A measured step forward

Chlorination Manual

Dosing | *Liquids*
Conveying | *Gases*
Control | *Systems*

1. Preface

1.1. This manual shall be a useful tool for planners, operators and maintenance personnel to accomplish their tasks. It contains basic notes on chlorination technology. It does not replace the product-specific operating instructions.

1.2. Applicable local rules must be observed.

1.3. Lutz-Jesco chlorination technology manual will help to make use of all advantages of our products in your systems and to ensure trouble-free operation for many years.

1.4. Experience shows that avoidable product errors result mainly from system design or poor maintenance and service. Careful reading of this manual allows to avoid such errors and their consequences.

1.5. Lutz-Jesco GmbH is an official member of the „Chlorine Institute“ and works actively on improving the safe handling of chlorine.

1.6. If you have any questions or suggestions for improvement, please do not hesitate to contact us any time under the following phone number or e-mail address:
Lutz-Jesco GmbH +49 (0) 5130 580280
info@jesco.de
For product information please visit our website www.jesco.de. We are very interested in working closely together with the users of our products! General danger and safety instructions

2. General danger and safety instructions

2.1. The following warning signs are used here:
2.1.1. 1 Dangerous chemicals.
2.1.2. 2 Danger of electrical current.
2.1.3. 3 Caution.
2.1.4. 4 Note.

2.2. The system designer and installation company is responsible for the technically perfect installation of the complete system according to the local rules. After acceptance, the user is responsible for maintenance, inspection and service of the system. The staff in charge of operation and maintenance must be trained correspondingly. Service and repair may only be carried out by technical personnel. Unprofessional installation or service represents a danger for everyone!

2.3. Danger to health! Chlorine is a dangerous chemical. Chlorine is a greenish yellow toxic gas with of sharp smell. It is 2.5 times havier than air. It is poisonous when inhaled. In serious cases chlorine may cause death. It affects eyes, respiratory organs and skin and has a very toxic effect on water organisms. The extraordinary reactivity is the reason for its toxicity. It reacts with organic and vegetable tissue and thus destroys it. Air containing 0.5 to l vol % of chlorine has a deadly effect on mammals and human beings within a short time, because the respiratory tracts and pulmonary alveoli are cauterized (formation of hydrogen chloride or hydrochloric acid). After inhaling air containing 0.01 vol % of chlorine (100 vol. ppm) for hours signs of fatal poisoning may occur, and even a chlorine concentration of 0.0001 vol. % (10 vol. ppm) already affects the lung seriously. 0.00001 vol. % of chlorine in the respiratory air still irritates the respiratory organs and can be identified easily by its odor. Chlorine reacts with water and air humidity and forms hydrochloric acid together with hydrogen.

2.4. Danger to biological organisms
Due to its reactivity chlorine is extremely detrimental to all organisms.

2.5. Other dangers
2.5.1. Fire: Chlorine is neither explosive nor inflammable but has a fire-supporting effect.

2.5.2. Chemical reactivity: Chlorine is a highly reactive substance. It reacts with many organic and inorganic matters.

2.5.3. Corrosion of metals: Dry chlorine (liquid or gaseous below 100°C does not affect steel. Chlorine in connection with humidity, however, is extremely corrosive. Therefore the entry of humidity (also air humidity) into chlorine-carrying system components must be avoided by all means. The entry of ambient air with normal air moisture is sufficient to cause serious damage. Due to its intense reaction with organic and inorganic matters and the resulting reaction products, chlorine has an extremely corrosive effect! If exposed to the environment, chlorine attacks most of the materials.

2.5.4. Expansion of liquid chlorine: The volume of liquid chlorine expands on heating (see diagram in section 7.3.2). A container filled by e.g. 88% at 20°C is thus filled by 100% at 68°C, a further temperature increase may result in bursting of the container. Therefore a safety valve and/or a rupture disk and/or an expansion container must be provided wherever liquid chlorine may be enclosed as, for e.g., in the case of liquid chlorine lines between two shutoff valves. The max. admissible temperatue for chlorine cylinders is 50°C, for higher storage temperature relevant regulations have to be checked.

2.5.5. Chlorinators: Lutz-Jesco chlorinators may be used exclusively for the dosing of chlorine gas according to the prescribed instructions. Other gases such as carbon dioxide or ammonia are not allowed. If other gases are to be dosed, a written certificate of no objection is required from Lutz-Jesco or appropriate dosing units have to be used.

2.6. Danger by electrical current: Caution! Partly the dosing units need electrical energy, works on these components may only be carried out by qualified electricians. In any case the units must be disconnected from voltage before working on them.

2.7. Protective measures
2.7.1. Extract from §20 of Ordinance on Hazardous Substances:
§ 20 Instruction manual
(1) The Installer must prepare an instruction manual in respect of the working range and the chemical agents, which points out the danger potential for human beings and environment and defines the required protective measures and behavioural rules; attention has to be drawn to the proper disposal of dangerous waste materials produced. The instruction manual must be written in an understandable way and in the language of the user and must be put in an appropriate place within the working premises. The instruction manual must also contain instructions on how to behave in a case of emergency and on first aid.

(2) Users who are handling hazardous substances must be instructed of the existing danger potentials and the protective measures by means of the instruction manual. The instructions must take place before the start up and then at least once a year with regard to the work-place. Contents and date of instruction have to be fixed in writing and to be confirmed by the signature of the instructed persons. The proof of instruction must be filed for two years.

2.7.2. Personal protective equipment: All works on the chlorination installation may only be carried out with the required protective clothing. Even during replacement of the containers/ Cylinders. A full protection gas mask with appropriate filter and name label must be available for each worker outside the chlorination room, well protected and easily accessible.The filter type gas mask to be used only if there is low level of leaks as ii does not withstand high chlorine leaks. In the case of a chlorine outbreak, the room concerned may be entered only with a compressed air breathing apparatus independent of circulating air. Observe the local regulations / rules. The personal protective equipment must always be kept within easy reach. When using chlorine drums, compressed air breathing masks must be used.

2.7.3. Behavioural rules
Make sure that foreign gases, air, water or other substances never enter the chlorine containers and the system.
In the case of leaking connections, the container valves must be closed immediately and new gaskets must be mounted without delay.
Before working on the chlorine installation, it must be free from chlorine, i.e.: the system must be emptied (evacuated) and then flushed with nitrogen.
In the case of failures which cannot be corrected without assistance, contact a specialist.
Even the minor leakages must be eliminated at once as they grow quickly and the chlorine air damages the equipment in the vicinity of the reach of chlorine.

2.7.4. Safety equipment:
2.7.4.1. Building - room design: The required condition of the chlorine gas rooms is defined in detail in the local regulations. VBG 65 „Chlorination of Water“, which describes the minimum requirements.

2.7.4.2. An emergency plan must be put in a conspicuous place.

2.7.4.3. Gas detector: A gas detector which monitors the max. chlorine gas concentration in the room air is strongly recommended, partly it is required due to local regulations. Chlorine gas detectors are safe facilities which detects the release of chlorine gas. Besides the audio-visual alarm signalling (horn and warning light), the gas detector can also be connected to the process control. The following functions are possible:
Activation of room aeration, possibly via an airwasher.
Activation of a sprinkler system.
Automatic shutoff of the chlorine containers and line valves.
alarm signal in installation control room.
The chlorine detectors have normally two settable alarm values for signaling and activation of the different measures. If a low alarm value is set, a time delay of 30 seconds should be adjustable so that alarms due to short-term chlorine loads (e.g. containers replacement) are avoided. In many countries it is admissible to switch off the chlorine gas detector when entering the room, if it is re-activated automatically on leaving the room. For this purpose a door contact switch is used in most cases. Please follow the local regulations of the usage of gas detector.

2.7.4.4. Ventilation: Appropriate ventilation of the chlorine gas rooms is recommended to remove small amounts of chlorine gas. Caution: Partly there are locally defined regulations!

2.7.4.5. Chlorine absorber: gas neutralisers which binds chlorine gas in caustic soda or other form of the neutralisers are to be used as per the chlorine institute manual.

2.7.4.6. Sprinkler systems: spray nozzles fixed to the ceiling of a chlorine room. The mist binds and precipitates chlorine gas. This system is not recommended as the chlorine solution forms when water mixes the leaking chlorine gas is corrosive in nature and will corrode the eqipment when comes in contact with this equipment.

2.7.5. Staff and training
2.7.5.1. Operating staff: The operating staff in charge may only consist of persons who have been trained and instructed appropriately in handling chemicals and chlorination installations. They must be fully trained and know the potential danger when handling chlorine gas and be able to operate the devices. The device manufacturer cannot be made liable for operational errors.

2.7.5.2. Specialists are staff who are familiar with handling chlorination installations due to their professional education and experience.

2.7.5.3. Service staff are especially trained persons who have all qualities of operating and maintenance personnel and, in addition, have been instructed by the manufacturer in the devices to be serviced.

2.7.5.4. All persons who are working with or on the chlorination installation must be trained for the case of an emergency or FOR chlorine gas outbreak (see section 2.7.6).

2.7.5.5. The staff must be instructed in:
- handling chlorine gas containers
- operating the chlorination installation
- startup and shut down the system.
- the danger potential coming from the installation.
- required protective measures and behavioural rules.
- personal protective equipment.
- behaviour in the case of failure or danger.
- localities of the safety and protective equipment.
- first aid.

2.7.6. Behaviour in the case of accidents
2.7.6.1. A chlorine gas outbreak affects human beings and environment significantly, therefore the following precautions must be taken immediately.

2.7.6.2. Emergency equipment: The emergency equipment is part of the equipment of a chlorine gas room. It is required to escape danger. The scope of this equipment is described in the locally defined regulations. Lutz-Jesco recommends the following means as minimum equipment:

- Breathing apparatus as full mask with gas filter „B“, class 2, identifying colour grey, and spare filter.
- Breathing mask full face positiv pressure type with 30 Min. of carring cylinder.
- Protective shoes, protection class S1 according to DIN EN 345.
- Chlorine emergency equipment for cylinders or barrels
- Safety shower at the entrance of the chlorination plant.

2.7.6.3. Measures: If chlorine gas is released, the following immediate steps have to be taken:

- Activate the sprinkler or absorber system immediately, if this does not happen automatically.
- If larger amounts of chlorine gas escape, fire-brigade and police have to be informed.
- Move against the direction of the wind.
- In the case of fire, the task force has to be notified of the existing chlorine on stock.

2.7.6.4. First aid

- Call a doctor. Injured persons must be removed immediately from the contaminated area, the rescue party taking care of his/her own safety (personal protective equipment, breathing apparatus, etc.).
- As chlorine settles in the clothes, remove them immediately.
- Use blankets to keep injured persons warm.
- Rinse skin sections cauterized by chlorine immediately with plenty of water.
- In the case of cauterized eyes use an eye rinsing bottle. Transport of injured persons only lying.
- The injured person must be kept quiet. Provide him/her with fresh air. Possibly pure oxygen. By no means artificial respiration as long as the affected person is breathing on his own.

3. Extract from the applicable national and international guidelines, rules, regulations and laws.

Attention! This list is just for your information, the locally applicable regulations have to be identified and taken as a basis.

