.0
M111 – M189, G250 – G500	0.5

An admission pressure in the intake pipe will not result in any problems. Higher intake heights can be achieved. Smaller intake pipe cross-sections are possible.
A filter with a mesh width of less than 100 µm has to be installed into the intake pipe in order to prevent damage at intake and pressure valves as well as HP sealings.

4.3.2 Pressure pipe

The pressure pipe and the pertaining accessories must withstand the maximum outlet pressure of the pumps. The pressure strength may only be fallen short of when an adequate safety valve is installed in the pressure pipe. The cross section of the pressure pipe must not be smaller than that of the pressure port. A smaller cross section will reduce output capacity and lead to higher warming of the pumping medium.

4.3.3 Pumping medium

The pumps may only be used for media that are listed in the media endurance schedule. Any other media have to be tested before utilisation by MAXIMATOR for compatibility with pump materials. Recommended are hydraulic oils with a viscosity of 46 - 68 cst as defined in DIN 51524 T2, DIN 51519 and ISO VG 46. Viscosity of the hydraulic oil should not exceed 100 cst.

Recommended hydraulic oils:

Manufacturer	Hydraulic oil according to DIN 51524 T2, DIN 51519 and ISO VG 46
ARAL	VITAM GF 46
BP	ENERGOL HLP 46
ESSO	NUTO H 46
SHELL	TELLUS Oil 46 HYDROL DO 46 HYDROL HV 46
DEA	ASTRON HLP 46

4.4 Start-up

The pump and the hydraulic system have to be vented to ensure trouble-free operation. The pump is operated at a low stroke frequency. A low stroke frequency is achieved by reducing drive pressure or limiting volume flow. The pump will not intake medium against an existing operating pressure at the outlet socket. The high-pressure side can be vented by loosening the pressure pipe, which facilitates priming of the pump. Longer storage periods may result in gluing of O-rings on the main block valve with the sleeve. The minimum drive pressure will increase. The pump has to be charged with a higher drive pressure (ca. 1.5 to 2 bars) to operate.

5 Maintenance and servicing

5.1 Maintenance notes

The air drives of all pumps are pre-treated with high-performances grease during erection and require no other form of lubrication. During maintenance and servicing work of the pumps, the servo-valves and air pistons shall be treated with an acid- and silicon-free high-performances grease provided by the manufacturing company.

5.2 Servicing

5.2.1 Pressure system

Possible fault	Cause of fault	Fault removal
Pump fails to run at low air pressure.	Friction of O-rings on servo-valve is too high.	❑ Re-lubricate. ❑ Replace O-rings on servo-valve.
	O-rings swell due to use of wrong oil or lubricant.	❑ Change O-rings. ❑ Use acid- and silicon-free lubricant.
Pump runs only a high air pressure.	Air escapes through plunger guide in top cap.	❑ Change O-rings on plunger extension.
	Air escapes through sieve disk in bottom cap.	❑ Replace O-rings on air piston.
Pump fails to run or operates only slowly.	Exhaust or servo-valve covered with ice..	❑ Dewater compressed air with water separator.
	Formation of residue in the silencer.	❑ Clean the silencers. ❑ Replace, if need be.
Pump fails to run. Air escapes through the exhaust.	O-rings at servo-valve are defective.	❑ Change and grease O-rings.
	O-ring at air piston defective or worn out.	❑ Change and grease O-ring.
Pump fails to run. Air escapes through plunger guide in top cap.	Pilot valve is hung up.	❑ Clean and grease pilot valve. ❑ If need be, change pilot valve and sealing.

Possible fault	Cause of fault	Fault removal
Pump fails to run. Air flows through small boring at servo-valve housing.	Servo-valve is hung up.	❒ Clean servo-valve and sleeve. ❒ Check O-rings and sleeve and replace, if need be. ❒ Lubricate.
Pump fails to run. Air escapes through small boring in bottom cap.	Pilot valve in top or bottom cap is hung up.	❒ Clean and grease pilot valve. ❒ Check for wear and tear and replace, if need be.
Pump runs with high frequency and short strokes.	Pilot valve in top or bottom cap is defective.	❒ Clean and grease pilot valve and replace, if need be.
	O-ring on plunger piston in top cap defective.	❑ Replace and grease O-ring.

