Purpose of full-vacuum chlorinators

Chlorine gas is important for the disinfection of potable and swimming pool water but also represents a source of danger as far as handling, transportation and storage are concerned. Therefore the vacuum principle has been used in chlorination installations already for decades. According to this principle, the pressure of the chlorine gas is reduced to vacuum, and only then, if the vacuum is sufficient, will chlorine gas flow to the metering point.
The main safety aspect is that the escape of chlorine gas is actually avoided. Even in the case of a line rupture chlorine gas cannot escape but only ambient air can be primed.

Full-vacuum chlorinator C 2212

The full-vacuum chlorinator used as pressure reducing valve is of central importance for the safety in vacuum installations. For this reason the C 2212 version has been designed in accordance with the highest safety standards. Its compact design is most suitable for installations of simple structure. The C 2212 combines several functions in one housing:
(all numbers in brackets refer to the schematic diagram on the page MB 2 04 12 / 3).

a) Vacuum regulation

In the initial position the ball (1) rests on the valve seat (2). It is pressed onto the seat by the locking spring (3) and the chlorine cylinder pressure and closes the system. After switching on the ejector (water-jet pump), a vacuum is generated. The vacuum applies a force to the working diaphragm (7) of the full-vacuum chlorinator, which is directed to the right. This force is transferred to the valve ball (1) by the valve rod (8) so that chlorine gas enters the vacuum system. If the vacuum breaks down, the valve ball falls back immediately onto the valve seat and stops the chlorine gas supply.

b) Flow indication and adjustment

A flow meter is mounted on the front side of the C 2212 full-vacuum chlorinator. The positon of the float element (11) indicates the flow directly at the scale on the gauge tube. Gauge tubes with maximum rates between 25...4000 g Cl_2/h are available.

Attention:
The constant volume of chlorine gas delivered per hour from one chlorine cylinder must not exceed 1 % of the original contents. Consequently the maximum rate for e.g. a 65 kg cylinder is 650 g Cl_2/h. Otherwise there is the risk of cylinder icing. If larger amounts are required, the chlorine is supplied simultaneously from several cylinders (see installation examples).

The chlorine gas flow can be easily adjusted using the needle valve (12) located directly at the measuring glass holder.

Note:
For automatic control of chlorination an electrically operated chlorine control valve (see MB 2 07 10) is used. If required, it is installed anywhere in the tubing line to the ejector non-return valve.

Note:
If the chlorination installation is to correspond to the German standard DIN 19606, a back-pressure regulator must be used, which avoids pressure fluctuations in the system. The back-pressure regulator is integrated in the non-return valve (see MB 2 32 01).

c) Safety valve

If the inlet valve of the vacuum chlorinator does not close completely due to impurities, it is possible that an excessive pressure develops in the vacuum piping system which causes undesired chlorination. To avoid this, the safety valve is used. Even the lowest pressure causes the large working diaphragm (7) to move to the left. Thus the spring (8) is compressed and the diaphragm disk (9) lifts off from the valve seat (10). As a result a flow tunnel opens at the diaphragm disk, and the excessive pressure escapes into the left chamber of the vacuum chlorinator.
The end of the blowdown pipe is run near the gas sensor. Thus an immediate alarm signaling is ensured.

d) Residual pressure preservation

While emptying the chlorine cylinder, the cylinder pressure decreases until it is too low to remove the ball (4) against the spring (6) from the valve seat (5). A residual pressure of approx. 0.1 bar remains in the cylinder.
Thus humidity cannot enter the cylinder during replacement. The humidity of the entering air would cause the chlorine cylinder to corrode internally so that the chlorine gas could be contaminated. Consequently, the residual pressure preservation helps to extend the operational life of the chlorine cylinder.

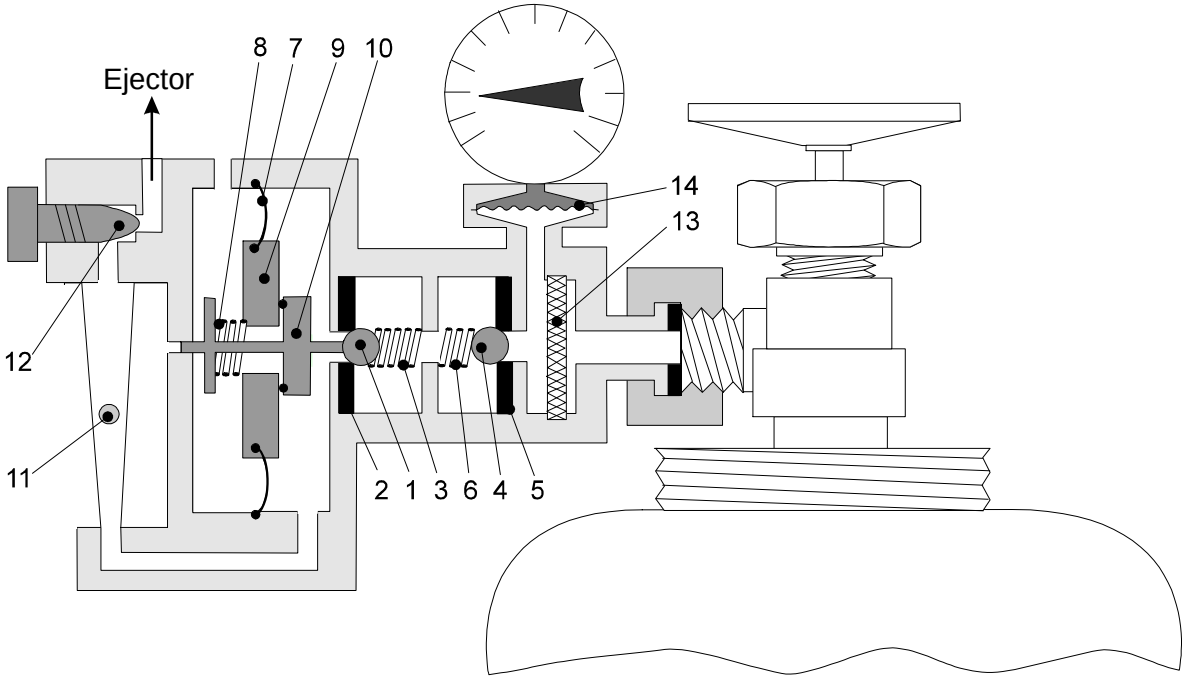
e) Pressure gauge

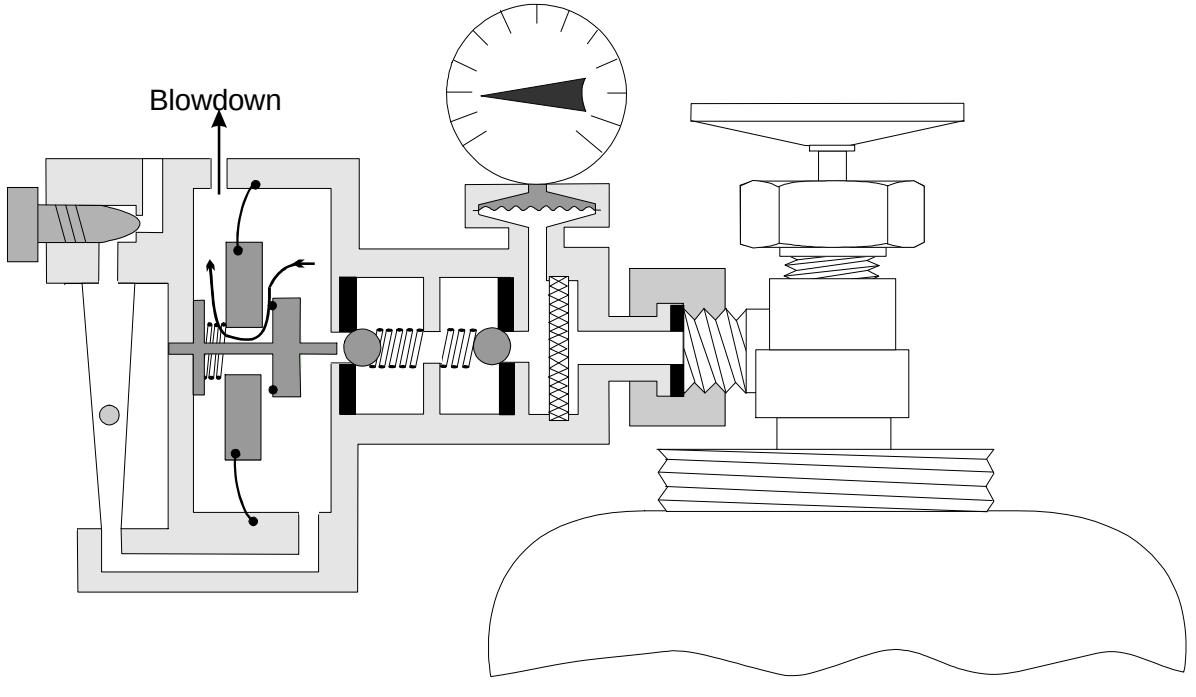
The C 2212 chlorinator is equipped with a pressure gauge for the indication of the cylinder pressure. The gauge is protected by a silicone-diaphragm separator transmitting the pressure harmlessly, and has a hydraulically coupled, splash-proof measuring element in a plastic housing. The separating diaphragm (14) is coated with a silver film as a protection against the chlorine gas. In order not to damage it by dirt particles the chlorine gas is directed through an integrated filter (13) before reaching the pressure gauge.
The measuring range of the pressure gauge is -1...0...15 bar so that also the residual pressure preservation function can be controlled.

