Chlorine

Physical datas

Chemische formula	Cl_2
Atomic weight	35.453
Molecular weight	70.941
Density (fluid)	1468 kg/m³ (bei 0° C)
Density (gas)	3.214 kg/m³ (0° C 1013 mbar)
Relative weight, gas	2.486 (Luft = 1)
Volume of 1 kg chlorine at 1013 mbar	0.311 m³
Boiling point	- 34.05° C (1013)
Melting point	- 100.98° C
Melting heat	0.0267 kWh/kg (bei 103,5° C)
Vaporisation heat	0.0744 kWh/kg (bei 0° C)
Specific heat (-34° C)	2.58 10^{-4} kWh/kg·K
Head conductivity of liauid chlorine	6.13 10^{-4} kWh/m² (bei 30° C)
Critical temperature	144.0° C
Critical pressure	77.6 bar abs
Density at critical point	0.573 g/cm³
Colour	greenish
MAK-value	0.5 ppm = 1.5 mg/m³
Synonyms	
German:	flüssiges Chlor
French:	chlore liquide, chlore liquéfié
Italian:	chloro liquido
English:	liquid chlorine

Chlorine container

	Net	Tare	Test pressure
Tank wagen	16-56 t	13-15 t	22 bar
Rolling tanks	approx. 500 kg	approx. 275 kg	22 bar
Rolling tanks	approx. 1000 kg	approx. 390 kg	30 bar
Bottles	approx. 60 kg	approx. 35 kg	22 bar

Normal purity > 99% chlorine

Chlorine is liquid under specific temperature and pressure conditions. If chlorine is in a closed container (chlorine cylinder, chlorine drum) then at each temperature a specific vapour pressure occurs (see diagram A).

Diagram A
Chlorine vapour pressure curve

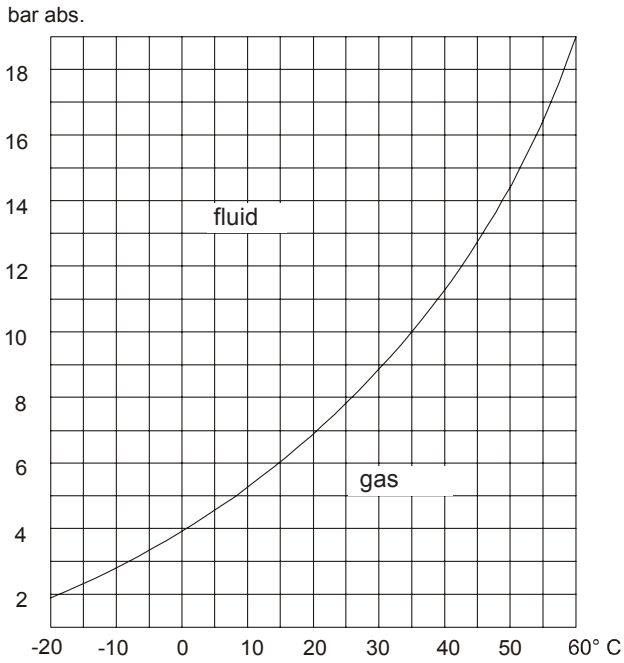


Diagram A shows the relationship between temperature and pressure.

This vapour pressure is present in the chlorine container for as long as liquid chlorine is present in the container. The pressure does not fall on further offtake until liquid chlorineis completely vaporized, but when the pressure begins to fall, 98% of the contents have already been taken off. Above the illustrated curve liquid chlorine and chloribne gas are present together in the container. Below the curve the container only contains chlorine gas.
In chlorine gas installations without an evaporator, the chlorine is taken from the container in gas form. The liquid chlorine cools unit a balance is achieved between the amount of heat expended for vaporization and the amount of heat taken from the environment of the chlorine container. The effect of this is that offtake from a chlorine container cannot be extended to a specific quantity per unit of therefore loss of performance of the chlorine installation. Too great an offtake in the long term would cause so much cooling that the chlorine container would ice up on the outside.
In practice, for long-term operation approcimately 1% of the container contents can be taken off per hour. For temporary, short-term offtake, a multiple of the given quantity can be taken off depending on room temperature, offtake quantity and container size.
The gas leaving the chlorine container is in a saturated state, i.e. cooling of the gas leads to condensation of liquid chlorine. Care must therefore be taken to ensure that the gas does not cool below the chlorine container temperature after it has left the container. Otherwise accumulations of liquid chlorine in pipes and components and the resultant breakdowns cannot be avoided.
If it is not possible to adjust room temperature above that of the container, the pipes must be heated and/ or a pressure reducing valve used, which should be fitted as close as possible to the chlorine reliquefaction does not occur.
Chlorine is soluble in water and the maximum concentration, as with all gases, is a function of gas pressure and water temperature. Solubility of chlorine in water as a function of temperature is shown in diagram B and as a function of pressure in diagram C.