5.2.2 Hydraulic system

Possible fault	Cause of fault	Fault removal
Pump runs without pumping or runs irregularly. Pump fails to reach its arithmetic end pressure.	Air in hydraulic system.	❑ Vent hydraulic system. ❑ Check intake pipes and bolted unions for leakages. ❑ Check sealing kit between air and hydraulic systems.
	Intake pipe too long.	❑ Shorten intake pipe.
	Intake cross-section too small.	❑ Extend intake cross-section, otherwise the intake flow is disrupted.
	Failure of non-return valve.	❑ Check, clean or, if need be, replace non-return valves.
	Soiled intake filter.	❑ Clean intake filter.
	Worn out packing ring or HP sealing.	❑ Replace sealing kits.

Possible fault	Cause of fault	Fault removal
Fluid escapes through the exhaust.	Worn out packing ring or HP sealing.	❑ Replace sealing kits. ❑ In case of excessive wear: inspect fluid for impurities and sealing compatibility.
Fluid escapes through sieve disk in bottom cap.	Worn out packing ring or HP sealing.	❑ Replace sealing kits.

5.3 Repair

NOTE

Repair instructions for the high-pressure pumps can be found on the Internet at www.MAXIMATOR.de.

CAUTION

Repair work has to be carried out by qualified skilled operatives. Make sure to observe absolute cleanliness. Minor impurities may cause serious damage at precision-machined hydraulic and pneumatic components.

Individual parts of the pumps can be ordered as spare parts from MAXIMATOR. Sealings are subject to high wear and tear. The order numbers and compositions of sealing kits in indicated in the respective drawing. Said drawing is part of each pump documentation and is enclosed to the packaging of the pumps. Please, quote the serial number of the pumps when ordering spare parts. The serial number (a 6-digit number) is located on the machine plate and the pumps housing.

NOTE

You can ship defective pumps for repair to MAXIMATOR. All repair work is conducted by qualified personnel in clean rooms.

5.3.1 Liability for material defects

For high-pressure pumps, manufacturer grants a warranty of twelve (12) months on material quality and workmanship. Said warranty commences on the pump shipment date.

This warranty does not cover defects caused by application of inadmissible fluids and foreign matter in the drive or pumpage media. This shall also apply to excision of maximum operating pressure. This warranty does also not apply to damage resulting from normal wear and tear (wear parts, such as sealings, guiding elements, etc.), improper operation and inadequate maintenance.

6 Technical data

Type	Pressure ratio (i1 / i2)	Stroke volume cm^3	Max. operating pressure bars	Output capacity l/min	Ports		Weight kg
					Inlet A	Outlet B	
MO pumps single-acting with one air drive piston							
MO4	1:4	30.5	40	14.81	G 3/4	G 1/2	2.5
MO8	1:9	14.7	90	7.07	G 3/4	G 1/2	2.5
MO12	1:14	9.4	140	4.55	G 3/4	G 1/2	2.5
MO22	1:29	4.6	290	2.22	G 3/8	G 1/4	3.0
MO37	1:47	2.8	470	1.36	G 3/8	G 1/4	3.0
MO72	1:88	1.5	880	0.72	G 3/8	G 1/4	3.0
MO111	1:133	1.0	1000	0.48	G 3/8	G 1/4	3.0
MO189	1:225	0.6	1000	0.28	G 3/8	G 1/4	3.0
MO pumps double-acting with one air drive piston							
MO22D	1:28	9.2	280	3.91	G 3/8	G 1/4	4.5
MO37D	1:46	5.6	460	2.35	G 3/8	G 1/4	4.5
MO72D	1:86	3.0	860	1.24	G 3/8	G 1/4	4.5
MO111D	1:130	2.0	1000	0.82	G 3/8	G 1/4	4.5
MO189D	1:220	1.2	1000	0.49	G 3/8	G 1/4	4.5
S pumps single-acting with one air drive piston							
S15	1:17	28.3	170	9.38	G 3/4	G 3/4	9.1
S25	1:25	19.6	250	6.72	G 3/4	G 3/4	9.1
S35	1:39	12.6	390	4.31	G 3/4	G 3/4	9.1
S60	1:61	8.0	610	2.75	G 1/2	G 3/8	9.1
S100	1:108	4.5	1000	1.55	G 1/2	G 3/8	9.1
S150	1:156	3.1	1000	1.08	G 1/2	G 3/8	9.1
S-D pumps double-acting with one air drive piston							
S15D	1:16	57	160	17.56	G 3/4	G 3/4	14.5
S25D	1:24	39	240	12.00	G 3/4	G 3/4	14.5
S35D	1:38	25.2	380	7.58	G 3/4	G 3/4	14.5
S60D	1:60	16.0	600	4.80	G 1/2	G 3/8	14.5
S100D	1:107	9.0	1000	2.68	G 1/2	G 3/8	14.5
S150D	1:155	6.2	1000	1.85	G 1/2	G 3/8	14.5