Technical data of the full-vacuum chlorinator

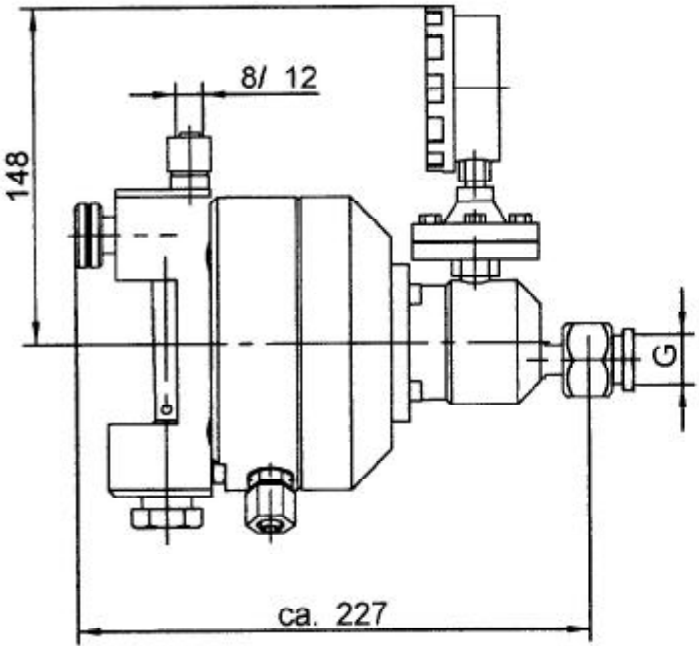
Materials	chlorine-resistant such as nickel-plate brass, Hastelloy, PVC, Viton
Operating vacuum	80 mbar (for 200g/h)
Response pressure of safety valve	30 mbar
Maximum flow	depending on the measuring glass, up to 4000 g/h
Setting ratio	1:20
Accuracy	+/- 6% final scale reading
Weight	3000 g
Pressure stage	PN16
Pressure conneciton	union nut W1", G5/8, G3/4
Metering connection	PE tubing d 8/12
Blowdown connection	PE tubing d 8/12

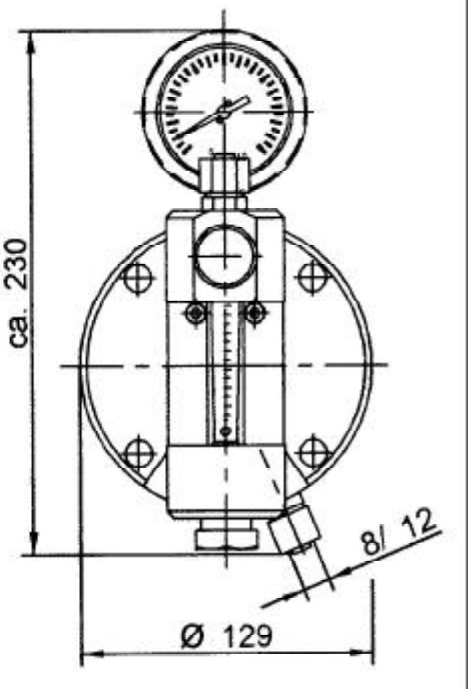
Schematic diagram of the full-vacuum chlorinator C 2212





Dimensions C 2212





Full-vacuum chlorinator C 2212

Measuring range	Cylinder connection		
	W 1"	G 5/8	G 3/4
1... 25	20401200	20401208	20401216
4... 80	20401201	20401209	20401217
10... 200	20401202	20401210	20401218
25... 500	20401203	20401211	20401219
50... 1000	20401204	20401212	20401220
100... 2000	20401205	20401213	20401221
125... 2500	20401206	20401214	20401222
200... 4000	20401207	20401215	20401223

Tubing / Accessories

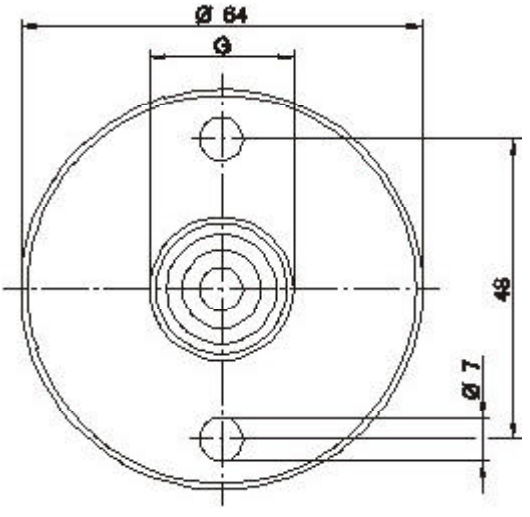
PE d 8/12	Part No. 97124
PVC d 8/12	Part No. 97561
PE d 12/16	Part No. 97176
Ammonia bottle (30ml)	Part No. 13513
Accessories kit (5m PE tubing, mounting brackets, ammonia)	Part No. 22412
Fork wrench SW32	Part No. 15901

Wall holder

Two different wall holders are available:
A PVC wall holder is used to receive the chlorinator while the cylinder is exchanged and closes the pressure connection at the same time. Thus the entry of humid air is avoided effectively also during replacement of the cylinder.

A steel wall holder (see MB 2 23 03) is used as a permanent connection unit. The chlorinator is mounted onto the wall holder and is supplied simultaneously from several chlorine cylinders via a manifold. Thus it is possible to meter large quantites with just one chlorinator (see installation example 2).

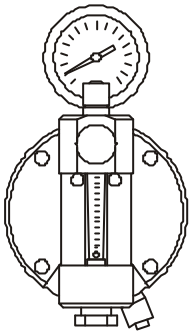
Dimensions and Part Nos.



PVC wall holders for C 2212

Threaded pin W 1"	Part No. 28380
Threaded pin G 5/8	Part No. 29752
Threaded pin G 3/4	Part No. 28360

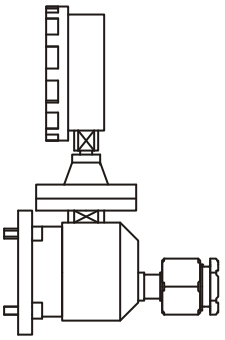
(Delivery incl. mounting material)



Maintenance kits for chlorinator C 2212

Full-vacuum chlorinator C 2212 **ET 2 04 12 / 2**

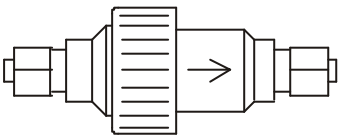
Maintenance kit for chlorinator wihtout inlet valve:
1 diaphragm, 10 O-rings
1 snap ring, 6 screws Part No. 35040



Inlet valve **ET 2 04 12 / 3**

Maintenance kit for inlet valve:
1 filter, 4 O-rings, 2 valve seats, 2 balls,
1 joint washer, 8 screws

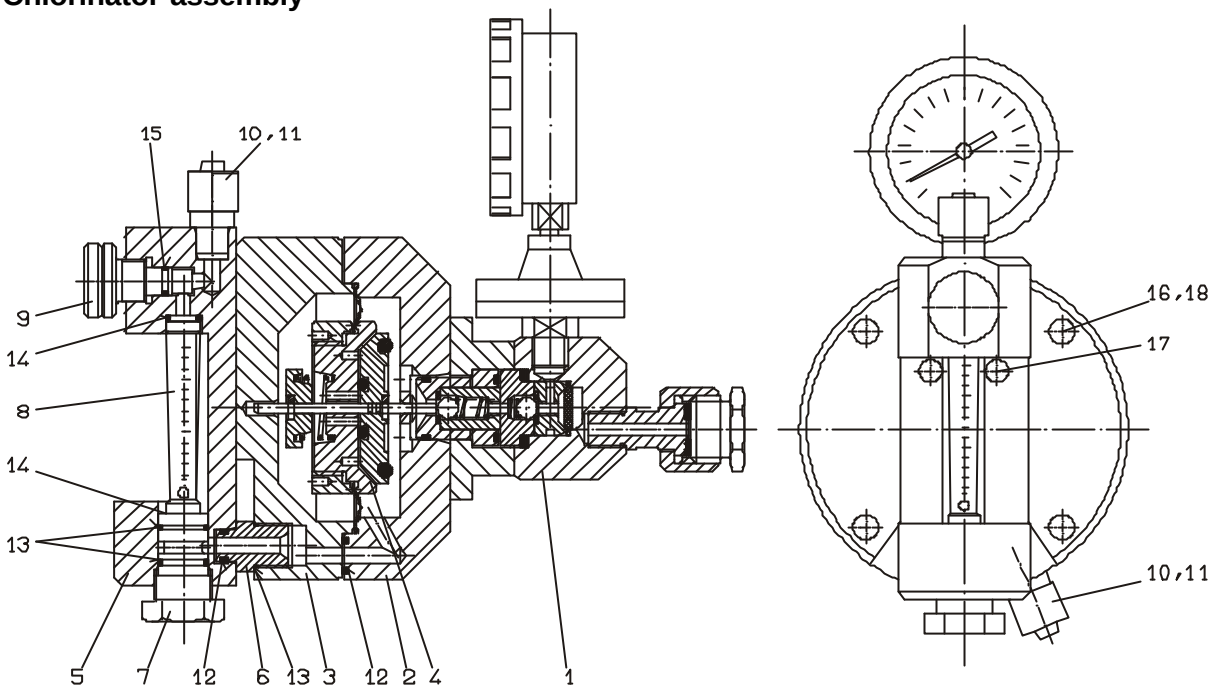
chlorine cylinder connection G 5/8 and 1": Part No. 35037
chlorine cylinder connection G 3/4: Part No. 35038