3.1. DIN EN 937 „Chlorine“
3.2. DIN 19606 „Chlorinators for Water Treatment“
3.3. DIN 19643 „Treatment of Pool Water“
3.4. VBG 65 „Chlorination of Water“
3.5. GUV 0.1 „General Regulations“
3.6. GUV 0.3 „First Aid“
3.7. GUV 92.1 „Pressure CONTAINERS/DRUMS/CYLINDERS Ordinance“
3.8. GUV 2.10 „Electrical Systems and Operating Material“
3.9. GUV 9.9 „Gases“
3.10. GUV 20.5 „Instruction about First Aid in the Case of an Accident“
3.11. GUV 20.6 „Dressing Material for First Aid in the Case of an Accident“
3.12. ZH 1/134 „Breathing Mask Instruction Card“
3.13. GUV 29.6 „About Handling Cauterizing Agents“
3.14. ZH 1/230 „Chlorine“
3.15. GUV 49.1 „Check List for Regulations for Prevention of Accidents - Chlorination of Water“
3.16. DIN 477 „Gas Cylinder Valves, Construction, Building Material, Connections, Threads“
3.17. TRG 280 „Operation of Pressurized Gas Containers“
3.18. TRG 310 „Special Requirements on Pressurized Gas Containers (Cylinders) „
3.19. TRG 330 „ Special Requirements on Pressurized Gas Containers (Barrels)“
3.20. DIN 3179, Part 1,2 „Classification of Breathing Apparatuses“
3.21. The Chlorine Institute Pamphlet 1 „Chlorine Manual“
3.22. The Chlorine Institute Pamphlet 5 „Liquid Chlorine“
3.23. The Chlorine Institute Pamphlet 6 „Piping Systems for Dry Chlorine“
3.24. The Chlorine Institute Pamphlet 9 „Chlorine Vaporizing Equipment“
3.25. The Chlorine Institute Pamphlet 40 „Maintenance Instructions Angle Valve“
3.26. The Chlorine Institute Pamphlet 60 „Pipelines“
3.27. The Chlorine Institute Pamphlet 63 „First Aid“
3.28. The Chlorine Institute Pamphlet 64 „Emergency Response Plans for Chlorine Facilities“
3.29. The Chlorine Institute Pamphlet 73 „Atmospheric Monitoring Equipment for Chlorine“
3.30. The Chlorine Institute Pamphlet 82 „Chlorine Cylinders“
3.31. The Chlorine Institute Pamphlet 85
3.32. The Chlorine Institute Pamphlet 89 „Chlorine Scrubbing Systems“
3.33. The Chlorine Institute Pamphlet 95 „Gaskets for Chlorine Service“
3.34. The Chlorine Institute Pamphlet 97 „Safety Guidelines for Swimming Pool Applicators“
3.35. The Chlorine Institute Pamphlet 151 „Training Guide“
3.36. The Chlorine Institute Pamphlet 155 „Water and Waste Water Operators Chlorine Handbook“
3.37. The Chlorine Institute Pamphlet 164 „Reactivity and Compatibility of Chlorine with Various Materials“

4. Environmental protection

Lutz-Jesco products are made from environmentally acceptable, recyclable materials as far as possible. In some cases, however, also other materials are used because of chemical resistance requirements. If necessary, these are subject to an ecologically beneficial disposal.

5. Why chlorine

Chlorine has been used as a desinfectant for much more than 100 years. Due to the use of chlorine the spread of epidemic diseases could be checked strongly.
Chlorine plays an important part in water treatment, due to its reactivity germs are killed fast and reliably at comparatively reasonable costs. Chlorine is used for the disinfection of 98% of the Western European potable water.

6. Chlorine

6.1. Danger and safety indication according to EU guidelines

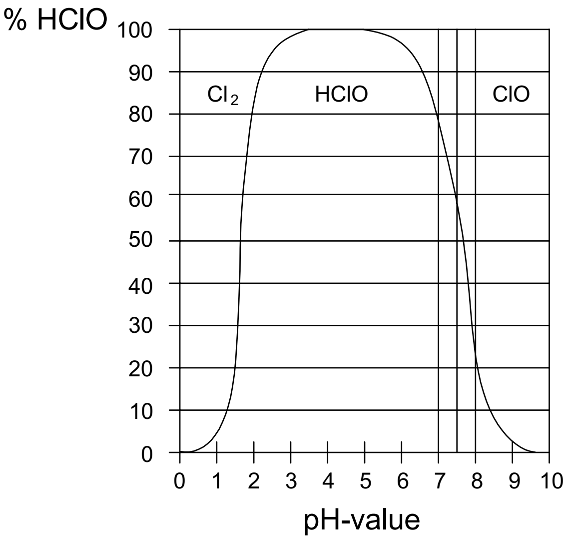
- Danger symbols and designations
- T: toxic
- N: environmentally hazardous
- Note on special risks in the case of dangerous materials:
- R 23: toxic on inhalation

- R 50: very toxic for water organisms
- R 36/37/38: irritates eyes, respiratory organs and skin
- Safety advice for dangerous materials:
- S 45 In the case of an accident or sickness, ask for medical advice immediately (show label, if possible).
- S 61 Avoid release to environment. Observe special instructions or safety data sheet.
- S 7/9 Keep Containers tightly closed in a well-ventilated place.

6.2. Chemico-physical reaction

If chlorine reacts with water, hypochlorous acid (HClO) and hydrochloric acid (HCl) are produced: $Cl2 + H2O$ — $HClO + HCl$. The germs are actually killed by the resulting hypochlorous acid (HClO) formation. In hypochloric acid further dissociates into hydrogen (H+) and hypochlorite ions (ClO-), the hypochlorous acid concentration depends on the pH of the water. The disinfecting function of the hypochlorite ion is less than 10% of the hypochlorous acid. The HClO concentration is 90% at a pH value of 6.5 and 50% at a pH value of 7.5. The dependency can be read from the dissociation curve shown below. It becomes clear that the disinfecting power of chlorine is neglectable at pH values higher than 8.

6.2.1. Dissociation diagram



7. Chlorine properties

7.1. General notes

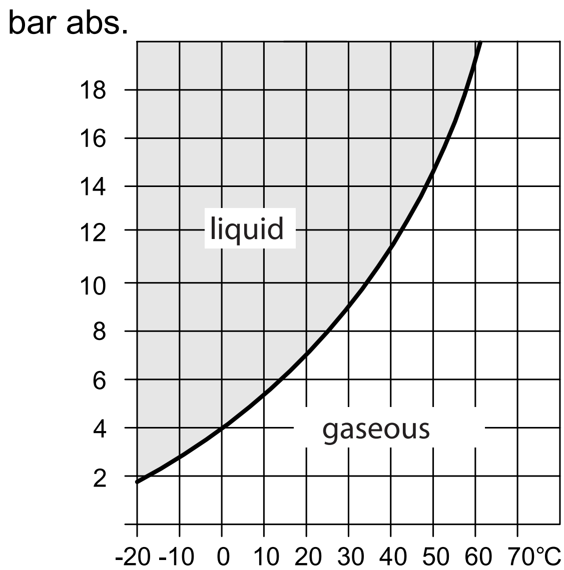
Chlorine is an element which belongs to the group of halogens. In nature it is found in many compounds, mostly as a part of sodium chloride (NaCl) - known as common salt - which is also an important component of the human organism.

7.2. Physical properties

Chemical formula	Cl2
Atomic weight	35.453
Molecular weight	70.906
Density (liquid, 0°C approx. 4bar)	1468 kg/m^3
Density (gaseous 0°C 1013mbar)	3.214 kg/m^3
Relative weight (gaseous, air=1)	2.486
Volume 1kg chlorine at 1013mbar, 0°C	0.311m^3
Viscosity liquid chlorine at 0°C	0.3863 mPa*s
Viscosity chlorine gas at 0°C	0.0125 mPa*s
Boiling point at 1013mbar	-34.05°C
Melting point	-100.98°C
Vapour pressure at 20°C	6.73bar
Melting heat (at -103.5°C)	744kJ/kg
Evaporation heat (at 0°C)	269kJ/kg
Specific heat (-34°C)	2.58 10 power-4 kWh/kgxK
Thermal conductivity of liquid chlorine (30°C)	6.13 10 power-4 kWh/m2
Critical temperature	144°C
Critical pressure	77.6 bar abs
Density at critical point	0.573 g/cm^3
Colour	yellow greenish
Max. workplace concentration value	0.5 Vol.-ppm

The reaction of chlorine is hygroscopic, from air humidity it forms hydrochloric acid (HCl) in connection with.

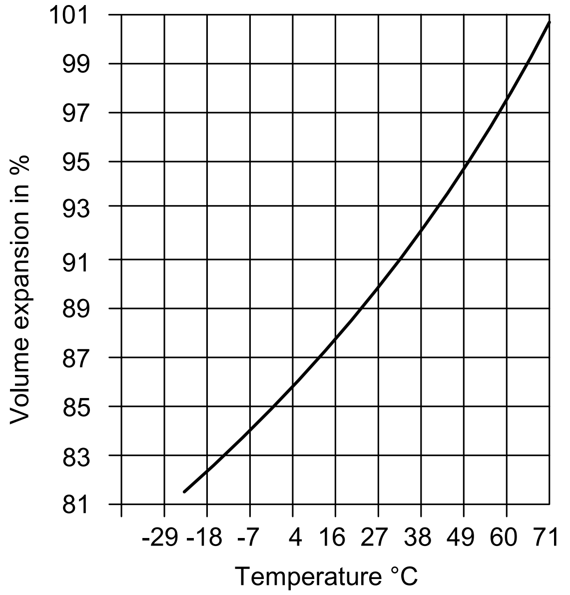
7.2.1. Vapour diagram



The above curve explains the liquid and gaseous phase of the chlorine against the temperature. The area above the curve is chlorine in liquid phase and the area below the curve is chlorine in gaseous phase. 1 liter of liquid chlorine expands to 457 liter of chlorine gas (at 0°C and a standard pressure of 1013mbar). 1 kg chlorine amounts to 311 liter of chlorine gas (at 0°C and a standard pressure of 1013mbar).

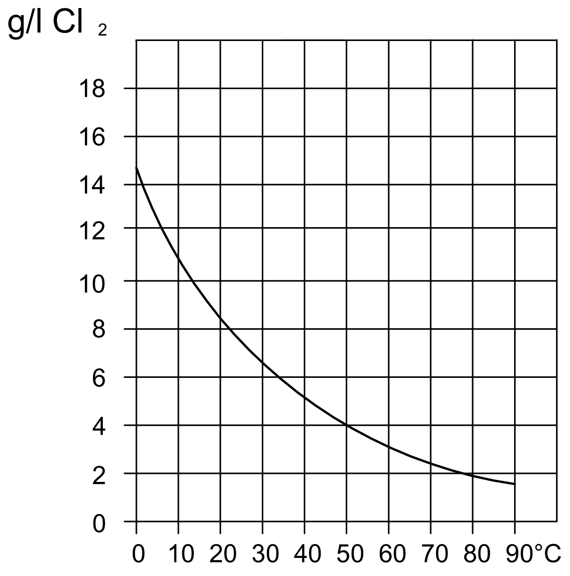
Example: In the case of a container leakage up to 1000kg chlorine may escape, i.e.: a cloud of 457m ^{3} pure chlorine gas develops. If the chlorine air concentration of 1% is taken as a basis, a volume of 45700m^3 becomes a deadly trap. This corresponds to a superficial area of approx. 22850m^2 (at a height of 2m) or the area of 4 soccer fields.

7.2.2. Volume expansion of liquid chlorine (temp)



7.2.3. Diagram „density of gaseous chlorine“ (pressure)

7.2.4. Diagram „water solubility“ (temp)



7.2.5. List of concentrations

ppm	mg/l g/m^3	g/l	%
10,000	10,000	10	1
1,000	1,000	1	0.1
100	100	0.1	0.01
10	10	0.01	0.001
1	1	0.001	0.0001

7.2.6. Technical chlorine for disinfection
The chlorine used in Lutz-Jesco chlorination installations must have minimum purity of 99.5%. This corresponds to DIN EN 937.
The remaining 0.5% contain water, carbon dioxide, nitrogen, bromine, mercury, iron and other substances. Partly these impurities precipitate in within the chlorination installation (see also section 7.3.13 „Chlorine butter“).