Type	Pressure ratio (i1 / i2)	Stroke volume cm^3	Max. operating pressure bars	Output capacity l/min	Ports		Weight kg
					Inlet A	Outlet B	
M pumps single-acting with one air drive piston							
M4	1:4	30.5	40	14.81	G 1	G 1/2	3.0
M8	1:9	14.7	90	7.07	G 3/4	G 1/2	3.0
M12	1:14	9.4	140	4.55	G 3/4	G 1/2	3.0
M22	1:28	4.6	280	2.22	G 3/8	G 3/8	2.8
M37	1:46	2.8	460	1.36	G 3/8	G 3/8	2.8
M72	1:86	1.5	860	0.72	G 3/8	G 3/8	2.8
M111*	1:130	1.0	1300	0.48	G 3/8	G 3/8	2.8
M189*	1:220	0.6	2200	0.28	G 3/8	G 3/8	2.8
M-D pumps double-acting with one air drive piston							
M22D	1:28	9.2	280	3.91	G 3/8	G 3/8	3.7
M37D	1:46	5.6	460	2.35	G 3/8	G 3/8	3.7
M72D	1:86	3.0	860	1.24	G 3/8	G 3/8	3.7
M111D*	1:130	2.0	1300	0.82	G 3/8	G 3/8	3.7
M189D*	1:220	1.2	2200	0.49	G 3/8	G 3/8	3.7
M-2 pumps single-acting with two air drive pistons							
M111-2*	1:261	1.0	2500	0.35	G 1/4	9/16-18 UNF	3.9
M189-2*	1:440	0.6	4000	0.21	G 1/4	9/16-18 UNF	3.9
M-3 pumps single-acting with three air drive pistons							
M111-3*	1:391	1.0	2500	0.24	G 1/4	9/16-18 UNF	4.6
M189-3*	1:660	0.6	4000	0.14	G 1/4	9/16-18 UNF	4.6
G pumps single-acting with one air drive piston							
G10	1:11	90	110	18.53	G 1	G 3/4	16.0
G15	1:16	62.0	160	12.86	G 1	G 3/4	16.0
G25	1:28	35.3	280	7.24	G 3/4	G 3/4	14.5
G35	1:40	24.5	400	5.02	G 3/4	G 3/4	14.5
G60	1:63	15.4	630	3.21	G 3/4	G 1/2	13.5
G100*	1:113	8.8	1050	1.81	G 3/4	G 1/2	13.5
G150*	1:151	6.6	1450	1.36	G 3/4	G 1/2	13.5

Pumps marked with * are equipped with a port with G (BSP) thread up to max. 1000 bars as a standard. Port threads for higher pressures with 9/16-18UNF can be delivered.