Back stop **ET 2 04 12 / 4**

Maintenance kit for back stop:
2 O-rings, 1 ball Part No. 35062

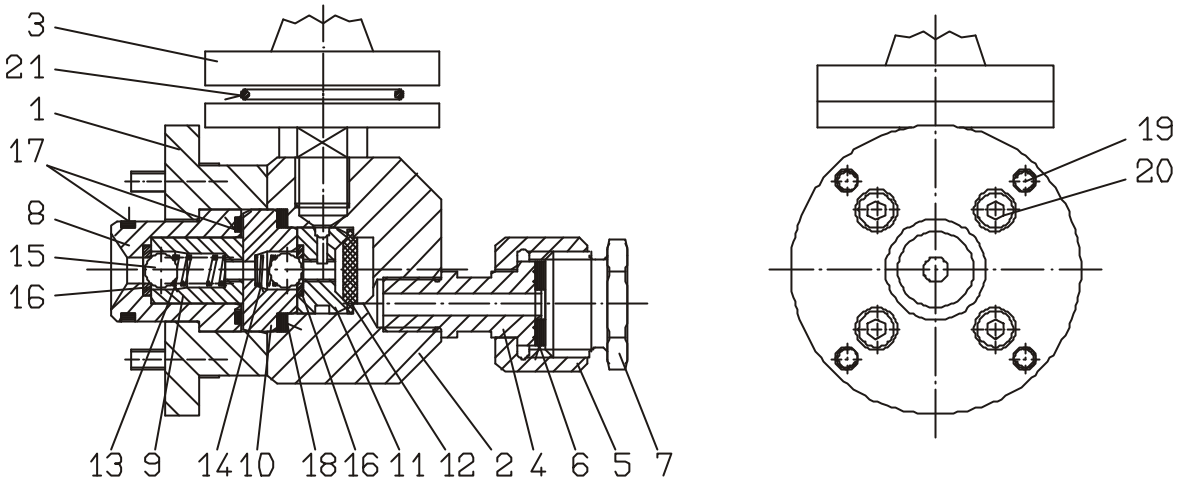
Chlorinator assembly



Item	Description	Material	Qty	Part No.
1	Inlet valve assembly W1"	misc.	1	35007
	G 5/8			35008
	G 3/4			35009
2	Housing bottom with bushings	PVC / brass	1	35027
3	Housing cover with bushing	PE / brass	1	35028
4	Diaphragm disc assembly	PVC / viton / silver	1	35026
5	Measuring glass holder	PVC	1	33340
6	Reduction G 3/8-d12 for measuring glass connection	PVC	1	28797
7	Set screw for measuring glass	PVC	1	28804
8	Measuring glass 1 ... 25 g/h	Glass	1	87008
	4 ... 80 g/h			87009
	10 ... 200 g/h			87010
	25 ... 500 g/h			87011
	50 ... 1000 g/h			87012
	100 ... 2000 g/h			87013
	125 ... 2500 g/h			87014
	200 ... 4000 g/h			87535
9	Adjusting screw up to 200 g/h	PMMA	1	31107
	up to 4000 g/h			28803
10	Clamping connection d12-8/12	PVC	2	22325
11	Union nut	PVC	2	10365
12*	O-ring d 9x2.2	Viton	2	80622
13*	O-ring d 14x1.78	Viton	3	80003
14*	O-ring d 10x2mm	Viton	2	81384
15*	O-ring d 7.65x1.78mm	Viton	1	80006
16*	Screw M5x40mm	A4	4	83604
17*	Screw M5x16mm	A4	2	83796
18	Cap black	Plastic	4	83851

* contained in spare parts kit.

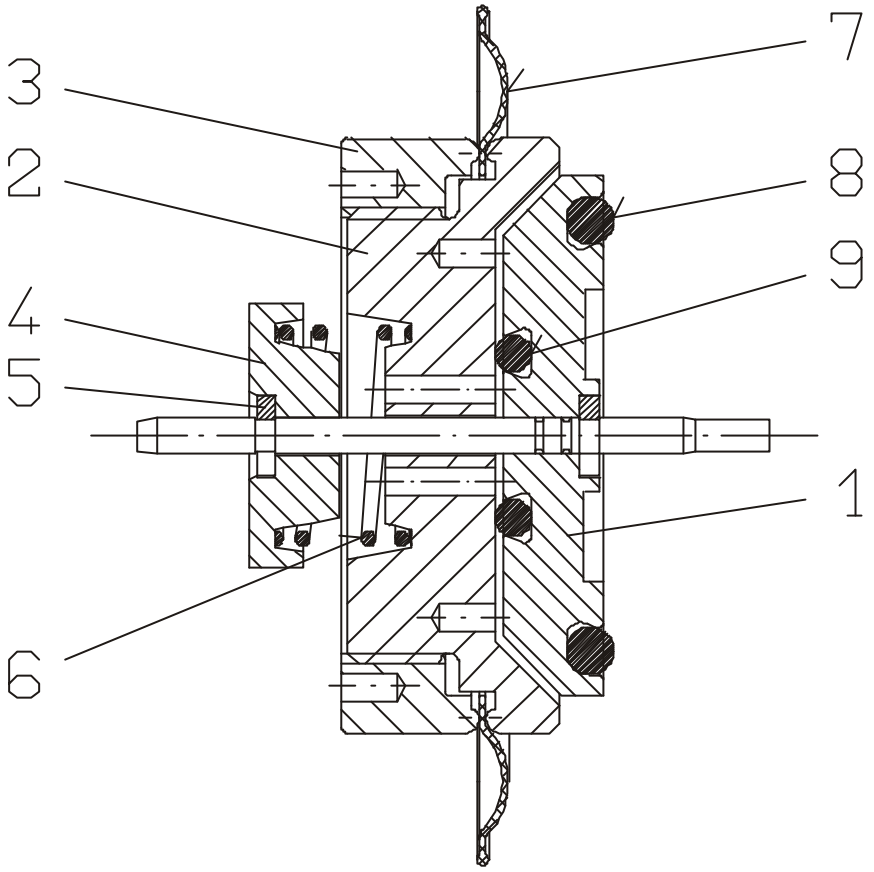
Inlet valve



Item	Description	Material	Qty	Part No.
1	Clamping ring	Brass. nickel-plated	1	35000
2	Valve body	Brass. nickel-plated	1	35001
3	Pressure gauge -1..0..15 bar	Brass / silver / ABS	1	24087576
4	Connecting part W 1". G 5/8 G 3/4	Monel	1	10157 15828
5	Union nut W 1" G 5/8 G 3/4	Brass. nickel-plated	1	10158 26089 15827
6*	Gasket W 1". G 5/8 G 3/4	AF	1	81043 81164
7	Plug W 1" G 5/8 G 3/4	PVC	1	26418 29797 26419
8	Valve cap	PVDF	1	35002
9	Ball guide	PVDF	1	35003
10	Spring support	PVDF	1	35004
11	Valve seat holder	PVDF	1	35005
12*	Filter d 20mm	PTFE-felt	1	35006
13	Pressure spring d 7.5x18mm	Hastelloy	1	10051
14	Pressure spring d 6.9x10mm	Hastelloy	1	28390
	(Pressure spring d 6.8x12mm for increased residual pressure)		1	(34388)
15*	Ball	Ceramic	2	10033
16*	Valve seat	Viton	2	10032
17*	O-ring d 19x2.5mm	Viton	2	80817
18*	O-ring d 21x3.5	Viton	1	80819
19*	Screw M5x16mm	A4	4	83796
20*	Screw M5x30mm	A4	4	83858
	Inlet valve assembly W1" (increased residual pressure W1") G 5/8 G 3/4			35007 (35220) 35008 35009
21*	O-ring	Viton	1	80827

* contained in spare parts kit

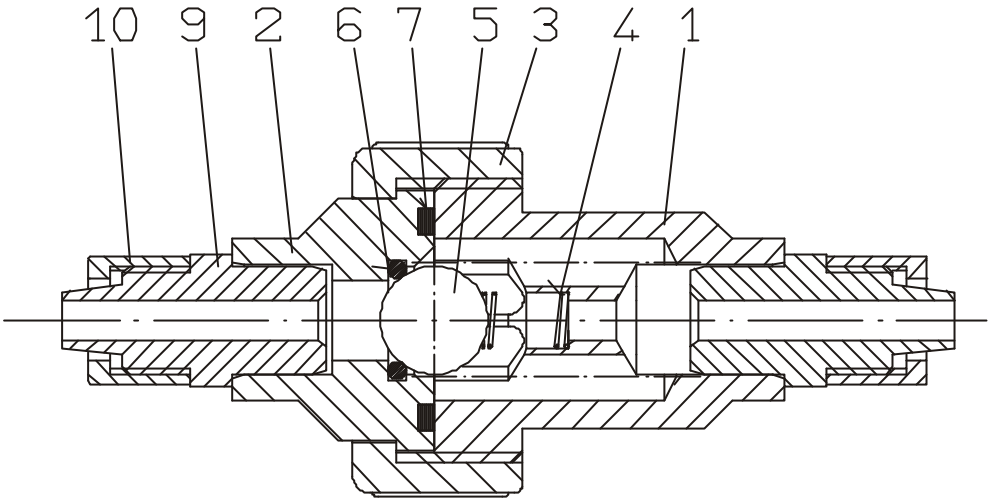
Diaphragm disc assembly



Item	Description	Material	Qty	Part No.
1	Valve seat with silver pin	PVC / silver	1	35023
2	Diaphragm disc	PVC	1	35024
3	Threaded ring	PVC	1	28806
4	Spring support	PVC	1	35025
5*	Snap ring	PVC	1	28798
6	Pressure spring d 24x30mm	Hastelloy	1	28802
7*	Ring diaphragm	Viton	1	81599
8*	O-ring d 40.65x5.34	Viton	1	80078
9*	O-ring d 14x4mm	Viton	1	80736
	Diaphragm disc assembly			35026

* contained in spare parts kit.