7.3. Definition of terms
7.3.1. Chlorine
The chemical element in its pure form, liquid or gaseous, as described above.

7.3.2. Liquid chlorine
Pure chlorine which exists as liquid due to the pressure and temperature (see vapour diagram). With standard atmospheric pressure this is only possible at temperatures below -34°C, or at room temperature with pressures above approx. 7 bar, consequently in pressure lines and containers. Condensation allows liquid chlorine to form temporarily in certain places of the chlorine gas system. Liquid chlorine must not be mixed up with chlorine solutions, humid chlorine or sodium hypochlorite.

7.3.3. Chlorine gas
Technically pure chlorine existing as gas for disinfecting purposes according to DIN EN 937.

7.3.4. Dry chlorine
Pure chlorine containing no water or less water than admissible. It is not correct to refer to solid chlorine products, e.g. chlorinated lime, as dry chlorine.

7.3.5. Humid chlorine
The opposite of dry chlorine contains too much water. Humid chlorine is not liquid chlorine. It has an extremely corrosive effect, also on system components which are fully resistant to dry chlorine.

7.3.6. Saturated chlorine gas (saturated steam)
If saturated chlorine gas cools off or the pressure is increased, part of the gas will condense (see condensation).

7.3.7. Saturated liquid chlorine
If heat is added to the saturated liquid chlorine or the pressure is reduced, part of the liquid chlorine will evaporate. This is the normal process in a chlorine containers on withdrawal of gas-pressure loss in the containers caused by tapping gas.

7.3.8. Condensation (reliquefaction)
(see also saturated liquid chlorine)
The reliquefaction of chlorine gas is a serious problem as the

chemical resistance of materials is different for chlorine gas and liquid chlorine. PVC, for example, is fully resistant to chlorine gas whereas liquid chlorine will destroy PVC. Reliquefaction can be prevented by either increasing the temperature or reducing the pressure. A pressure reduction unit is thus installed in the chlorine gas line (directly after the chlorine containers, in the case of gas withdrawal or directly after the chlorine evaporator, if liquid chlorine is withdrawn). It is also, or additionally, possible to install a heated mist collector directly before the vacuum regulator. Therefore it is highly recommended to make sure that the temperature in the chlorination room is 5°C higher than in the chlorine storage room. If chlorine condenses in a line, frost of icing effects take place on the line and chlorine gas reliquifies into liquid.

7.3.9. Chlor solution (chlorine in water)

Is the solution of chlorine and water resulting e.g. from mixing in the ejector. At a water temperature of 20°C up to 9g chlorine dissolve theoretically in one liter of water. This corresponds to 0.9% or 9000ppm (mg/l). Chlorine added on top of that will be outgassing from the water again. (See diagram „Solubility of chlorine in water“ and table „Concentrations“.)

7.3.10. Chlorinated lime

Available as granulates, tablets or clear solution with a chlorine concentration of up 60% according to DIN EN 900

7.3.11. Sodium hypochlorite

Liquid chemical produced from caustic soda and chlorine with an active chlorine concentration of up to 12% according to DIN EN 901. Is used for disinfection by means of dosing pumps.

7.3.12. Chlorine butter

Often condensations of impurities and their products from reaction with air humidity are called chlorine butter. This greenish pasty substance partly causes trouble at sensitive system parts. Chlorine butter often precipitates as hard particles which , on opening of the devices, liquify and sometimes even evaporate when it comes in contact with air humidity.

7.4. Production of chlorine gas

7.4.1. By large-scale industry

Mercurial method: Anodes are immersed in a continuously flowing brine. The Cl accumulated on their surface is removed with the depleted brine and then escapes as gas. Mercury acting as cathode flows through the electrolytic cell. The separated alkali metal atoms form amalgam in connection with Hg and flow from the cell into the decomposer. There the alkali metal reacts with the decomposer water and forms a very pure alkali base and hydrogen. The mercury flows back to the cell.
Diaphragm method: A diaphragm permeable to gas divides the electrolytic cell into an anode section and a cathode section. The sodium chloride solution is decomposed in the electrolytic cell thus forming elementary chlorine at the anode.

7.4.2. By on-site electrolysis

Here the required amount of chlorine gas is produced similar to the diaphragm method.

7.4.3. By chemical reaction for laboratory purposes.

If sodium hypochlorite (NaOCl) and hydrochloric acid (HCl) are mixed, chlorine is released.

8. Neutralization and bonding of chlorine

8.1. Chlorine concentration in the water

The addition of 1.44 l (30%) peroxide eliminates 1 kg chlorine. The addition of 875 g soidum thiosulphate eliminates 1 kg chlorine.

8.2. Chlorine gas

So-called gas scrubbers bond the chorine by feeding chloric air by means of atomized spray from e.g caustic soda. Chlorine bonds with caustic soda. Sodium hypochlorite is formed.

9. Chlorine containers

9.1. Chlorine gas is normally supplied in pressure containers.

The chlorine is always kept in compressed condition so that it remains in the liquid form. This results in high pressure (usually 6-8 bars) in the containers (see also vapour diagram). The content is specified in mass. The following details must attached clearly visible and permanently:
- type of gas content
- tare weight
- max. filling weight gross and tare weight.
- Manufactures name
- date of production
- date of next check

9.2. Standard chlorine containers

chlorine gas are available in different sizes and dimensions, standard sizes in Germany are e.g.:

Type	Chlorine gas content	Empty weight approx.	Overall d x l approx.
Cylinder	65kg	35kg	270 x 1230mm
Cylinder	50kg	45kg	200 x 1650mm
Container /Drum	500kg	275kg	760 x 1500mm
Container /Drum	1000kg	390kg	850 x 2000mm

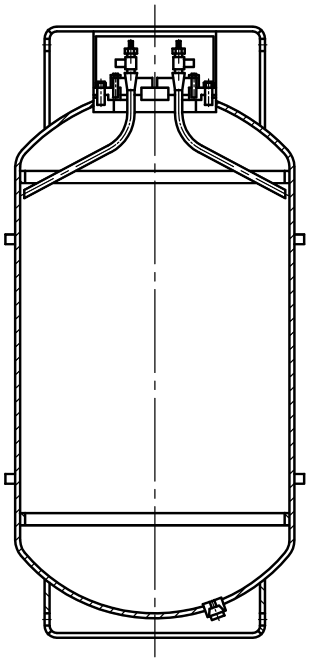
9.2.1. General

9.2.1.1. Barrels and cylinders are made from special steel. Body yellow. The content of chlorine containers is determined by the weight, the pressure depends on the containers temperature (see vapour diagram).

9.2.1.2. Because of the high volume expansion of liquid chlorine with rising temperature, cylinders and barrels must never be filled with chlorine completely. The max. admissible filling level is 84% of the containers volume. Thus a remaining is in the form of gas bubble is ensured even at the highest admissible temperature.

9.2.2. Containers/Drums

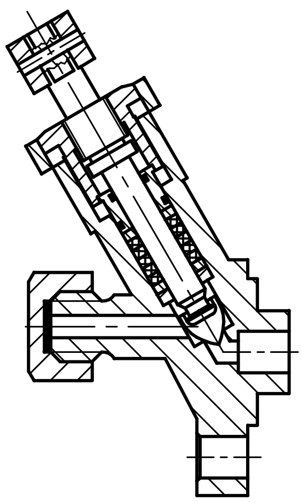
9.2.2.1. These are welded steel container/drums with a capacity of 500 - 1000 kg chlorine. The barrels are fitted with two identical valves to be able to supply liquid or gaseous chlorine. The upper valve is for tapping gas, the lower one for tapping liquid. The valves are protected by a cover during transportation and storage. The bottoms have a concave or convex form, the sides are bended to the inside to allow a crane hook to be attached safely. The content of chlorine container/drums is determined by the weight, the pressure depends on the container/drum temperature.



9.2.2.2. Barrel valves used

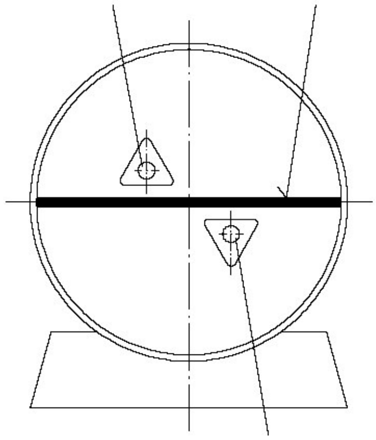
On the outlet side of barrel valves the following connection threads are available (others possible):
- W 1 1/4" DIN 477
- 3/4"BSP F
- 5/8"BSP F
- G1/2"
- 1.030" - 14NGO-RH-EXT

The connections are standardized. The devices and fittings to be connected must fully match the Containers/Drums/Cylinders valve used!



9.2.2.3. Storage and transportation of chlorine container/drums

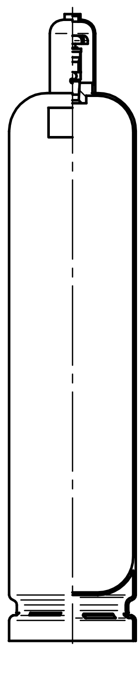
- container/drums are stored in horizontal position (see drawing of barrel). They are placed on barrel storage stacks so than they cannot start to roll. Barrels for operation are placed on roller trunnions so that they can be turned into the right position for operation. During operating the colour marking must be horizontal. The upper valve supplies chlorine gas, the lower one supplies liquid chlorine.



9.2.3. Cylinders

9.2.3.1. Chlorine cylinders

are seamless produced or welded cylinders with a capacity of 45 to 68 kg chlorine. The cylinders are positioned vertically and must be secured with chains or bows to avoid accidents. If the cylinders are not in use, the valve locking nut and protective cap must be screwed on. Chlorine gas is taken from the valve screwed on top of the cylinder. The content of chlorine cylinders is determined by the weight, the pressure is dependent on the cylinders temperature.

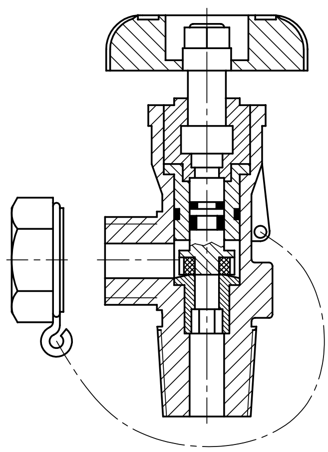


9.2.3.2. Cylinder valves used

On the outlet side of cylinder valves the following connection threads are available (others possible):

- W 1" DIN 477
- 3/4 BSP F
- G 5/8 BSP F
- G 1/2

Also in this case it must be made sure that the mounted devices and fittings have the same threaded connection.



9.2.3.3. Labeling of chlorine cylinders

9.2.3.4. Handling chlorine cylinders

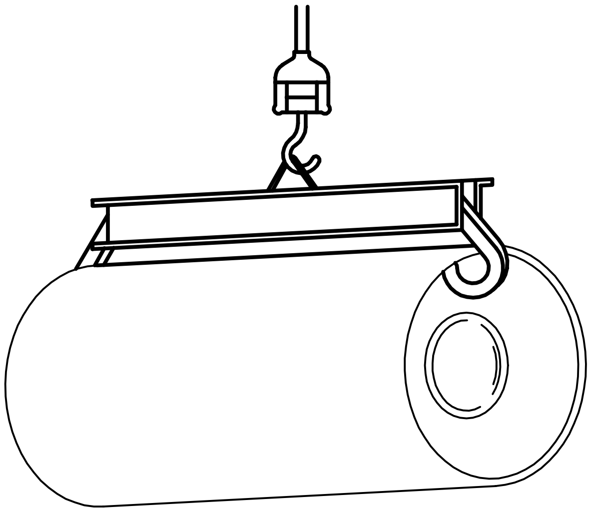
9.3. Storage of chlorine containers

9.3.1. Attention!

Chlorine containers may only be handled by professional staff. The safety equipment required according to the local rules must be maintained. Stored chlorine gas containers connected during operation as well as full and empty containers ready for further use. Chlorine containers can be stored inside or outside the building. In the case of storage outside a building the containers must be protected against weather and direct sunlight. No combustible materials may be stored near chlorine containers. The ambient temperature must not exceed 50°C. Unnecessary exposure of the containers to environments developing corrosion must be avoided. The containers must be secured by suitable measures to prevent them from falling or rolling. Chlorine gas storage rooms may only be used for storing chlorine gas containers. The nature of chlorine gas storage rooms and the corresponding safety equipment are specified by the local rules. Lutz-Jesco recommends a minimum temperature of 15°C for chlorine gas rooms in which containers for chlorine gas supply are stored.