Diagram B
Solubility of chlorine in water (at 1013 mbar)
g/l Cl_2

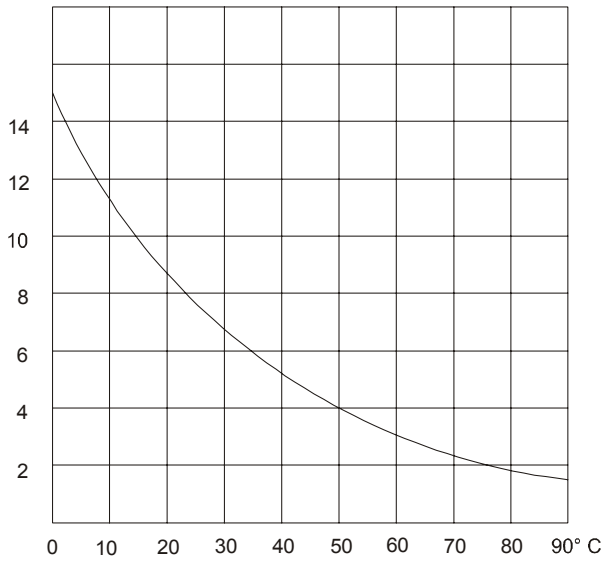
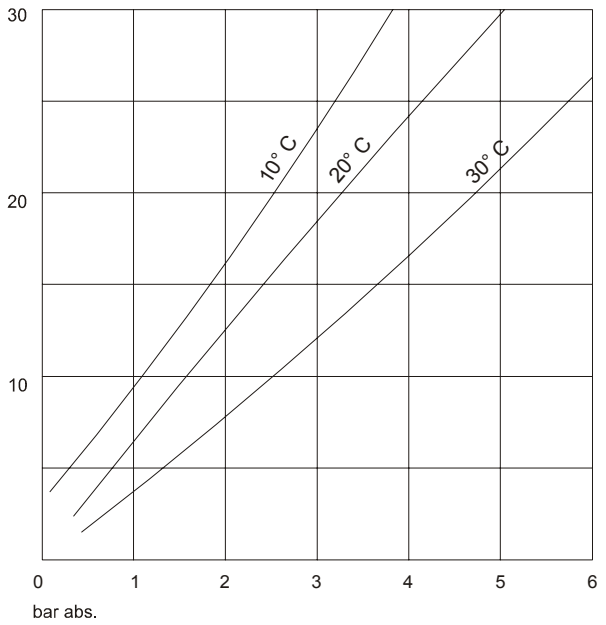


Diagram C
g/l Cl_2



Vapour pressure and specific gravity of liquid chlorine

Temperature 0° C	Steam pressure bar	Specific weigth kg/Liter
-34.1	1.033	1.557
-30	1.238	1.547
-20	1.85	1.521
-10	2.67	1.494
0	3.75	1.467
10	5.12	1.439
20	6.84	1.410
30	8.95	1.380
40	11.51	1.349
50	14.56	1.317
60	18.16	1.282
70	22.38	1.246
80	27.25	1.206
90	32.84	1.163
100	39.23	1.116

Storage

The chlorine container must be stored in asecure non flammable area.
The liquid chlorine filled to legal regulations (0.8 dm^3 filling space for 1kg chlorine at ambient temperature 20° C) fills the vessel completely at approx. 70° C. From that moment on the vessel is under the hydrostatic pressure of the liquid chlorine, so that there is immediate danger of explosion.