Back stop



Item	Description	Material	Qty	Part No.
1	Ball guide for back stop	PVC	1	35059
2	Seat holder for back stop	PVC	1	35058
3	Union nut G1 1/4	PVC	1	82213
4	Pressure spring d 8.1x27mm	Hastelloy	1	25082
5*	Ball d 16	Glass	1	82457
6*	O-ring d 12.4x2.62mm	Viton	1	80004
7*	O-ring d 25x3mm	Viton	1	80138
8	Arrow label	Adhesive film	1	87395
9	Tubing connection 8/12	PVC	2	33350
	12/16			15533
10	Union nut 8/12	PVC	2	10365
	12/16			15534
	Back stop assembly 8/12			20435060
	12/16			20435061
	d 16i			20435118

* contained in spare parts kit.

Contents

1. General description

C2211 Chlorinators are designed according to the highest safety standard DIN 19606 with several functions going beyond that standard. With these devices so-called full-vacuum installations can be set up with vacuum beginning directly at the chlorine cylinder. Even in the case of a line rupture chlorine gas cannot escape.

The full-vacuum chlorinator is of central importance for the safety in vacuum installations and provides the following functions in addition to the vacuum regulation which is the basic function: (for a detailed description cf. MB 2 04 11).

Residual pressure preservation
against a complete evacuation of the cylinder in order to avoid corrosion caused by humidity of the entering air.

Filter
for protecting the valves against dirt particles from the cylinder or from the connection area.

Cylinder pressure gauge
for the indication of the cylinder pressure with diaphragm pressure transmitter as a double-safety feature.

Safety blowoff valve
for protecting the vacuum system against overpressure even in the case of a clogged inlet valve.

Flowmeter
with metering valve mounted directly on vacuum regulator representing the easiest system design.

The ejector and the nonreturn valve are designed as separate components. The backpressure regulator required according to DIN 19606 is used to avoid metering faults resulting from priming pressure fluctuations of the ejector. It is intergrated in the ejector nonreturn valve and therefore does not require additional installation space or time. Besides the generally required components, a large number of useful supplementary devices are available.
A backstop or a safety stop valve increase the safety of the system even beyond the required range.
Automatic switch-overs ensure a constant chlorine delivery even if chlorine drums are becoming empty.
Electrically actuated control valves are installed at an arbitrary point between flow meter and ejector backpressure valve in the vacuum line. Therefore the installation of automatically working systems is easily possible.

2. Scope of delivery

Be careful when unpacking the chlorinators and order-related accessories in order not to miss small parts, as for example fixing screws for wall installation. Compare the scope of delivery with the delivery note. If there are any discrepancies, try to find out the reason.

Safety instructions

⇒ Chlorine gas may be dangerous for your health and life. Therefore the highest caution must be spent when working on chlorine gas metering systems. All working steps on the system require special knowledge and safety precautions and may only be carried out by specialist staff.

⇒ When working on chlorine gas metering systems make sure that local accident prevention rules are observed. In Germany the *Accident Prevention Rule Chlorination of Water* (VBG 65) of the German Professional Association is valid. It can be obtained in its current version from the German Municipality Accident Insurance Association (Gemeinde-unfallversicherungsverband).

⇒ Before starting work on chlorine gas metering systems the cylinder valves must be closed. All chlorine leading pipes must be evacuated using the ejector.

⇒ Liquid chlorine must never enter chlorinators not being explicitly authorized for liquid chlorine. If necessary, a pressure reducing valve, a catch pot or a pipe heating must be provided.

⇒ When changing the cylinders make sure that a protective mask is used. The cylinder valve (and if necessary the cylinder auxiliary valve) must be closed. In case that the pressure gauge at the vacuum regulator still indicates a pressure, the pressure has to be discharged using the ejector.

⇒ Before startup of the chlorination installation all connections must be carried out properly and tightened using the suitable tools. The tightness of the whole installation must be tested using ammonia solution.

⇒ Chlorine gas is highly hygroscopic. Therefore humidity penetrates the system at every open connection of the units or pipes resulting in the formation of hydrochloric acid thus inevitably causing damage of the units. Therefore all connections (at the vacuum units and vacuum pipes as well) must be closed at any time.

⇒ If chlorinators must be used with other gases than chlorine gas, the chemical resistance of the unit must be checked after consulting the manufacturer.

4. Installation

The installation of the chlorinators usually is carried out according to the drawings of the planning department. Examples for installation diagrams are presented in MB 2 04 11. There you can also find hints to other data sheets that should be taken into consideration.
Besides the possible local rules the **Accident Prevention Rule VBG 65** must also be observed.
The installation must be carried out by specialist staff as already small mistakes during installation may cause faulty metering or even destroy the units.

Always use **appropriate tools** for the installation, for example when tightening the union nut a second wrench must be used for counter-holding in order to avoid a distortion of the units. Otherwise mechanical stress may cause damage of the components.
Before mounting, **the threads** should be lubricated using silicone grease or PTFE-spray. In that case the threads can be unscrewed more easily even after a long operation time.

Note:
Vaseline is not suited for lubricating chlorine system components. Because of its hygroscopic effect chlorine gas extracts water out of the vaseline so that it hardens.

All units must be mounted in the position that is shown in the installation examples. Otherwise malfunction or even damage of the units caused by liquid chlorine cannot be excluded.

For fixing wall holders or mounting clamps use the screws, washers and pegs included in the scope of delivery as they are perfectly suitable for this purpose regarding material choice and dimensioning .

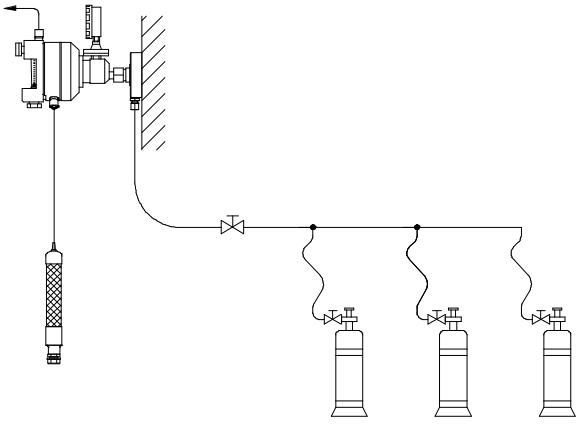
4.1 Chlorine delivery

4.1.1 Limited delivery quantity

The constant volume of chlorine gas delivered per hour from one chlorine cylinder or barrel must not exceed 1% of the original contents. Otherwise the energy loss resulting from chlorine evaporation may cause the risk of cylinder icing and consequently an inadmissably high pressure loss in the chlorine cylinder. This means that the maximum rate for e.g. a 65 kg cylinder is 650 g Cl2/h at an ambient temperature of 10°C. The maximum delivery rate increases up to e.g.1,000 g Cl_2/h at 15°C if a room heating is used.

4.1.2 Cylinder batteries

Vacuum regulators type C 2212 are available for metering capacities of up to 4,000g Cl_2/h. In the case of such high metering capacities, several chlorine drums are simultaneously connected in so-called battery operation.

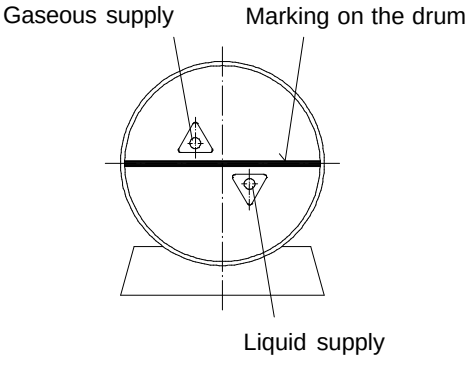


A collective pipe connects all cylinders forming one pressure system so that chlorine is supplied simultaneously from all cylinders. For connecting the chlorine cylinders with the collective pipe flexible copper pipes are used. Each flexible copper pipe is equipped at the end with an cylinder auxiliary valve which is closed when exchanging the cylinders so that the escape of chlorine gas is avoided.

4.1.3 Comments regarding chlorine drums

At higher metering capacities chlorine drums are often used. Depending on the ambient temperature, up to 7 kg/h chlorine gas may be supplied from a 1,000 kg drum (10°C:3kg/h, 15°C:5kg/h, 20°C:7kg/h).

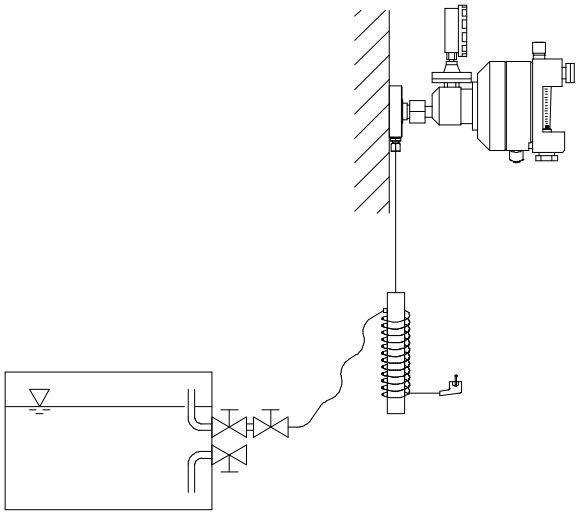
Chlorine drums are equipped with two connections, one for gaseous chlorine supply (top) and one for liquid chlorine supply (bottom).



The position of the drum on the support must be such that the feedpipe in the barrel is vertical (marking on the drum horizontal). In this case the position of the connecting valves needs not be observed as they are staggered.