9.4. Transportation of chlorine gas containers within the plant

For the transportation of chlorine gas containers only auxiliary and lifting equipment suitable and meant for the application are allowed.



There are e.g. special crane cross-beams which engage safely with the notches of the corresponding barrel ends. For local transportation of gas cylinders, cylinder carts are suited on which the gas cylinders are secured against falling. Chlorine containers must be fitted with protective caps and covers before moving them.

9.5. Handling of chlorine gas containers

9.5.1. The containers should be used in chronological order of delivery so that the storage time of all containers is almost the same. Thus the risk of stuck containers valves due to long periods of non use is minimized.

9.5.2. On acceptance and before connection the containers must be inspected visually. If the condition is questionable, the containers must be marked and returned to the supplier.

9.5.3. First put the containers in the position prescribed for use and secure them with the appropriate auxiliary equipment. Barrels are fixed and locked horizontally on roller gantries. Cylinders are positioned vertically and secured with clips or chains. The protective caps may be removed and the containers connected only after the latter have been fixed in their final position. Before supplying chlorine the containers content must have settled and have achieved the room temperature.

9.6. Chlorine containers in use

9.6.1. Withdrawal of gas

General rule: In the case of gas withdrawal at room temperature (18-20°C), theoretically a maximum of approx. 2% of the original content can be withdrawn from chlorine cylinders and approx. 0.7% from chlorine drums, i.e.: approx. 1kg from a cylinder and 7kg from a 1000kg barrel. In case of doubt it is recommended to ask the chlorine supplier. If the withdrawl rate is more than the evaporation rate of chlorine in containers, icing will be formed on the containers. The energy supply by ambient heat is further reduced due to the ice layer and the chlorine gas supply fails.

Gas lines must pass rising temperature zones, otherwise condensation and the formation of liquid chlorine will occur. If this cannot be guaranteed, a pressure reducing valve must be installed close to the chlorine containers or an accompanying heater must be mounted on the piping. Material resistant to

chlorine gas is not necessarily resistant to liquid chlorine as well - danger of accident!
In the case of gas supply from drums, a liquid collector must be installed before the chlorinator, because the rising pipe of the valve for gas supply contains a certain amount (approx. 200cm³) of liquid which would flow to the chlorinator and damage it. Several chlorine containers can be connected in parallel for battery operation in order to achieve the required amount of chlorine gas. For an installation with 10 kg Cl2/h, for example, two 1000kg barrels are joined in a manifold. Either the containers are connected by means of pressure manifold which feeds a single vacuum regulator, or two vacuum regulators are mounted on one barrel each and connected to a vacuum manifold.

9.6.2. Withdrawal of liquid

In the case of liquid withdrawal at ambient temperatures exceeding 10°C, up to 30% of the original content of the chlorine liquid may be withdrawn. For liquid chlorine supply an evaporator is required to transform the chlorine into gas. The supply and installation of systems for liquid chlorine is much more complicated than for chlorine gas. The increased danger potential is mainly due to higher throughputs and hydraulic forces of the liquid. If there is the possibility of locking liquid chlorine in system parts, e.g. between two shutoff devices, this part of the system will burst in the case of minor heating. Therefore appropriate expansion vessels and/or rupture disks/ safety blowoff valves must be provided here. For liquid supply not more than one drum should be used at a time, if possible, in order to minimize the quantity of chlorine escaping in the case of leakage.

9.6.3. Types of connection for devices and fittings

The devices are either connected to the drums valves using union nuts or mounted on the sealing surface of the container valve using a clamp strap.

9.6.4. Measures for the replacement of chlorine containers

9.6.4.1. Breathing masks

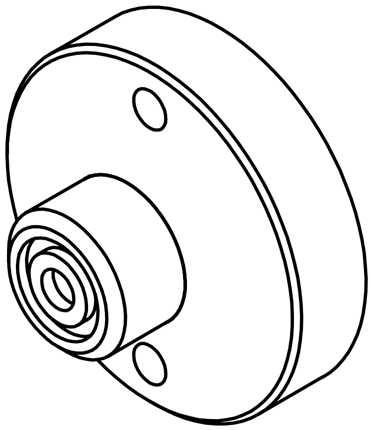
are mentioned when replacing chlorine gas containers. The open connections and lines must be closed immediately by plugs and caps. Entry of ambient air and dirt must be avoided by all means. If necessary, dry connections before screwing. Seals of unscrewed connections must be replaced, they are suitable for single use only. If they are used a second time, there will be leakage. It is recommended to lubricate the new seal slightly with e.g. silicon grease. It can then be removed easily on the occasion of the next replacement. Open the container valves slowly and without applying force after replacement. Check all pressure lines with ammonia vapour but do not wet the system parts with ammonic solution since this causes corrosion! Pass the open ammonia bottle along the line parts. With appropriate plastic bottles ammonia vapour can be released deliberately on pressing.

9.6.4.2. Closing of line ends

Open line ends must be closed immediately by all means, entering air humidity causes damage to the the system parts!

9.6.4.2.1. Hold appropriate plugs ready, for vacuum regulators, there are corresponding wall holders available for this purpose.

The connection matches the containers valve connection and holds the vacuum regulator at the same time.



10. Chlorination technology

10.1. Chlorination installations

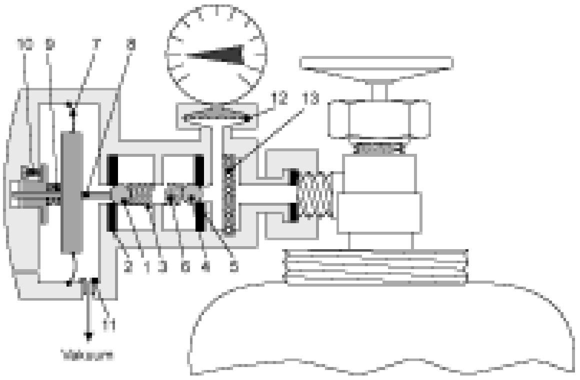
are distinguished by the way of adding the chlorine gas to the water. In the case of the so-called vacuum technology, chlorine is mixed into (absorbed by) the water by means of ejectors (water jet pumps). The major part of the system is under vacuum, i.e.: the pressure in the system parts is lower than the atmospheric pressure. The changeover from pressure to vacuum takes place in the vacuum regulator. Pressure-carrying lines and fittings can be installed before the vacuum regulator. In the case of full-vacuum chlorination installations, the vacuum regulator is mounted directly on the chlorine container so that chlorine under pressure exist only in the container. Pressure-type chlorination systems are completely under pressure, i.e.: the chlorine is pressed into the medium to be chlorinated, mostly by means of a diffusEr.

10.2. Vacuum chlorination

10.2.1.

Today full-vacuum chlorination installations are state of art. A vacuum regulator is mounted directly on the chlorine gas cylinder and opens only if the dosing connection is under vacuum. This functional principle reduces the pressure-carrying system parts to a minimum (cylinder, cylinder valve and connection point), in the case of leakage at the vacuum lines only ambient air is sucked in, chlorine gas cannot escape. This technology is limited by the maximum gas supply from the containers.

10.2.2. Schematic view and function of a vacuum regulator, taking the Lutz-Jesco vacuum regulator C 2211 as an example



The vacuum regulator used as pressure reducing valve is of central importance for the safety in vacuum installations. For this reason the C 2211 version was designed according to the latest design. The device combines several functions in one housing:

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 vacuum regulator, which moves to the right. This force is transferred to the valve ball (1) by the valve rod (8) so that chlorine gas can enter the vacuum system. If the vacuum breaks down, the valve ball falls back immediately onto the valve seat and stops the chlorine gas supply.

Simultaneous delivery

From a chlorine containeronly a certain percentage of the original content may be tapped continuously per hour. Thus the maximum supply rate for e.g. a 65 kg cylinder is 1300 g Cl2/h under optimum conditions.

In many applicatons, chlorine supply from only one cylinder is not sufficient because much more chlorine than 1300 g/h is required. In these cases, chlorine is supplied simultaneously from several cylinders in so-called battery operation.

In order to make sure that the cylinders are emptied uniformly, all vacuum regulators must start the chlorine supply at the same vacuum. For this purpose Lutz-Jesco C 2211 chlorinators are fitted with an opening pressure adjusting device. The adjusting screw (10) is used to set the effect of forces between springs (9) and (3). As a result, it is ensured that the opening pressure is the same for all vacuum regulators and that the chlorine gas is supplied from all connected containers as simultaneously as possible.

Simultaneous delivery works with rates of approx. 200 g/h and more. In order not to remain under this rate, the number of connected cylinders should not be larger than necessary.

Flow limiter

If some cylinders of a battery are already emptied and the full dosing capacity is required, the supply rate of the partly filled cylinders becomes extremely high, thus causing icing of the cylinder. To avoid this, a flow limiter (11) is integrated in the vacuum connection, which allows a maximum supply rate of approx. 1000 g/h.

If the vacuum regulator is mounted on a chlorine barrel or in the case of sufficient chlorine supply from other sources, the device allows throughputs of up to 10 kg/h. For this purpose, the flow limiter can be removed easily. (As a standard the flow limiter is an integral part of the delivery).

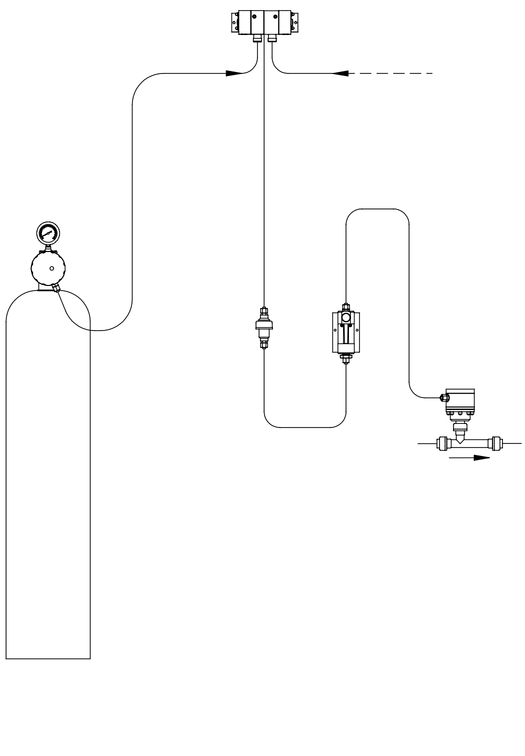
Pressure gauge

The C 2211 chlorinator is equipped with a pressure gauge (optional)for the indication of the cylinder pressure. The gauge is fitted with a diaphragm separator transmitting the pressure and a hydraulically coupled, splash-proof measuring element in a plastic housing. The separating diaphragrm (12) is coated with a silver film as a protection against the chlorine gas. In order not to damage this component or other ones by dirt particles the chlorine gas is directed through an integrated filter (13) before reaching the pressure gauge.