WARNING!
Containers for liuid chlorine must be protected from heat and sunlight.
For chlorine offtake open the cylinder or drum valve slowly. In the case of drums make sure that one of the two valves is provided for gas offtake and the other for liquid chlorine offtake. The drums must be set up properly at the point of use and the auxiliary drum of valve connected ot the appropriate offtake valve.
The mark on the drum must be horizontal.

After a long period of storage without operating the valves, particulary at low temperature, the valve stem may be jammed by the action of chlorine. Force should not be used in these circumstances. If normal pressure with a spanner on the square end of the valve stem is unsuccessful the packing box may be loosened slightly. If the valve stem still does not move, it helps to warm the whole cylindervalve. Take care, however, that only the cylinder valve is warmed. Under no circumstances should the steel cylinder itself be warmed. For the reason already given, it is not permitted to heat the chlorine container, pipes and valves by direct flame. The best method is to wrap the valve in a cloth soaked in hot water until the valve is warmed through. The valve stem can then generally be moved. When doing this, use a second spanner as a counter-support on the valve body. The tighten the packing box and the guard ring. Tighten the valve by hand without using tools. If the offtake pipe from the chlorine cylinder valve to the installation is removed when changing the cylinder or during shutdowns, the screw cap with packing washer must be put immediately on to the thread connection. If this is not done the inner parts of the valve may be damaged be hunidity. The same aplies when replacing cylinders. Before transportation, the cap must be screwed tightly on to the steel cylinder.
Chlorine cylinder valves may only be replaced at the filling plant.

Aggressiveness at high temperatures

Dry (water-free) liquid chlorine and chlorine gas is not corrosive to iron at ambient temperatures. At a temperature of 100°C chlorine becomes corrosive to iron, increasing rapidly as the temperature rises further and possibly causing complete destructions of the container walls. In all circumstances, therefor, avoid heating chlorine containers, pipes and valves by direct flame.

Leakproof test

Leakage at cylinder valve or other chlorine flow fittings can be determined by using ammoniak (small plastic bottle). The leakage points are indicated by a whitish cloud.

Persons who have inhaled chlorine gas should always be given immediate treatment by a doctor. After inhalation of large amounts they should be taken lying down into a well-ventilated room. When lying down do not let the victim breath deeply, but if possible he should inhale water vapour and alcohol vapour if available. Hot coffee, tea or milk are appropriate to relieve irritation. Do not apply artifical respiration. Oxygen enrichent of the air is recommended.
The additional safety precautions detailed in the accident provisions of the Chemical Industries Association must be strictly observed.

Chlorine transportation

The Police Regulations on portable closed containers for compressed and liquefied gases released under pressure (Pressure Gas Regulations) apply to chlorine transportation.
The accident prevention regulations of the Chemical Industries Association must be observed.

Handling chlorine containers

A vessel containing chlorine, whether in gos or liquid form, presents a degree of risk and must be handled with care.

Note that the centre of gravity displacement resulting from partial filling must be taken into account.

Never drop the container or subject it to heavy impact. Never use a magnetic lifting device, belt cable of chain when handling the containers.

When returing empty containers, close the valves and check whether chlorine gas is escaping at the valve. Before shipping, ensure that the cap and the locknut are properly on the container. The cap is to protect the valve and should always be put on the container when it is not in use.

The chlorine valve should be closed as soon as the container is empty to prevent penetration of water or moisture. The container is intended exclusively for chlorineand should not be used for other purposes. The container valve should be opened slowly without using force.

Never use a tool that is not provided for the purpose. The chlorine container valve is a packing box valve.

Absorption of chlorine (chlorine neutralisation)

For absorption of 1kg chlorine, 1.25kg sodium hydroxide (NaOH) is required, giving a 27.5% caustic soda solution in 3.5 litres of water. Injectors etc. can be used to extract the chlorine-laden air with this sodium hydroxide solution.

Other chemicals which may be used for chlorine neutralisation are:

- Soda solution N2CO3
- Lime solution Ca (OH)2
- Sodium hyposulphite solution