ATTENTION

Do not fix the vacuum regulator directly to the chlorine drum. After transportation the feedpipe is mostly filled with liquid chlorine which must not penetrate the metering units. Therefore a catch pot should be provided. The installation of a heating element for evaporating the liquid may also be useful.

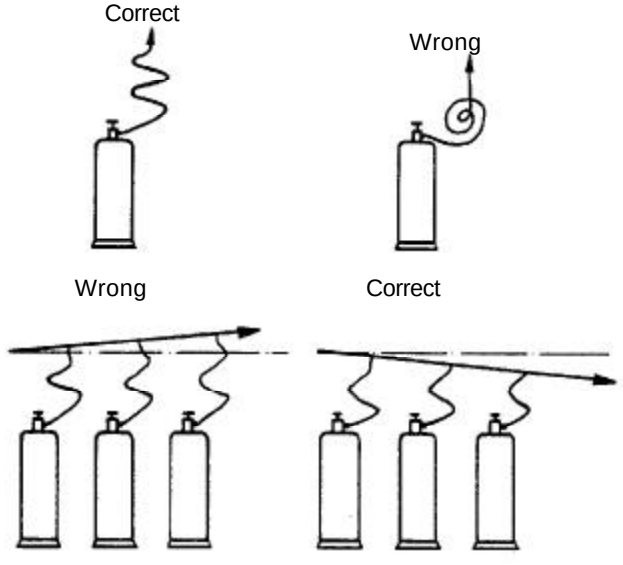


4.2 Design of the piping system

For leading the chlorine gas, metal and plastic pipes are used. In the overpressure range metal pipes are mandatory, in the vacuum range mainly plastic pipes are installed.

4.2.1 Overpressure pipes

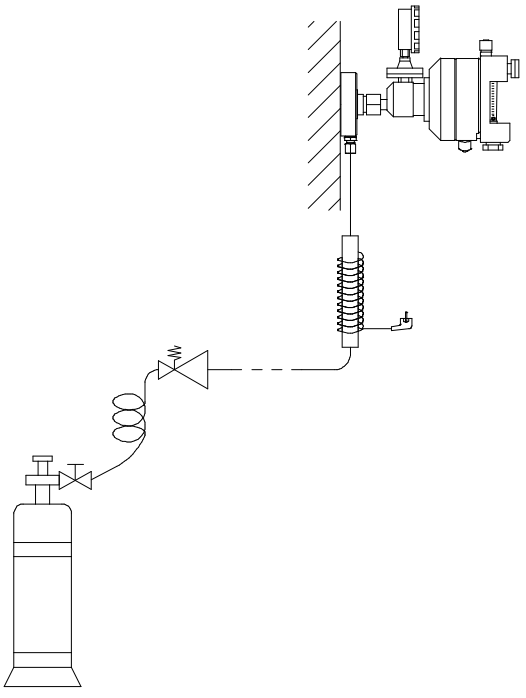
Chlorine gas metering units are perfectly suitable for gaseous chlorine. However, liquid chlorine chemically attacks the unit. Therefore the penetration of liquid chlorine into the units must be avoided. Overpressure pipes must be run upwards in direction of the metering units. This also applies for flexible connection pipes. Therefore the turns of the flexible copper pipes must be positioned horizontally so that condensate drops may flow back into the cylinder.



As a result of temperature variations, chlorine gas may condense to liquid chlorine in the overpressure system. Therefore a uniform ambient temperature must be provided. A room heating is recommended.

If a uniform temperature is not possible because of structural reasons, a pressure reducing valve has to be installed in order to reduce the temperature at which condensation starts. If necessary, the chlorine has to be heated up using a chlorine heating block before entering the metering unit.

As **solid lines,** seamless pipes are used for overpressure piping. An internal corrosion protection is not required as steel (e.g. St37-2) is chemically



resistant against chlorine. Please make sure that the entering of humidity is avoided so that hydrochloric acid cannot be formed. Permanent thread connections are usually made tight using diacrylate sealing compound. Organic substances, e.g. hemp, must not be used at all.

For connecting **flexible lines,** cutting ring connectors are used.The installation of these connectors is described in detail in data sheet SD 2 01 03.
As a result of the mechanical strain, the service life of flexible cop per pipes is limited. Accident Prevention Rule VBG65 for example stipulates an exchange of these lines after two years at the latest.

4.2.2 Vacuum lines

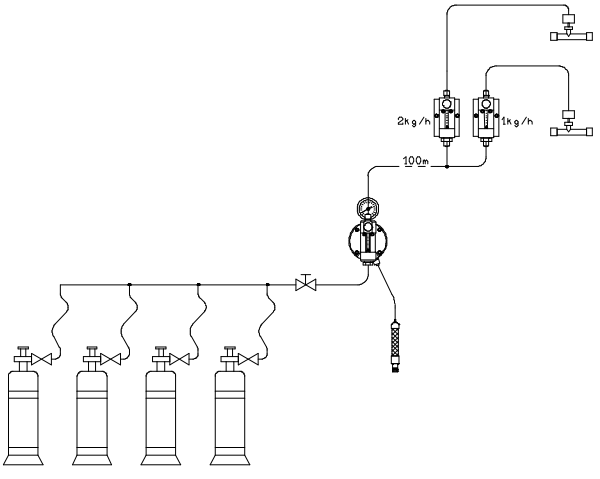
As vacuum lines, inelastic PVC pipes and flexible PE tubes are used. In most cases PVC hoses are not suitable for vacuum and even fabric reinforced hoses which should be vacuum-proof are diffused by the chlorine gas and therefore not resistant.
Because of the low pressure, chlorine gas condensation in the vacuum lines is almost impossible. Only below -30°C it might become possible. However, temperature must never decrease to such a low level because considering the embrittlement of the materials.
The ejector builds up the vacuum which is necessary for transporting the chlorine gas.

Theoretically the vacuum could amount to a maximum of 1 bar, but the ejector primes only at a technically reasonable slight vacuum. Therefore the pressure loss resulting from pipe friction in the vacuum lines must not be higher than 50 mbar. The following table shows the required line cross section in relation to the length of line and the metering capacity.

Maximum tube length for vacuum lines

Tube length	d 8/12 mm	d 12/16 mm
10m	7 kg Cl_2/h	20 kg Cl_2/h
20m	5 kg Cl_2/h	15 kg Cl_2/h
50m	3 kg Cl_2/h	9 kg Cl_2/h
100m	2 kg Cl_2/h	6 kg Cl_2/h

The total value of the chlorine gas flow is decisive for the line dimensioning. If for example the line is divided into two lanes directly in front of the ejectors, the long lane must be dimensioned considering the whole chlorine gas flow.



In this example the long distance is carried out in DN12, and for the relatively short unit connections a 8/12 PE tube is used.

4.3 Installation of units

4.3.1 Installation of vacuum regulator

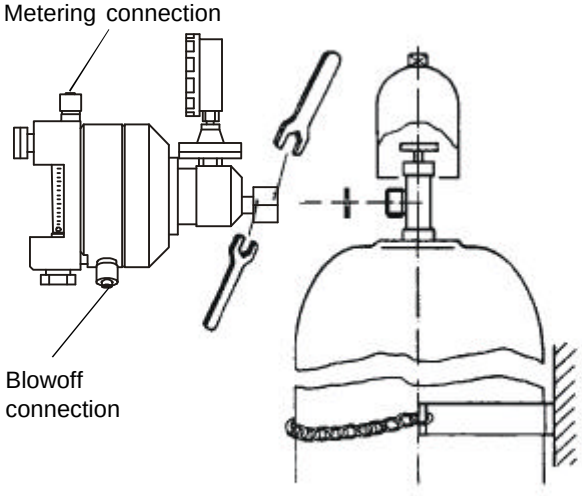
The chlorine cylinders must be secured by wall holders when being s. Before connecting the units, the cylinders should have reached room temperature and the cylinder contents must have calmed down after transportation.

When using chlorine drums make sure that the marking of the drum is in horizontal position. For a supply of gaseous chlorine the upper connection is used.(See also 4.1.5 *Comments regarding chlorine drums*).

The vacuum regulator is either mounted directly on the chlorine cylinder valve or on the wall holder. In this case the flow meter is positioned vertically with the metering connection pointing upwards.

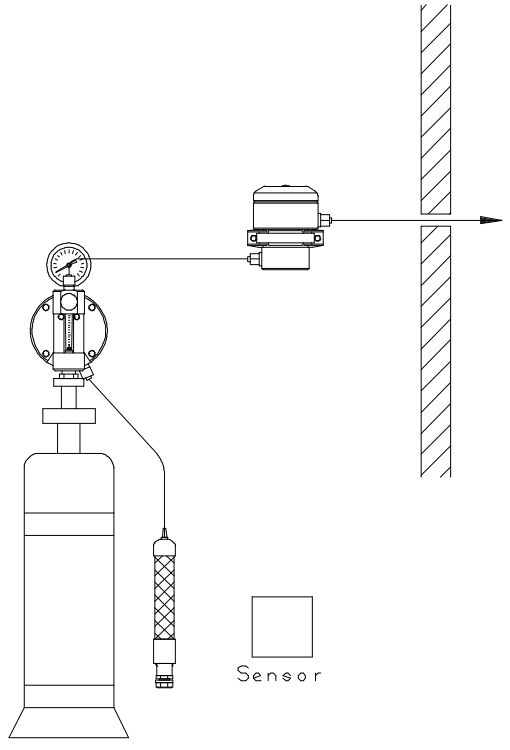
With cylinder-mountd vacuum regulators a PVC wall holder is mounted above the chlorine cylinder. When exchanging the cylinder the vacuum regulator is attached to the wall holder and the cylinder connection is protected against the penetration of humidity.