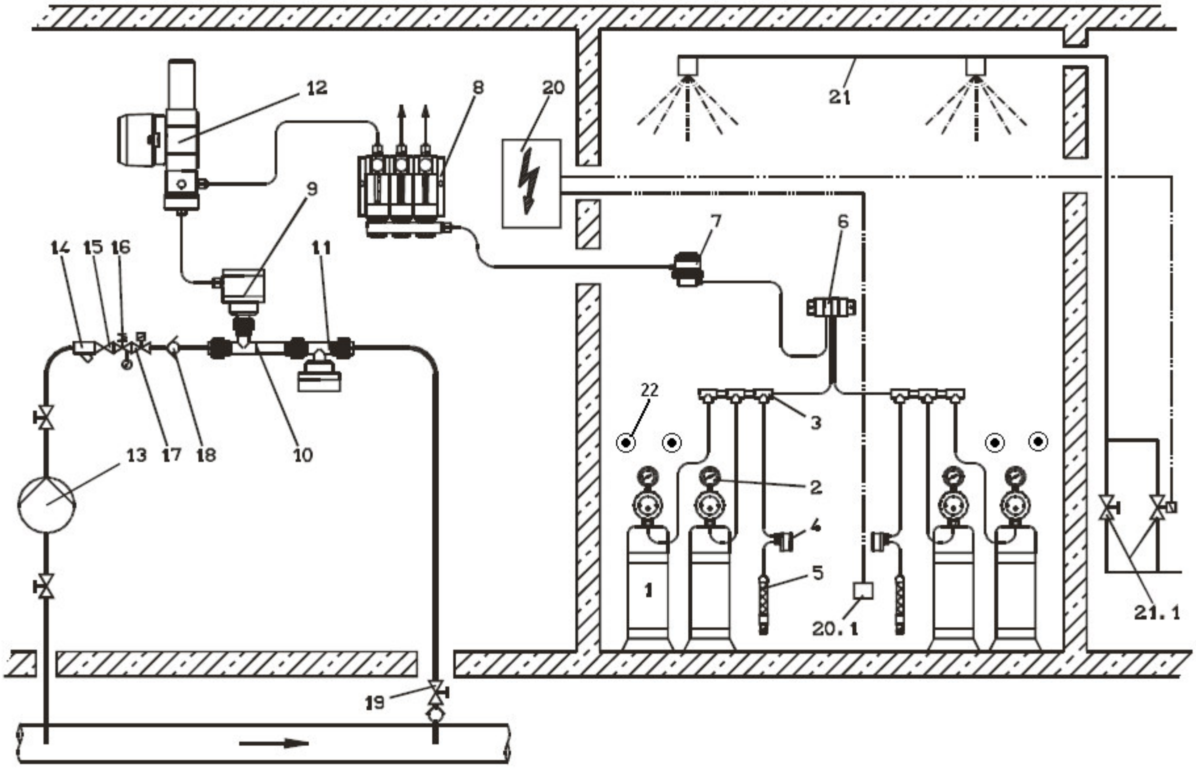
10.2.2.1. Vacuum generation by ejector

The ejector generates the required vacuum. It works according to the principle of a liquid jet gas compressor (see section XXX „Ejector“).

10.2.2.2. Easy installation



10.2.2.3. Typical design of a (full-vacuum) chlorination installation



Legend:
1 Chlorine cylinder
2 Vacuum regulator
3 Vacuum manifold
4 Safety blowoff valve (possibly also integrated in item 2)
5 Activated-carbon cartridge (optional)
6 Chlorine changeover unit
7 Safety shutoff valve
8 Flow meter
9 Ejector non-return valve
10 Ejector
11 Vacuum breaker
12 Control valve
13 Booster pump
14 Dirt trap
15 Shutoff valve
16 Pressure reducing valve with pressure gauge
17 Solenoid valve
18 Ball non-return valve
19 Chlorine solution injector
20 Chlorine gas detector
20.1 Sensor for gas detector
21 Sprinkler system
21.1 Fittings for sprinkler system
22 Wall holder

10.2.2.4. Installation with additional safety equipment

10.2.2.4.1. Safety blowoff valve

The safety blowoff valve is connected to the vacuum line. In the case of excessive pressure (e.g. due to a defective inlet valve of the vacuum regulator) the safety valve opens and discharges the chlorine gas deliberately. An activated-carbon filter should be installed at the end of the line to absorb small amounts of chlorine.

10.2.2.4.2. Safety shutoff valve

Function

During operation of a chlorination installation according to DIN 19606 the ejector builds up a vacuum. As a result of this vacuum first the safety shutoff valve is opened via the diaphragm surface and only then the vacuum regulator. During operation the shutoff valve is virtually just a piece of piping for the dosing system. If the ejector is switched off, the vacuum collapses and the shutoff valve closes due to spring load. The valve shuts down the dosing line completely so that even in the case of an excessive pressure at the valve inlet chlorine gas cannot reach the outlet side. By mounting the safety shutoff valve within the chlorine gas room monitored by the gas detector the installation is safe even in the case of malfunction (see installation diagram).

10.2.2.4.3. Back stop

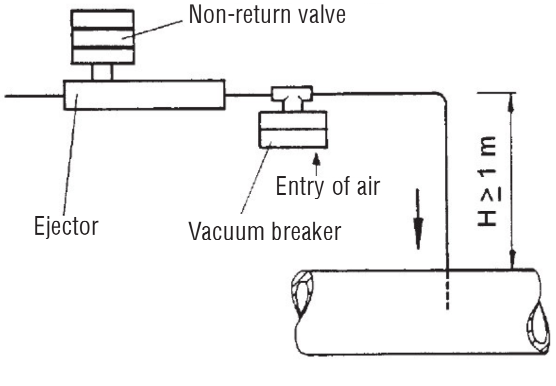
Back stop / back-pressure valve

It is an experience that even the best ejector non-return valve may become untight sometime because of impurities. Therefore the installation of an additional back stop is prescribed by law in some countries. Its function is to prevent effectively water from entering the chlorinators even in the case of a failure so that these devices are not damaged. The back stop has a second safety function. It needs a small differential pressure to open. The value of this differential pressure has been chosen by construction so that it slightly exceeds the minimum response pressure of the safety valve. Even in the case of creeping chlorine leakage at the vacuum regulator, the safety valve responds exactly thus avoiding excessive pressure to develop in the vacuum system. Back stop and safety shutoff valve mainly have the same function. The disadvantage of the back stop in comparison to the valve is the drop of pressure. This requires a higher vacuum of the ejector.

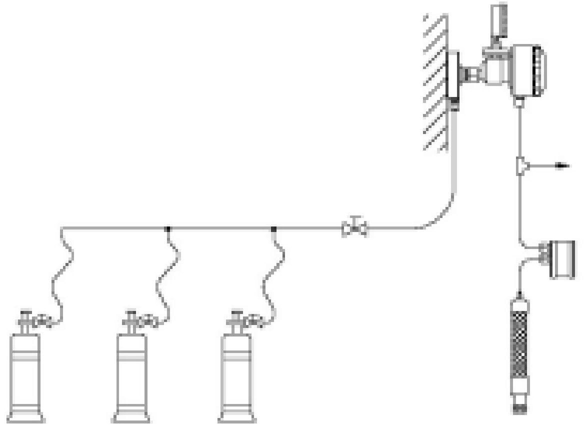
10.2.2.4.4. Locking valve (electrical)
The electrical locking valve is connected directly to the control. If chlorination is stopped, the vacuum dosing line is locked.

10.2.2.4.5. Injector non-return valve
In vacuum chlorination installations the vacuum is built up by so-called ejectors. The vacuum is generated by the water flow of these water jet pumps. If the water flow is disturbed or interrupted, the water pressure is also present at the suction nozzle of the ejector. Therefore it is essential that the ejectors are equipped with non-return valves in order to prevent water from entering the vacuum sections of the chlorinators, leading to corrosion and failure of the connection equipment.

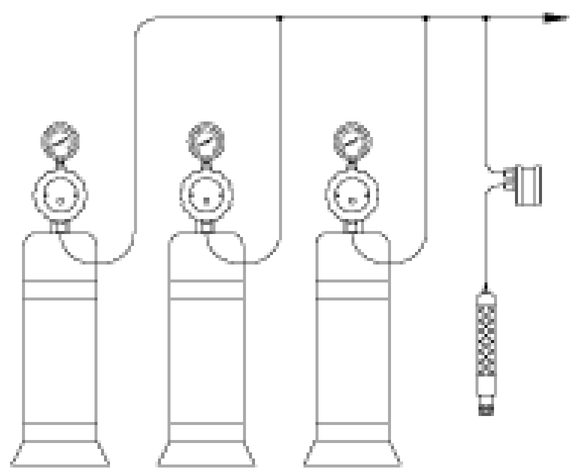
10.2.2.4.6. Vacuum breaker
Chlorination installations according to DIN 19606 are operated under vacuum, which is produced by an ejector. arbeiten unter Vakuum. The motive water required is supplied either by a booster pump or by hydraulic piping. Many installations are switched off simply by interrupting the motive water supply. In this type of installations, often vacuum breakers must be used in order to avoid undesired chlorination. Vacuum breakers are required if, even after switching off the motive water supply, the vacuum may exceed 0.1 bar due to system-related conditions. This vacuum can be caused by geodetic difference in altitude of the chlorine solution injection point (see installation example) or by a vacuum in the main pipe. The vacuum breaker is designed like an ejector non-return valve. The opening pressure is, however, only 0.05 bar (compared to 0.1 bar of the ejector non-return valve). As a result, the vacuum breaker lets air enter the piping before chlorine is unintentionally primed.



10.2.2.5. Battery installation with pressure manifold
This type of installation connects the chlorine container to a manifold which supplies one chlorinator/vacuum regulator. The cylinders are emptied simultaneously because of physical laws.



Battery installation with vacuum manifold

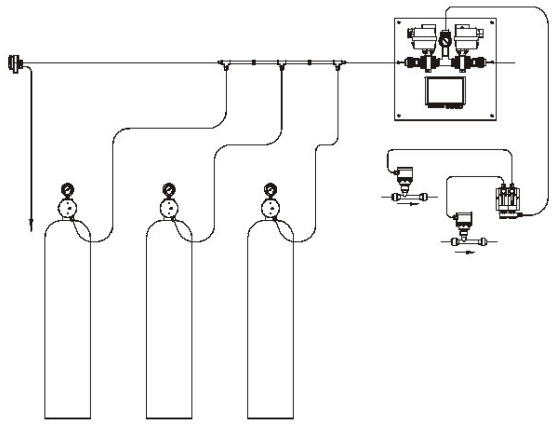


This installation is to be preferred as the system parts under pressure are reduced to a minimum. The complete installation is designed as a vacuum piping system, the vacuum starting at the chlorine container. For simultaneous emptying of the chlorine cylinders, some requirements must be met: same cylinder temperature, same filling level at the beginning, supply rate not less than 200g/h/cylinder, suitable vacuum regulators, adapted to each other.

10.2.2.6. Service and standby container with changeover equipment

10.2.2.6.1. With auxiliary energy

One or two motor-driven valves are controlled by an electronic unit. In the case of low supply pressure, a pressure gauge transmits a signal.



10.2.2.6.2. Without auxiliary energy for vacuum

This type of changeover unit uses the increasing vacuum of an empty container to operate a changeover valve.

10.3. Pressure chlorination

10.3.1. Schematic diagram and function

11. Technical notes on selection and installation

11.1. Requirements for installation areas

11.1.1. Attention! The requirements for chlorine gas rooms are regulated locally (see VBG65)

.

11.1.2. Chlorine gas rooms accommodate system parts of chlorination installations using chlorine gas. Storage rooms for chlorine containers are also referred to as chlorine gas rooms.