Type	Pressure ratio	Stroke volume cm^3	Max. operating pressure bars	Output capacity l/min	Ports		Weight kg
					Inlet A	Outlet B	
G250*	1:265	3.8	2650	0.77	G 1/2	9/16-18 UNF	13.5
G300*	1:314	3.2	3140	0.65	G 1/2	9/16-18 UNF	13.5
G400*	1:398	2.5	4000	0.51	G 1/2	9/16-18 UNF	13.5
G500S*	1:519	1.9	4500	0.39	G 1/2	9/16-18 UNF	13.5
G pumps double-acting with one air drive piston							
G10D	1:10	180.0	100	28.85	G 1	G 3/4	22.0
G15D	1:15	124.0	150	19.84	G 1	G 3/4	22.0
G25D	1:27	70.6	270	11.36	G 3/4	G 3/4	19.0
G35D	1:40	29.0	400	7.74	G 3/4	G 3/4	19.0
G60DS	1:63	31.4	630	5.04	G 3/4	G 1/2	17.0
G100DS*	1:113	17.6	1050	2.78	G 3/4	G 1/2	17.0
G150DS*	1:151	7.6	1450	2.10	G 3/4	G 1/2	17.0
G pumps single-acting with two air drive pistons							
G10-2	1:22	90.0	220	15.89	G 1	G 3/4	20.5
G15-2	1:32	62.0	330	11.02	G 1	G 3/4	20.5
G25-2	1:56	35.3	560	6.19	G 3/4	G 3/4	19.5
G35-2	1:80	24.5	800	4.0	G 3/4	G 3/4	19.5
G60-2*	1:126	15.4	1260	2.76	G 3/4	G 1/2	18.0
G100-2*	1:226	8.8	2100	1.55	G 1/2	9/16-18 UNF	18.0
G150-2*	1:300	6.6	2900	1.16	G 1/2	9/16-18 UNF	18.0
G250-2*	1:530	3.8	4500	0.66	G 1/4	9/16-18 UNF	22.0
G300-2*	1:628	3.2	4500	0.56	G 1/4	9/16-18 UNF	22.0
G400-2*	1:796	2.5	5500	0.44	G 1/4	9/16-18 UNF	22.0
G500-2*	1:1038	1.4	5500	0.34	G 1/4	9/16-18 UNF	22.0

Pumps marked with * are equipped with a port with G (BSP) thread up to max. 1000 bars as a standard. Port threads for higher pressures with 9/16-18UNF can be delivered.

Type	Pressure ratio	Stroke volume cm^3	Max. operating pressure bars	Output capacity l/min	Ports		Weight kg
					Inlet A	Outlet B	
MSF pumps single-acting with one air drive piston, intermediate chamber and leakage boring							
MSF4	1:4	30.5	40	14.81	G 1	G1/2	6.7
MSF8	1:9	14.7	90	7.07	G 3/4	G1/2	6.7
MSF12	1:14	9.4	140	4.55	G 3/4	G1/2	6.7
MSF22	1:28	4.6	280	2.22	G 3/8	G 3/8	3.5
MSF37	1:46	2.8	460	1.36	G 3/8	G 3/8	3.5
MSF72	1:86	1.5	860	0.48	G 3/8	G 3/8	3.5
MSF111	1:130	1.0	1000	0.28	G 3/8	G 3/8	3.5
GSF pumps single-acting with one air drive piston, intermediate chamber and leakage boring							
GSF10	1:11	90.0	110	18.53	G 1	G 3/3	20.0
GSF15	1:16	62.0	160	12.86	G 1	G 3/4	20.0
GSF25	1:28	35.3	280	7.24	G 3/4	G 3/4	19.0
GSF35	1:40	24.5	400	5.02	G 3/4	G 3/4	19.0
GSF60	1:63	15.7	630	3.21	G 3/4	G 1/2	18.0
GSF100*	1:113	8.8	1050	1.81	G 3/4	G 1/2	18.0
GSF150*	1:151	6.6	1450	1.36	G 3/4	G 1/2	18.0

Type	Pressure ratio	Stroke volume cm^3	Max. operating pressure bars	Output capacity l/min	Ports		Air drive	Weight kg
					Inlet A	Outlet B		
GX pumps								
GX35	1:36	180	360	24.50	1 FNPT	3/8 FNPT	G 3/4	24.0
GX60	1:66	65	600	23.00	1 FNPT	3/8 FNPT	G 3/4	24.0
GX100	1:117	36	1000	9.00	1 FNPT	3/8 FNPT	G 3/4	24.0

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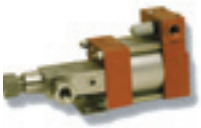

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MAXIMATOR® GmbH
Walkenrieder Straße 15 • D-37449 Zorge
Fon +49 (0) 55 86 / 80 30 • Fax +49 (0) 55 86 / 8 03-30 40
eMail: info@maximator.de • Internet: www.maximator.de

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