In order to make the exchange of the vacuum regulator easy, always use a new flat gasket which is slightly lubricated when connecting the vacuum regulator. The union nut for connecting the cylinder is tightened gently and the unit is secured against distorsion using a second wrench.



The blowoff connection of the safety valve is also carried out as tubing connection. The connected tubing should end close to the gas sensor so that in the case of malfunction an alarm can be be released immediately. The integration of an activated-carbon cartridge at the outlet of the safety valve avoids faulty alarms resulting from system-related temporary shock pressures.

It is advisable to use a PVC tubing for connecting the active-carbon cartridge. As soon as a chlorine contact occurs the appearance of the tubing changes from transparent to milky thus signalling a leakage.



4.3.2 Installation of backstop/safety shutoff valve

According to the regulations in some countries the integration of a valve is recommended which prevents water from entering the metering units even if the ejector nonreturn valve is untight. This function can be provided by two different valves.

a) Backstop

The backstop is an additional spring-loaded ball nonreturn valve being installed in the vacuum line.

b) Safety shutoff valve

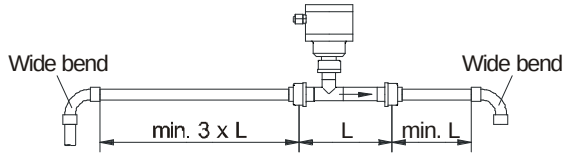
The safety shutoff valve is a diaphragm valve opening only in the case of ejector vacuum thus having a dual function:

- It prevents water from flowing back if the ejector nonreturn valve is untight.
- It prevents chlorine gas from escaping in the case of a faulty vacuum regulator even if the vacuum line is untight (e.g. maintenance work).

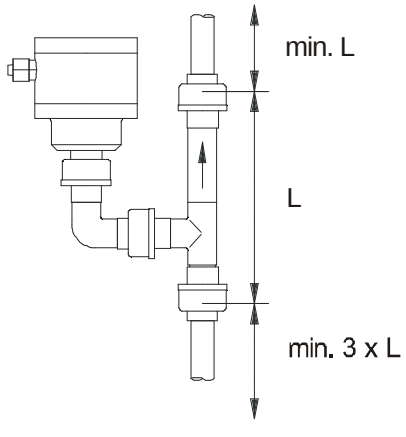
It is quite reasonable to mount the backstop or safety shutoff valve at a point in the vacuum line outside the area being monitored by the gas warning device, i.e. directly at the end of the chlorine cylinder room (see above drawing). A pipe clamp is delivered with the valves.

4.3.3 Installation of ejector

The ejector is mounted horizontally. The ejector nonreturn valve is mounted directly to the suction connection on top of the ejector.
On the pressure side the pipe line should be run at least 3 ejector lenghts in straight direction and the width should correspond to the nominal width of the ejector. The same applies for one ejector length at the outlet of the ejector. Please use wide bends rather than sharp angles for the pipe line.



In plants according to DIN 19606 a backpressure regulator is integrated in the ejector nonreturn valve (up to 6 kg/h). It regulates pressure fluctuations of the ejector resulting from the changing water pressure. For higher metering capacities separate backpressure regulators are available.
If the ejector must be installed vertically for space reasons the nonreturn valve must be connected using a 90° angle so that the diaphragm of the nonreturn valve is in horizontal position.



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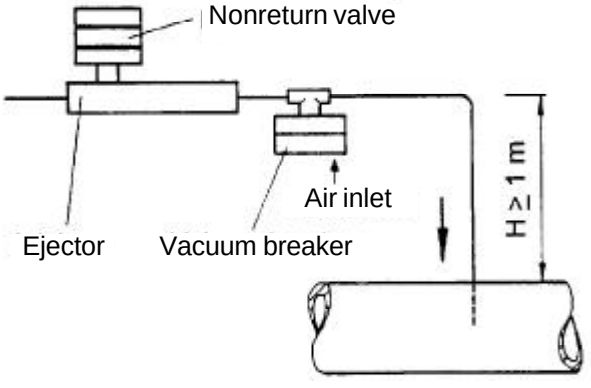
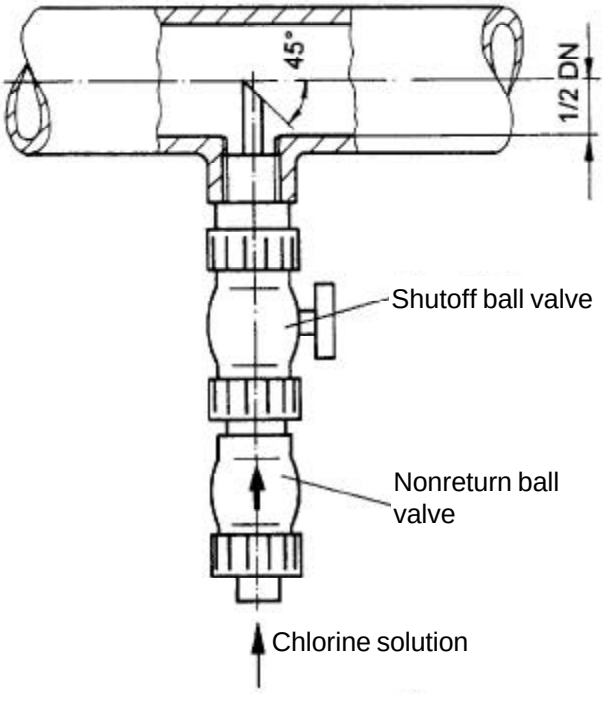


4.3.4 Installation of the solution inlet

Via the solution inlet the chlorine solution is led to the water to be treated. We recommend to dimension the injection pipe so that the chlorine solution penetrates the water line in the center if possible thus ensuring an optimal mixing. In addition to the nonreturn valve the solution inlet should be equipped with a shutoff ball valve in order to completely separate the chlorination plant from the water svstem.



5. Startup

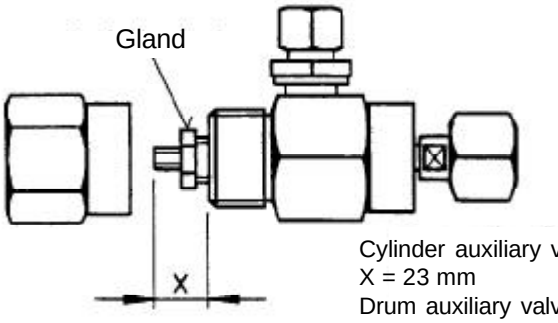
5.1 Leakage test

Before starting the chlorinators a leakage test of all plant components must be carried out. Make sure that both, plant components under overpressure and plant components under vacuum, are tested.

5.1.1 Overpressure lines

If the vacuum regulator is mounted directly to the cylinder only the cylinder connection and the inlet valve must be tested. With all other plants the whole piping system as well as the vacuum regulator have to be tested.
In order to carry out the test, the chlorine cylinder is opened slowly and all connection points are tested using ammonia (=ammonium hydroxide solution). One can either carry out pumping movements with the ammonia bottle in the proximity of the connection or hold a cloth soaked with ammonia close to the connection. Leaking chlorine gas and ammonia form a white dust .

ATTENTION!
Due to the high corrosivity of humid chlorine gas all leaking points rapidly aggravate in the course of time. Therefore even the smallest leakage must be removed immediately.
Note:
In the case of cylinder auxiliary valves the packing sealing might have settled since manufacturing. For tightening it again the handwheel is unscrewed completely and the gland is tightened by approx a 1/2 turning. When remounting the handwheel, the measure „x“ from the sketch below must be observed.



Cylinder auxiliary valve
X = 23 mm
Drum auxiliary valve
X = 35 mm

5.1.2 Vacuum lines

Leaking vacuum lines are not noticed during normal operation as chlorine gas does not escape but only ambient air is primed. However, at the same time humidity enters the piping system forming deposits along with the chlorine gas. This is why vacuum lines must also be leakage-tested carefully.
Switch on the ejector while the cylinder valve is closed. After a short period of time the ball in the flow meter will not move anymore. If it does, a leakage test of all components including the vacuum regulator must be carried out in order to remove the leaking point. Make sure that no water penetrates the vacuum line after switching off the ejector.Water penetrates the vacuum line only if the ejector non-return valve doesn't work perfectly.
For troubleshooting of the individual components, please also see paragraph 9, Maintenance.

5.2 Starting

For starting the plant the chlorine cylinder main valve must be opened first. Then the injection valve and the motive water supply must be opened. In the case of perfect operation conditions, a vacuum is produced in the ejector and will be transmitted via the non-return valve and the vacuum line to the vacuum controller thus opening the chlorine inlet valve. The pressurized chlorine gas is reduced to vacuum in the inlet valve.
The chlorine gas flow is adjusted using the needle valve of the measuring glass and can be read off at the largest ball diameter.
With automatic control systems the regulating valve is first arrested to 100 % opening and the chlorine gas flow is then adjusted using the manual valve. As soon as manual samples indicate a chlorine content in the treated water the measuring system is calibrated and the plant switches over to automatic operation.

6. Operation

During normal operation of the plant the chlorine gas flow is either adjusted automatically using the regulating valve or manually using the adjusting valve of the measuring glass holder. In the case of automatic control systems the measuring amplifier must be checked regularly by means of comparison measurements and must then be calibrated if necessary.

7. Cylinder exchange

If a cylinder is empty the pressure gauge will indicate a decreasing cylinder pressure. The residual pressure in the cylinder will amount to approx. 0,1..0,2 bar, thus preventing damaging air humidity from penetrating the cylinder and the inlet valve. At this residual pressure all liquid chlorine in the bottle is evaporated and there are only residual amounts of gaseous chlorine.