11.1.3. Storage rooms for chlorine gas containers without system parts for chlorination

11.1.4. Dosing equipment room which accommodates system parts for chlorination (without chlorine gas containers)

11.2. Chlorine pressure devices and lines

11.2.1. Admissible material for dry chlorine under pressure, liquid and gaseous (see „The Chlorine Institute Pamphlete 164“)

11.2.2. Installation with evaporator

This type of installation taps liquid chlorine from the chlorine containers. In an evaporator the required evaporating energy is added. Thus capacities of up to 220kg/h can be supplied. After the evaporator the installation is the same as in the case of gas supply.

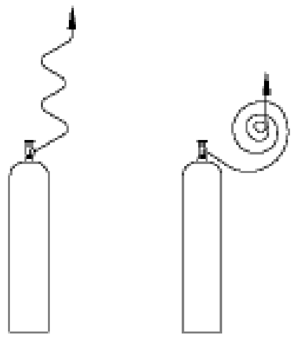
11.2.3. Auxiliary valves (or „isolating valves“) are connected directly to the valve of the chlorine container. They are required to separate the chlorine system in the case of container replacement. Otherwise chlorine gas would escape or air humidity enter the system.

11.2.4. Lines for chlorine gas under pressure

Lines installed for chlorine gas under pressure (higher than atmospheric pressure) or for liquid chlorine must correspond to pressure rating PN40 / Class 800. The lines must be kept as short as possible. They must be fixed tightly and protected against damage caused by shocks. The piping must be made from appropriate material (e.g. carbon steel or copper for flexible lines). The temperature to be expected must be considered with -37°C - +50°C.

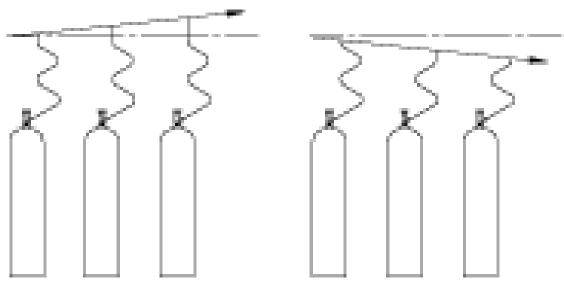
11.2.4.1. Flexible connection lines

To compensate for slight positional differences of the chlorine container valves, flexible lines are used for connection on the pressure side. These are made from copper and must be replaced every two years because of the mechanical load. It must be ensured that the lines are ascending constantly in flow direction (see left fig.) so that condensed chlorine can flow back. Otherwise liquid chlorine accumulates in the lower piping parts (right fig.).



11.2.4.2. Manifolds

To connect several chlorine containers, so-called manifolds are used. Also in this case a slight ascending gradient must be observed.



11.2.5. Mist collector (with and without heating)

At the end of a manifold so-called mist collectors are installed to catch and re-evaporate non-evaporated or condensed chlorine. A possibly installed heating support this process. Caution: Liquid chlorine destroys inappropriate devices and lines. In the case of vacuum regulators mounted directly on barrels, a mist collector must be provided.

11.2.6. Filter

Filters are installed as close as possible to the chlorine containers or directly after an evaporator. Coarse, solid impurities are caught by the filter, thus protecting the following fittings and devices against deposits which might disturb the function.

11.2.7. Pressure reducing valves

In chlorine gas pressure lines pressure reducing valves prevent chlorine from condensing at the subsequent line sections, because the chlorine does not tend to condense at the same temperature but lower pressure (see vapour diagram). Furthermore the pressure reducing valves sets a uniform supply pressure for the vacuum regulator and thus ensures constant operating conditions despite fluctuating pressures in barrels or cylinders.

11.2.8. Pressure gauge

Pressure gauges are required at different points of a chlorination installations to monitor the process pressures or operating vacuum. These pressure gauges are constructed especially for the use in chlorination installations.

11.2.9. Quick-acting gate valve

For the protection of the chlorination installation particularly after an evaporator to avoid entry of liquid chlorine in the dosing units. In the case of unclear operating conditions, the valve closes automatically (electrically or pneumatically).

11.2.10. Safety blowoff valve or rupture disk

To protect pressure-carrying lines and components against excessive pressures, spring-loaded safety valves or rupture disks are installed. They open, if the defined pressure is exceeded, and discharge the chlorine gas deliberately to a collecting vessel or an chlorine absorber.

11.2.11. Measuring glasses

Different measuring glasses are required for chlorine gas under pressure and for chlorine gas under vacuum, as the measuring glasses are calibrated for the corresponding density, which depends on pressure and temperature. Measuring glasses for chlorine gas under pressure are only useful if the conditions existing at the installation location are constant and clearly defined, as e.g. after a pressure reducing valve or before a back-pressure valve.

11.2.12. Line construction and routing

The line construction for dangerous pressure gases is subject to locally different regulations and ordinances to be observed. In any case the pressure losses to be expected must be taken into account for planning.

11.2.13. Leak test before startup using nitrogen

Before first startup with chlorine, the line system must be checked for leaks using nitrogen at max. 16 bar. This test does not replace the „sniffing“ at lines and fittings by means of ammonia vapour on first startup with chlorine.

11.3. Chlorine vacuum devices and lines

11.3.1. Admissible operating conditions for vacuum units

Lutz-Jesco vacuum devices have been designed for dry chlorine gas under vacuum, they are not suitable for pressure operation. The materials used have been chosen carefully and have a long service life if applied correctly. The specified operating parameters refer to operation under normal conditions. Normal conditions include an ambient temperature of 10-50°C and an ambient air pressure of 1013 mbar. If these values differ extremely, e.g. at higher altitudes or in arctic coldness, the performance of the devices may be restricted considerably or even fail completely. The devices must not be exposed to direct sunlight and must be protected against weather.

11.3.2. Fitting position of the devices

During construction the influence of gravity was partly taken into account so that the devices must be mounted according to the indicated position. Measuring glasses must be absolutely vertical to achieve a precise measuring result.

11.3.3. Admissible material for dry chlorine under vacuum

Here hard PVC has proved exceptionally successful. During operation the dark-grey PVC-U often bleaches at the surfaces in contact with the chlorine gas and thus shows a slight brittleness of the material, which is not critical. The wall thickness of the devices is dimensioned sufficiently and only the surface is subject to brittleness. Other materials are possible.

11.3.4. Vacuum devices (vacuum regulator)

11.3.5. Maximum piping lengths in meters for vacuum lines

In the case of vacuum lines pressure loss is an important aspect, because the devices require a minimum vacuum but not more than approx. 0.1 bar is available for line pressure losses. Maximun line lengths in meters are listed in the table below.

g/h	kg/h	di 8mm	di 12mm	di 15mm	di 40mm
80	0,08	4400			
200	0,2	1800			
500	0,5	700			
1000	1	150			
2000	2	45			
2500	2,5	30			
4000	4	14			
5000	5		65		
10000	10		19		
15000	15		9	27	
25000	25			11	
40000	40				500
60000	60				250
100000	100				100
120000	120				70
200000	200				29

11.3.6. Tubing connections

For vacuum tubing connections, mostly PTFE or PE tubing is used, for outdoor installations, black PE tubing must be used as it is more resistant to UV radiation. To avoid tearing, the end of tubing should be heated for mounting. A hot-air fan is most suitable for this purpose. PVC tubing is not suited at all because the chlorine destroys the softener in PVC tubes. Tighten the tubing connections by hand.

11.3.7. Piping connections

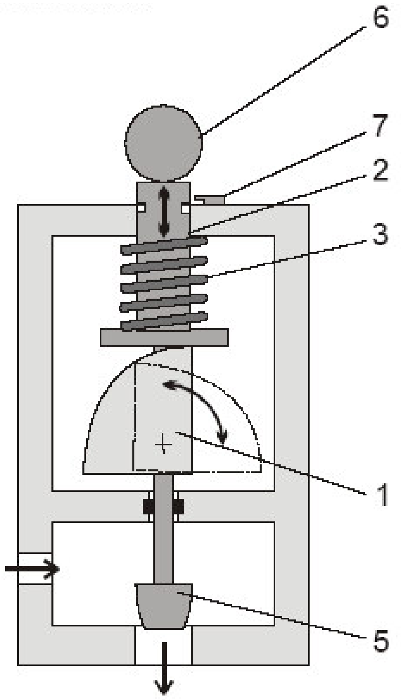
For dry chlorine gas up to 0.5 bar above atmospheric pressure, PVC-U has proved successful. The PVC piping is cemented using commercial adhesives (e.g. Tangit) or fitted with screwed or flanged connections to allow detaching. PTFE (teflon) or FPM (viton) must be used as sealing material. Threads of screwed connections are lubricated slightly with silicon grease or PTFE spray so that they can be tightened and detached gently.

11.3.8. Manifolds

Manifolds for chlorine gas under vacuum are made from PVC-U and allow the simultaneous use of several chlorine gas sources. Often shutoff devices are integrated or outlets for safety blowoff valves are provided.

11.3.9. Control valves

In modern vacuum chlorination installations the chlorine gas flow is rarely controlled by hand. In most cases the concentration of free chlorine in the water is monitored by an electronic controller which sets the required chlorine quantity by means of an electrically operated valve. The control valve C 7700 has been developed for this purpose. It is a plastic valve for chlorination installations working according to the vacuum principle.



A servomotor with 90° bevel actuates the adjusting eccecntric (1). It converts the rotary motion into the stroke movement of of the valve spindle (2). Contact between the valve spindle and eccentric is ensured by a spring (3). The actual control element is located at the lower end of the valve spindle. Up to 2500 gCl2/h, the control element is designed as a slotted jet in the form of a helically slotted cylindrical shaft (4), for larger quantities a control cone (5) is used. Both control elements are shaped so that the cross-sectional flow area changes in proportion to the position of the servomotor. The valve has a linear characteristic. For manual chlorination, the valve spindle can be lifted completely upwards by pulling the hand knob (6) and locked in position by means of a slide (7). The chlorine gas flow is then adjusted at the needle valve of the flow meter. The housing of the control valve consists of two chambers, the valve chamber and the eccentric chamber. The chambers are separated from each another by a seal to prevent contact between the mechanical drive and the chlorine gas.

11.3.10. Measuring glasses

Measuring glasses are available for capacities of 10g/h to 200kg/h. They are conical glass pipes, in which a float element moves up and down depending on the chlorine gas volume flow. For measuring accuracy, it is important that they are mounted vertically and designed for the prevailing pressure and temperature conditions. Deposits at the glass pipe or float element falsify the measuring result.

11.3.11. Line construction and routing

Screwed plastic connections must generally be lubricated with silicon grease or PTFE spray, as otherwise they tend to cold bonding and then cannot be detached anymore.

11.3.12. Maximum piping lenghts in the ratio throughput to inside diameter in meters:

g/h	kg/h	di 8mm	di 12mm	di 15mm	di 40mm
80	0,08	4400			
200	0,2	1800			
500	0,5	700			
1000	1	150			
2000	2	45			
2500	2,5	30			
4000	4	14			
5000	5		65		
10000	10		19		
15000	15		9		
25000	25			11	
40000	40				500
60000	60				250
100000	100				100
12000	12				70
200000	200				29

11.4. Installation on the water side

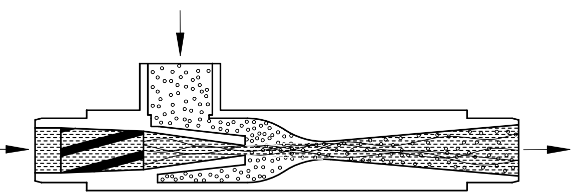
11.4.1. Admissible material for chlorine solution

Also in this case PVC-U has proved exceptionally successful. The chlorine solution, however, attacks the surface, the PVC bleaches and becomes brittle.

11.4.2. Ejectors

11.4.2.1. Functional description

The water swirled by swirl units (1) as shown in the drawing emerges through the nozzle (2) at high speed, the diameter of the jet widening as a result of the centrifugal force of its rotational movement. This jet has a piston-like effect in the opposing diffuser (3). Chlorine gas is entrained from the vacuum area by the water droplets and enters into a solution with the water. More and more chlorine gas is entrained as the vacuum is constantly generated. However, this very simple physical process pesupposes that the motive pressure, back-pressure and suction pressure are observed. If they are not, the ejector may be unable to prime chlorine gas or cannot restart after having been switched off or simply cannot extract the required volume of chlorine gas.

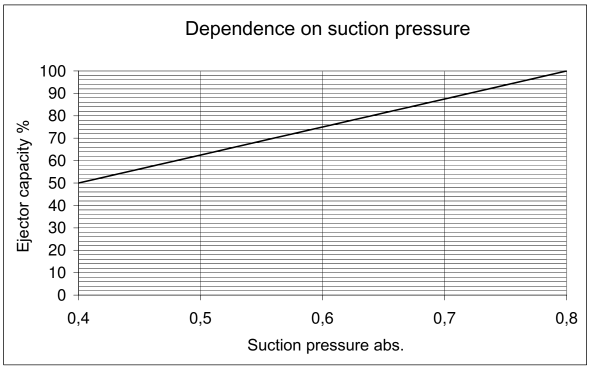


11.4.2.2. Ejector design.

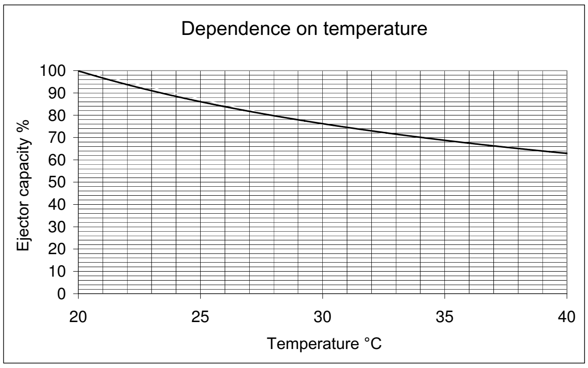
The ejector is selected in dependence of the following parameters: 1. chlorine gas volume to be handled, 2. back-pressure to be expected directly at the ejector output (with all line losses, etc.). There are different ejectors available, their output curves can be found in the corresponding documentation.

11.4.2.3. Capacity restrictions due to certain factors

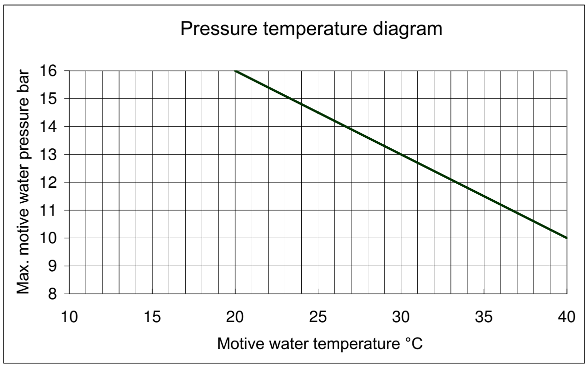
The ejector capacity is reduced in the case of low motive water pressure/ motive water flow, increased back-pressure, higher vacuum (low suction pressure). 0,7 bar abs., for example, corresponds to an ejector capacity of 85% at 0.8 bar abs. (see diagram „Dependence on suction pressure“).



At an increased motive water temperature, of e.g. 30°C, the output is only 75% of the ejector capacity at 20°C. This is due to the solubility of chlorine in water depending on the temperature. (see diagram „Dependence on temperature“).

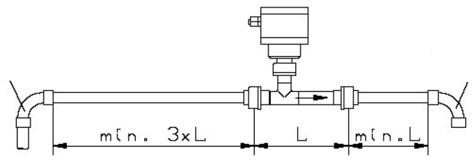


All pressures/temperatures to be measured directly at the ejector! Please take into account that the ejectors are made from PVC, i.e. the max. admissible operating pressure is reduced at an increased temperature (at 40°C only PN 10 instead of PN 16).



11.4.2.4. Ejector line routing

On the input side of the ejector the nominal width can be laid which corresponds to the discharge connection of the booster pump. A possibly necessary reduction to the ejector connection is admissible. On the output side of the ejector a line shoud be laid which does not allow flow speeds of more than 1.0 m/sec. This is the only way to avoid unnecessarily high pressure losses which act as back-pressue on the ejector thus causing a decrease in capacity. The pressure losses grow with an increasing line length. Therefore the solution line to the injection nozzle. should be kept as short as possible. Unavoidable turns in the line routing must be realized by bends instead of sharp angles. The following general rule serves as explanation: Each bar of pressure loss after the ejector means approx. 2 bar additionally required motive water pressure and thus a more powerful booster pump with a higher energy consumption.



11.4.2.5. Notes on how to avoid calcium precipitation (calcification)

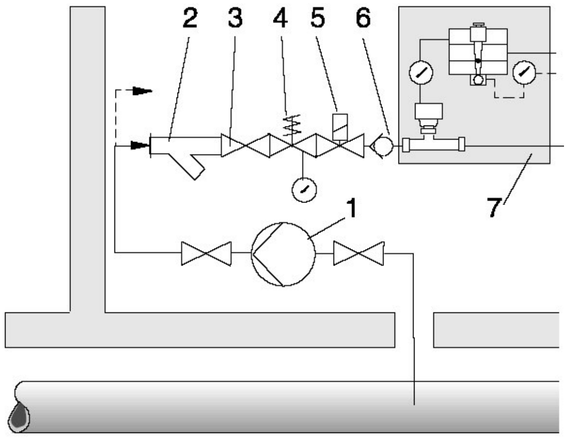
Hard water may leave precipitations in the ejector due to decarbonization. As a result the capacity of the ejector is reduced considerably or the ejector fails. The lime precipitations are normally destroyed by the hydrochloric acid contained in the chlorine solution. If the chlorine volume is decreased drastically while the motive water quantity remains the same, the hydrochloric acid which is also less in quantity is not able anymore to remove the lime precipitations from the diffusor. Therefore it is recommended in such cases to put through larger volumes of chlorine at certain intervals or to adjust the motive water quantity to the reduced constant chlorine volume. If the ejector fails some day due to lime precipitations, it cannot be cleaned with mechanical means but (10%) hydrochloric acid has to be used to remove the precipitations.

11.4.3. Booster pumps

Booster pumps must be resistant to the chemical components occurring in the motive water, as e.g. chloric motive water can be expected in swimming pool applications. Consequently, the booster pump must be designed correspondingly. It should not be overdimensioned with regard to energy-relevant aspects and is selected according to the ejector chosen and the local conditions

Example :

To operate the ejector of a chlorination installation, 1 m³/h water at 7bar supply pressure is required. The system supplies motive water at 1.5 bar. The needed pressure increase is 7-1.5 = 5,5 bar (in the case of long piping the pressure losses must be taken into account correspondingly!). From the QH diagram, pump DE 1-11 is chosen, which achieves a pressure increase of 6 bar at a flow rate of 1 m³/h. Consequently, the pump will reach 1.5 bar + 6 bar = 7.5 bar at the required quantity and thus exceeds the max. needed pressure by 0.5 bar.



Legend
1 Booster pump
2 Filter
3 Shutoff valve
4 Pressure reducing valve (with filter and pressure gauge)
5 Solenoid valve *
6 Non-return valve **
7 Chlorinator with ejector
* The solenoid valve is required, if the pump supplies several indedpendent installations.
** The non-return valve is required, if chlorine water flowing back might destroy fittings and pump.

12. After installation

the complete systems must be checked for danger of corrosion! All metal parts exposed to danger must be coated with a protective layer epoxy resin. Pipes carrying chlorine under pressure have normally yellow colour according to RAL ???. Also stainless steel components (e.g. screw) will corrode easily in chlorination installations. It is recommended to protect also these parts with e.g. a transparent coating.

13. Before startup

13.1. Visual inspection

13.2. Check connections for tightness

13.3. Verify the position of shutoff devices

13.4. Check individual units (if necessary)

13.5. Leakage test

of the chlorine pressure line parts and connections. Pressure-carrying installations must be checked for leakage using nitrogen. Only then may the system be supplied with chlorine gas

.

13.6. Test of ejector function

Switch on booster pump and bring shutoff devices, etc. into operating position. Check installation on the water side for leakage, eliminate possible leaks immediately. An existing vacuum gauge must now indicate a vacuum.

13.7. Tightness of vacuum lines

Fully close the adjusting valve of the dosing unit.
Leaks in vacuum lines are not noticed during normal operation because chlorine gas does not escape but only ambient air is primed. At the same time, however, also air humidity enters the line system and forms disturbing deposits in connection with chlorine gas. Therefore the vacuum lines must be checked carefully for leaks as well. Switch on ejector with the cylinder valve closed. The ball in the flow meter must be in a steady position after a short time. If this is not the case, the leak must be eliminated by checking all components including the vacuum regulator. After switching off the ejector, no water must enter the vacuum line with a correctly working ejector non-return valve, and a residual vacuum must be indicated by the vacuum gauge.

14. Startup

14.1.

Chlorination installations may only be started up after they were checked by a specialist and the tightness of all gas-carrying lines was confirmed!

14.2. Starting the installation

To start the installation, the chlorine cylinder main valve must be opened first. Then the injection valve is opened and the motive water supply is activated. Under perfect operation conditions, a vacuum is produced in the ejector which will be transmitted via the non-return valve and the vacuum line to the vacuum controller and thus open the chlorine inlet valve. The pressurized chlorine gas is reduced to vacuum in the inlet valve.
The chlorine gas flow rate is set at the needle valve of the measuring glass and read at the highest point of the float element (ball or cone). With automatic control systems the control valve is first fixed to 100% opening and the chlorine gas flow then adjusted at the manual valve. As soon as manual sample indicate a chlorine concentration in the treated water, the measuring equipment is calibrated and the installation is switched over to automatic operation.

15. Switching off

15.1. For short periods

For short operation interruptions, the cylinder valves are closed and the pipes are evacuated with the help of the ejector until the float element in the flow meter indicates that there is no more flow. Then the motive water supply is switched off and the shuttoff valves before and after the ejector are closed.

15.2. For longer periods (e.g in open-air pools during winter time)

Before longer operation interruptions the following steps should be taken to protect the units.
- Rinse all pipes (pressure and vacuum lines) and units for approx. 5 minutes with dry air or nitrogen.
- Close the chlorine cylinder tightly. Also slip on the protective cap for the connection thread.
- Dismount at least the vacuum regulators in unheated or hu mid rooms and keep them in a dry place.
- If possible, dismantle all units and service them. Slightly lubricate all threads and elastomeres with silicon grease.

- Close all units and piping connections tightly to prevent air humidity from entering and damaging the units.
- Empty all water-carrying lines in case of danger of frost.
- Turn all valves to the middle position so that they can be released in both directions when they are restarted.

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

15.3. Storage of chlorinators

For long-term storage of any technical equipment, an appropriate pretreatment and preservation is recommended for protection against influence of air humidity, dust and insects as well as with regard to temperature-related deformations.

1. For protection against corrosion, slightly grease metal parts with vaseline.
2. For protection against dust, the units should be vacuum-packed in transparent polyethylene sheets or bags, if possible.
3. To avoid excessive ventilation of the interior of the units, the connections are provided with appropriate plugs. Venting holes are closed using a strip of adhesive tape.
4. For protection against humidity and subsequent corrosion, it is recommended to enclose silica gel bags when packing the units in order to absorb air humidity which is either already included or diffuses the plastic sheet in the course of time. The silica gel has to be added in separate commercial bags. Approx. 200g silica gel should be provided per square meter sheet surface.
5. To prevent thermal long-term deformations of plastic parts, the storage temperature should not exceed 30°C.