When exchanging the cylinders, please proceed as follows:

- Close the cylinder valve (and if necessary the cylinder auxiliary valve)
- Evacuate possible residual chlorine amounts using the ejector until the ball in the measuring glass lies still.
- Unscrew the union nut of the cylinder connection and remove the old flat gasket (Attention: Do not damage the gasket surface!)
- Close the connection of the metering unit (using a PVC plug or by mounting it to the PVC wall holder)
- Close the cylinder connection with the screwed cap.
- Attach protection cap on the cylinder valve (if possible lubricate the thread using silicone grease)
- Exchange the cylinder
- Attach the new cylinder to the wall holder before connecting it in order to prevent it from falling down. Make sure that the cylinder content quiets down. The cylinder must have ambient temperature before connecting a metering unit.
- Always use new flat gaskets and lubricate them slightly with silicone grease when connecting the metering unit.
- Carry out leakage test using ammonia.

Comment:

As a result of the residual pressure of 0.1..0.2 bar, a very small amount of chlorine will escape when opening the cylinder connection. Extremely sensitive sensors are able to detect even such small amounts. Therefore it is permitted to deactivate the sprinkler system during cylinder exchange, if it will be reactivated after the cylinder exchange (e.g. by means of a door contact switch).

8. Switching off

For short operation interruptions the cylinder valves are closed and the pipes are evacuated until the ball in the flow meter indicates that there is no more flow. Then the motive water is switched off and the shut-off valves in front and behind the ejector are closed.

For longer operation interruptions (e.g. in open-air pools during winter time) the following steps should be taken in order to protect the units.

- Rinse all pipes (pressure and vacuum lines) and all units approx. 5 minutes with dry air or nitrogen.
- Close the chlorine cylinder tight. The protection cap for the connection thread must be slipped on.
- Dismount at least the vacuum regulators from unheated or humid rooms and keep them dry.
- If possible dismantle all units and service them. Please slightly lubricate all threads and elastomeres with silicone grease.
- Close all units and piping connections tight in order to prevent air humidity from penetrating and damaging the units.
- Exhaust all water leading lines in case of danger of frost.
- Turn all valves in middle position so that they can be released in both directions when they are restarted.

If these points are observed during operation interruptions the units will restart without any problems even after longer periods out of operation.

9. Maintenance

Regular maintenance spares yourself a lot of trouble!

A maintenance contract is advisable.

Please make sure that the chlorine cylinders are closed before starting work on the chlorinator. The plant must be evacuated using the ejector until the measuring glass indication is zero.

The vacuum regulator is then dismantled, cleaned and parts subject to wear are exchanged. All other parts are inspected visually and exchanged if necessary. The generally required parts subject to wear are included in the maintenance kit (also cf. ET sheet).

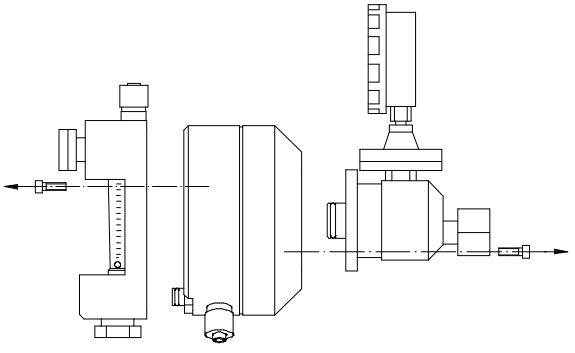
For cleaning the components, warm water or isopropyl alcohol are perfectly suited. Before remounting the components, make sure that they are dry.

Gaskets and diaphragms should be lubricated slightly using silicone grease. Do not use vaseline at any rates as it hardens because of dehumidification and thus may cause malfunction.

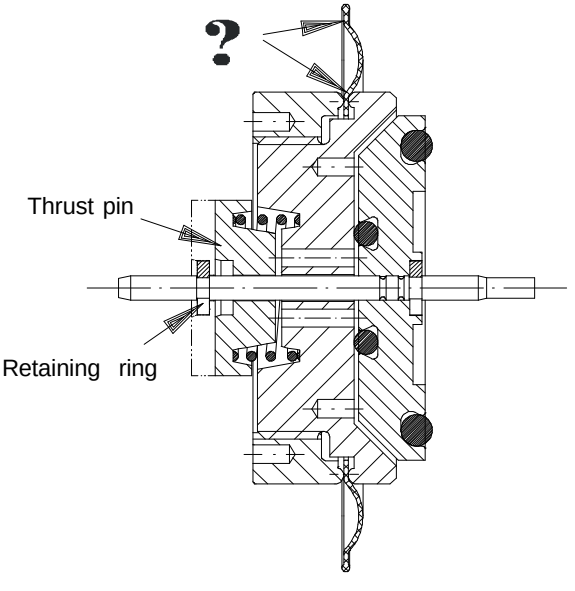
Pressure springs are no parts subject to wear in the original meaning of the word. However, they can also be attacked chemically by humidity. In that case they have to be exchanged. Pressure springs must never be compressed completely for testing because this will result in overstress.

9.1.1 Maintenance vacuum regulator

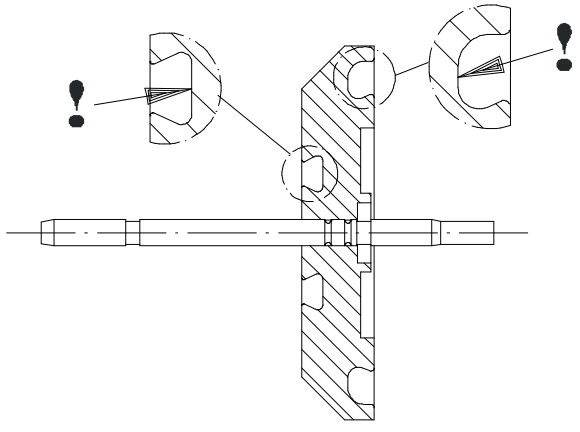
First the inlet valve is separated from the plastic vacuum part by unscrewing the four screws. Then it is pulled out of the PVC-part by rotating it. (Additional inormation regarding inlet valve, see 9.2.)
The two screws at the measuring glass holder are unscrewed and the whole measuring glass holder is lifted off the assembly pin also by rotating it. (Additional information regarding measuring glass holder, see 9.3.)
The four screws of the vacuum housing (below the cover plate) are unscrewed and the PVC-housing is dismounted by rotating it.



For dismounting the diaphragm disk the thrust pin is pushed down and the retaining ring is removed using a long nose plier.



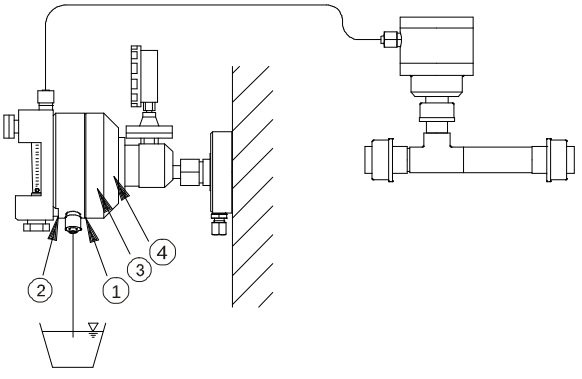
For dismounting the diaphragm, special clamping wrenches (part no. 31617) or face spanner (spigot Æ 3mm und 4mm) are used. The diaphragm must be exchnaged if it is defective or embrittled. The thick O-rings in the diaphragm disc should always be exchanged. In doing so, be careful not to damage the O-ring groove.



Before mounting the diaphragm to the diaphragm disc the diaphragm bulges should be lubricated with silicone grease. The threaded ring is first tightened by hand and then not more than 1/4 using a tool. Make sure that the diaphragm does not warp. Lubricate the O-rings with silicone grease, insert it and smooth it down with the thumb until they lie flat in the groove. Use a new retaining ring when mounting the valve seat into the diaphragm disc. Make sure that the diaphragm is properly positioned when assembling the plastic housing. Der Stömungskanal zum Durchflußmesser muß bei beiden Gehäuseteilen unten liegen und der O-Ring zwischen den Gehäusehälften darf nicht vergessen werden.
After maintenance work is finished the inlet valve and the measuring glass holder are mounted as described in para. 9.2 and 9.3 using a lubricated O-ring. For this purpose new screws have to be used. The screw thread has to be lubricated slightly with silicone grease so that they can easily be removed at the next maintenance session.

9.1.2 Vacuum regulator check

The whole vacuum regulator must be checked on vacuum tightness.
For this purpose the vacuum regulator is mounted to the wall holder or a closed chlorine cylinder and the ejector is connected using a metering tubing. One end of a transparent tubing is loosely put on the blow-off connection and the other end is immersed in water.

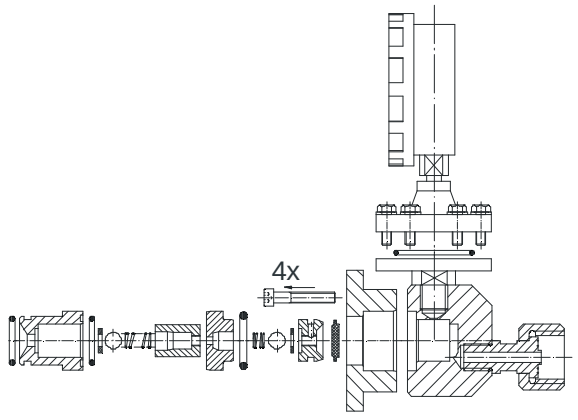


After switching on the ejector, the water level in the tubing rises only a few centimeters and then remains constant. The ball in the flow meter rises, then drops slowly and indicates zero after a short time.
If the flow meter does not indicate zero, there must be an untight spot where air finds its way into the system. In that case, especially the spots marked with an arrow have to be checked:

1 O-ring between housing parts
2 O-ring on the connection pivot for the measuring glass
3 O-ring and sealing surface in diaphragm disc
4 O-ring on inlet valve pivot

9.2.1 Inlet valve dismounting

For dismounting the inlet valve the four screws are removed so that the springs inside the inlet valve pull it apart. If this should not be the case, lay down the inlet valve in warm water for some time. Do not immerse the pressure gauge! In order to simplify dismounting, the ball guidance and the seat holder are provided with a M5 internal thread. The felt filter can be pushed out through the cylinder connection using a thin screw driver or wire.