In the way described before the units can be stored for up to 3 years. After that time the silica gel should be checked since it tends to wet if oversaturated.
After long storage periods, maintenance/inspection of the unit is possibly recommended because e.g. the material (springs, diaphragms) might have set.

16. Maintenance and inspection

16.1. General notes

Regular maintenance saves you a lot of trouble!
A maintenance contract is recommended.
As long as shorter maintenance intervals are not prescribed by laws/rules (e.g. VBG 65) or special notes, all Lutz-Jesco chlorinators have to be serviced and checked once a year by maintenance staff according to 2.7.5.3. Preferably at the beginning of a period of heavy-duty load before stopping or restarting the system. The chlorine containers must be closed by all means before working on the chlorination installation. It must be evacuated by means of the ejector until the measuring glass indicates zero. For maintenance, the vacuum regulator is dismantled, cleaned and parts subject to wear are replaced. All other components are inspected visually and only exchanged, if necessary. The generally required wear parts are included in the maintenance kit (see spare parts list). For cleaning the components, warm water or isopropyl alcohol is perfectly suitable. Before remounting the components, make sure that they are completely dry. Seals and diaphragms must be slightly lubricated with silicon grease. Do never use vaseline as it hardens because of dehumidification and thus may cause malfunction. The seals at the inlet valve are dry when inserted. Pressure springs are no actual wear parts. They can, however, also be attacked chemically by humidity. In such a case they must be replaced. Pressure springs must never be compressed completely for testing because this will cause excessive stress.

16.1.1. Maintenance staff:

Only properly trained personnel may carry out maintenance work. A corresponding training by the manufacturer of the devices is required.

16.1.2. Maintenance intervals

are partly prescribed by laws and ordinances. Lutz-Jesco devices must be serviced at least once a year if they are operated correctly. Under extraordinary operating conditions the maintenance intervals must be shortened correspondingly.

16.1.3. Preparation for maintenance:

Putting out of operation as described in section 15.2.

16.1.4. Parts to be replaced:

The device-specific maintenance instructions list the parts to be replaced in any case. These parts are available as spare parts kits. They are elastomer parts or safety-relevant parts subject to particular wear. If they are not exchanged, malfunction and release of chlorine gas may be the result.

16.1.5. Use exclusively original spare parts

with the corresponding part number.

16.1.6. Cleaning of parts

The parts can be cleaned with warm water (max 40°C). The addition of alcohol or a mild cleansing agent (e.g.Rabbasol) is allowed.

16.1.7. After cleaning and before assembling the devices,

these must be dried thoroughly. Device components not dried completely will be damaged considerably if they get in contact with chlorine gas.

16.1.8. Special tools required:

Partly special tools are necessary for assembly/disassembly. If these are not used, parts might be damaged.

16.1.9. All seals

may only be used once!

16.1.10. Evaluation of parts:

Parts which are not necessarily replaced during maintenance must be inspected. These checks are described in the maintenance instructions.

16.2. Daily inspection:

The devices are inspected visually every day, paying special attention to leakage.

16.3. Weekly inspection: na

16.4. Monthly inspection:

The tubings and flexible connection lines must be checked for damages. Check the connections of the chlorine containers for incrustation and discoloration, carry out leakage test with ammonia, if necessary.

16.5. Complete yearly maintenance according to device-specific maintenance instructions:

The devices are dismantled, cleaned, wear parts are replaced, and they are tested after assembly.

16.6. Maintenance every two years:

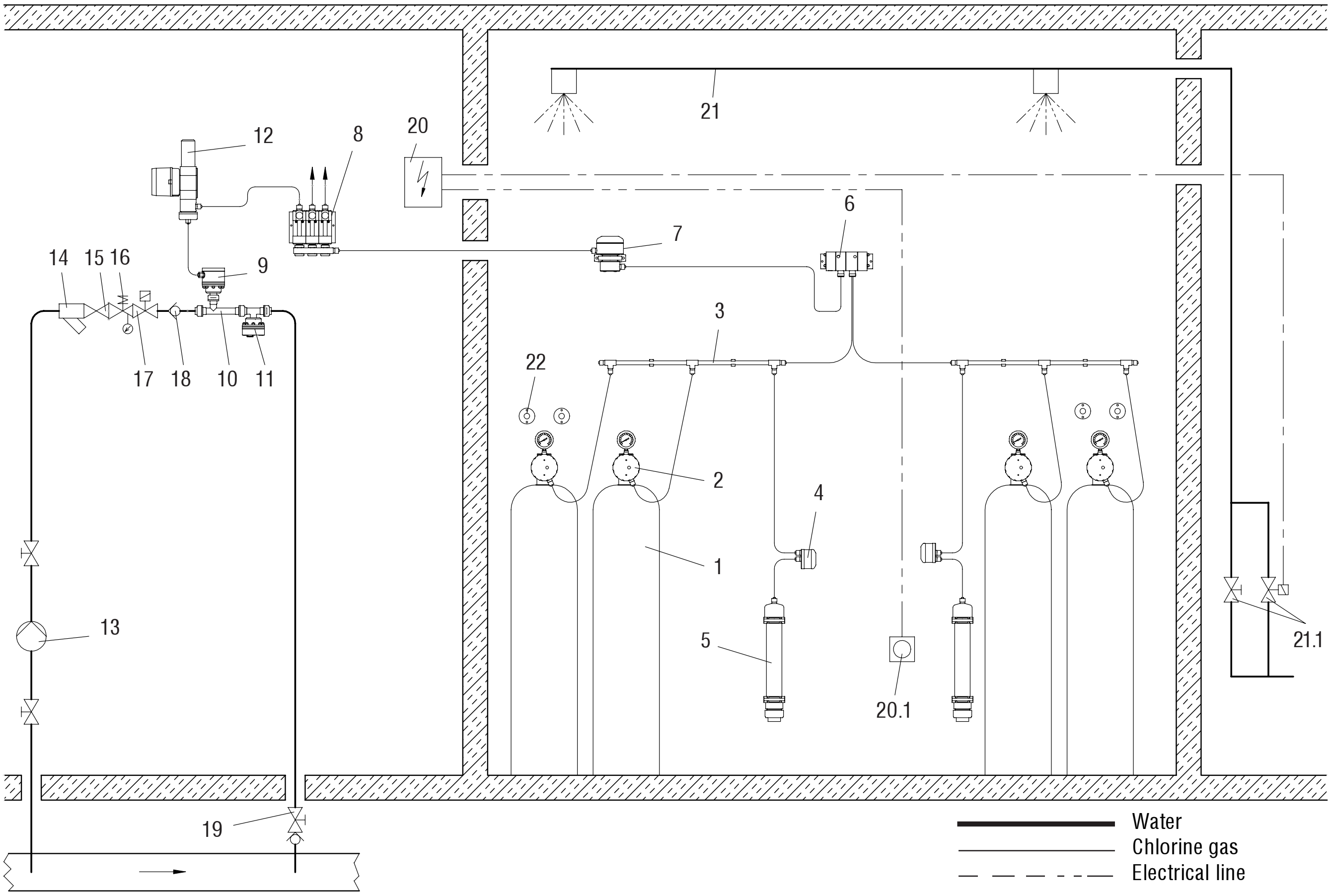
Replace all flexible connection lines on the discharge side.

16.7. Inspection on restarting

as on „Startup“.

Attachment

Installation example



Legend

1	Chlorine cylinder	13	Booster pump
2	Vacuum regulator	14	Dirt trap
3	Vacuum manifold	15	Shutoff valve
4	Safety blowoff valve (may also be integrated in item 2)	16	Pressure reducing valve with pressure gauge
5	Activated-carbon cartridge (optional)	17	Solenoid valve
6	Chlorine changeover unit	18	Non-return valve
7	Safety shutoff valve	19	Chlorine solution injector
8	Flow meter	20	Chlorine gas detector
9	Ejector non-return valve	20.1	Sensor for gas detector
10	Ejector	21	Sprinkler system
11	Vacuum breaker	21.1	Fittings for sprinkler system
12	Control valve	22	Wall holder

General

These short operating instructions imply a correct installation according to the relevant regulations including VBG 65, DIN 19606 and DIN 19643. Besides the rules and device-specific operating instructions have to be observed. Secure the chlorine cylinders carefully to prevent falling. The cylinder temperature must match the room temperature but must never be higher. The room temperature should not be lower than 15°C.
Only chlorine according to DIN EN 937 may be used.
Always wear breathing masks when working on chlorination installations (also when replacing cylinders).
The chlorine gas volume supply must not exceed 1% of the filling weight of the connected chlorine cylinders.
When applying chlorine changeover valves and chlorine manifolds in battery operation, unused connections must generally be closed hermetically.

1. Startup

1.1 Open chlorine solution injector (19).
1.2 Open motive water shutoff valves and solenoid valve (17), if necessary.
1.3 Release pressure reducing valve (16) by turning the handwheel to the left.
1.4 If a booster pump (13) was installed, open shutoff valves and switch on booster pump.
1.5 Set the required motive water pressure for the ejector (10) at the pressure reducing valve (16).
1.6 Open chlorine cylinder valve slowly and just a little bit for testing.
1.7 The device connection must be checked for leakage using an ammonia test bottle. In the case of leakage, close bottle immediately, evacuate residual chlorine and eliminate leakage.
1.8 After correct connection of the devices, open chlorine cylinder valve until stop and close again by one rotation.
1.9 Set required chlorine gas quantity at the adjusting valve of the flow meter (8). In the case of automatic control, the manual adjusting valves must be opened completely.

2. Switching off for short periods (e.g. filter backwashing)

2.1 Close chlorine cylinder valve. Operate system until the float element in the flow meter (8) is down to zero and the pressure gauge at the vacuum regulator (2) does not indicate pressure anymore.
2.2 Switch off booster pump (13) or interrupt water supply.
2.3 Close chlorine solution injector (19).

3. Switching off for longer periods (e.g. winter time)

3.1 Close chlorine cylinder valve. Operate system until the float element in the flow meter (8) is down to zero and the pressure gauge at the vacuum regulator (2) does not indicate pressure anymore.
3.2 Before longer operation interruptions, the line and device parts in contact with chlorine gas must be rinsed for approx. 5 minutes with nitrogen or dry air.
3.3 Switch off booster pump (13) or water supply.
3.4 Connections from which lines in contact with chlorine were detached must be closed hermetically to prevent humid air from entering.
3.5 Set room thermostat to at least 10°C.
3.6 Close motive water valves.
3.7 Close chlorine solution injector (19).
3.8 If there is the danger of frost, all water-carrying line and device parts must be emptied. During winter time interruption we recommend to set all valves to the middle position so that in spring they can be released in both directions.

4. Chlorine cylinder replacement

4.1 Close chlorine cylinder valve tightly because a residual pressure remains in the cylinder in the case of vacuum devices with residual pressure preservation.
4.2 Switch on device for 5 minutes to evacuate the connection.
4.3 Detach chlorinator from the cylinder and fix it to the wall holder (22) using a sealing. At the same time the wall holder prevents humidity from entering. Close lateral connection of the cylinder valve with the protective cap and mount protective cover over valve.
4.4 Secure new chlorine cylinder against falling. Connect chlorinator using a new sealing. If necessary, wait until cylinder temperature is down to room temperature.
4.5 Open cylinder valve slowly and carry out leakage check with ammonia.

5. Maintenance of the chlorination installation

5.1 If no other regulations apply, the chlorination installations must be maintained at least once a year by an authorized service partner according to the rules and operating instructions.
5.2 The dosing system must be checked visually every day.

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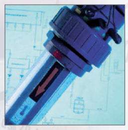

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