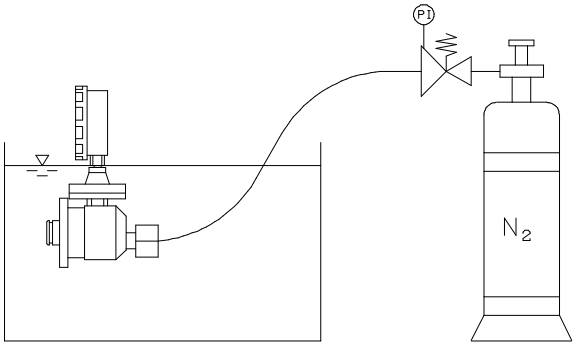
For cleaning purposes the pressure gauge flange can be opened without problems by unscrewing the six screws so that the silver diaphragm becomes visible. It must be wiped off carefully using a soft cloth. Do not use a sharp-edged toll at any rate.
nder no circumstance the pressure gauge may be unscrewed from the diaphragm flange. The connection piece is filled with a liquid and the gauge is calibrated. A new calibration may only be carried out by specialist staff.
If there are red spots on the nickel-plating of the inlet valve, it can be used further on. Only if the spots are located on a sealing surface for O-rings liegt, the component should be exchanged because otherwise chlorine could easily pass the sealing. In most cases damages of the nickel-plating result from humidity penetrating the inlet valve if the cylinder is exchanged or stored without using a sealing plug.

9.2.2 Inlet valve mounting

A PVC wall holder is quite useful when mounting the inlet valve. Attach the inlet valve to the wall holder using the union nut and then put it down. Now you have both hands free for carrying out the actual mounting work.
After cleaning and drying, the inlet valve is mounted in reverse order. All gaskets, balls and the filter are exchanged. All O-rings are slightly lubricated using silicone grease except for the valve seats which are mounted without being lubricated. Make sure that the felt filter is seated properly.
To be on the safe side, the screws should also be exchanged as stainless steel embrittles after being used in chlorous atmosphere which is not visible with the naked eye. They should be lubricated and tightened crosswise until the gap of the inlet valve housing is closed.

9.2.3 Inlet valve check

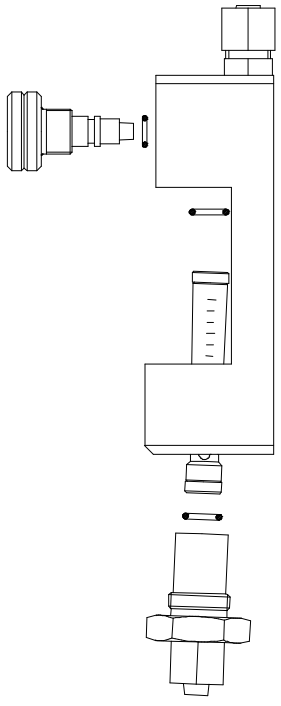
The inlet valve is the main safety valve of the whole chlorination plant. That's why it has to be checked particularly carefully. For the check you need dry compressed air or nitrogen.
Using an edgeless object (e.g. a biro without reservoir), press in the ball of the inlet valve and then let it off in order to make sure that it is properly seated. Connect the inlet valve to the compressed air using a tubing and immerse it in water. Immerse the pressure gauge only up to the transmitter!



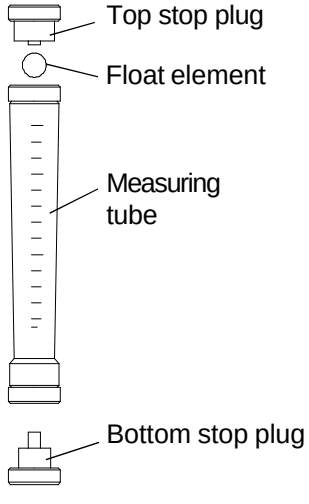
Neither at high pressures (e.g. 6 bar) nor at low pressures (e.g. 0.5 bar) bubbles must rise.
After the check the inlet valve is dried thoroughly and then inserted into the vacuum part by turning it slightly. The O-ring has to be lubricated.

9.3 Measuring glass

For maintenance purposes the measuring glass holder and if necessary the measuring glass are cleaned and the gaskets are exchanged.
To dismount it, the lower claming scew is unscrewed and the O-rings are carefully pulled out of the drilling hole using an edgeless object. Do not damage the PVC!
The O-ring on the setting spindle is carefully removed in the same way. The adjustment screw thread is cleaned from crusted grease using a brush and is then lubricated with fresh silicone grease. Do not use vaseline verwenden! It hardens so that the thread becomes stiff.



The plastic plugs of the measuring glass are carefully dismounted and the float element is removed. For cleaning isopropyl alcohol is perfectly suited.
ATTENTION! Do not mix up the float element with other measuring glasses and make sure that it is not damaged!
When mounting the measuring glass into the measuring glass holder, make sure that the O-rings are seated correctly.



The measuring glass holder checking is carried out after the vacuum regulator was completely mounted.

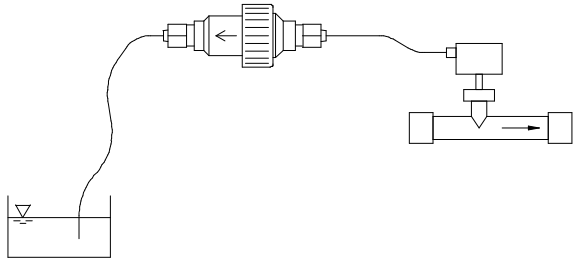
9.4 Activated-carbon cartridge

The filling of the activated-carbon cartridge has to be exchanged either if it is loaded with chlorine or if it gets lumpy due to humidity.

ATTENTION!
There is a strong chlorine smelling if activated carbon is loaded with chlorine gas. Therefore you should absolutely never exchange the filling in closed rooms or in the proximity of aspirating mouths of ventilating systems. For chlorine neutralization, sodium thiosulfate solution is perfectly suitable.

9.5 Back stop

The back stop is dismounted, cleaned and remounted along with new parts subject to wear. Please be especially careful when pulling the central O-ring out of the groove. Always use an edgeless object for this purpose.



The check is carried out under vacuum contrary to the flow direction. Connect a transparent tubing to the open side and immerse its end into water. The water may not rise in the tubing.

10. Troubleshooting

Type of fault	Possible cause	Recommended action
No flow meter indication or indicated value too low.	Chlorine cylinder empty.	Connect new cylinder.
	Cylinder valve or auxiliary valve not open.	Open valves.
	Vacuum system is not completely tight so that ambient air is primed.	Open valves step by step in order to find and remove untight point.
	Changeover unit did not switch to full cylinder.	Actuate changeover unit by hand and check its function.
	Filter of inlet valve clogged.	Replace filter element.
	Floating element in flow meter clogged.	Dismantle and clean flow meter.
	Dirt screen in motive water line clogged.	Clean and exchange filter.
	Solution injection fitting clogged.	Clean solution injection fitting or open the stop valve.
	Ejector performance too low.	Exchange ejector, reduce back pressure or increase motive water pressure.
	Ejector clogged.	Clean ejector.
	Carbonate precipitations in ejector.	Remove precipitations (e.g.10% hydrochloric acid approx. 5 min.). If possible, set higher chlorine concentration (1..2 g/l) and reduce, motive water pressure, if necessary.
	High back pressure at ejector resulting from incorrect running of solution line.	Optimize solution line, avoid sharp bends and cross-sectional contractions (possibly caused by excessive cement.
	Vacuum lines too small.	Use larger vacuum lines or increase ejector priming output.
Chlorine smell or chlorine alarm.	Leaking overpressure system.	Close chlorine cylinder immediately (using protecting mask) and evacuate lines using ejector. Look for leaking points as described in section LEAKAGE TEST.
	Safety valve bleeds off in the case of overpressure resulting from clogged inlet valve.	Maintain inlet and safety valve as described in section MAINTENANCE and exchange loaded activated carbon if necessary. If there are heavy dirt deposits in inlet valve, check chlorine gas purity and provide for room heating (approx. 20°C).
White deposits in flow meter.	Vacuum system is leaky and air humidity condenses forming white fog.	Look for untight spots and remove them. Otherwise incrustations will be formed affecting valve functions.
Water in vacuum system.	Ejector nonreturn valve untight because defective or clogged.	Maintain ejector nonreturn valve, install backstop.
	End of blowoff line under water and safety valve untight.	Maintain safety valve and pull out end of blowoff line of the water.
Cylinder iced.	Delivery rate too high.	Max. 1% of cylinder filling per hour is permitted. Install flow limiter, increase room temperature.
Cylinders are not emptied uniformly.	Conditions for simultaneous delivery not provided.	See section INSTALLATION.
	Chlorination plant designed for much higher metering capacities than actually required. As a result the delivery rate per cylinder is reduced.	Connect only as many cylinders as really needed. Fix remaining vacuum regulators to PVC wall holder using flat gasket.
	Incorrect adjustment of simultaneous delivery.	Readjust units as described in section MAINTENANCE.