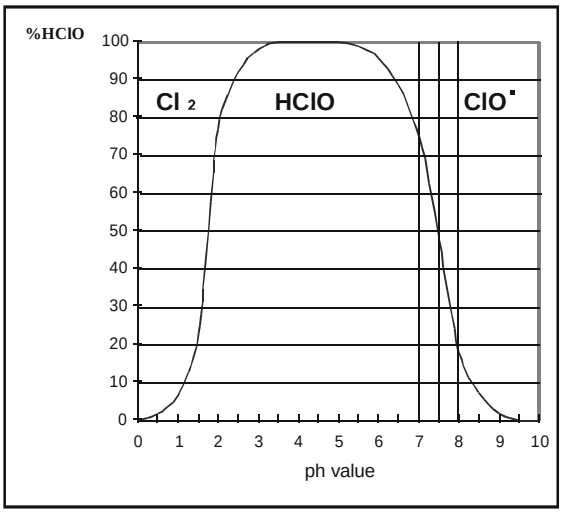
1. General

For the disinfection of any type of water, preference is given to chlorine gas or chlorine compounds. The germicidal effect is due to the formation of hypochloric acid (HClO) if chlorine is dissolved in water. The formation of hypochloric acid, however, depends strongly on the pH value which is shown in the dissociation diagram below.
Consequently, a constant pH value of the water to be analyzed is desired (preferably pH 7.00 or less). Otherwise the same chlorine concentration would cause different indications.



Calibration of sensors

As electrochemical sensors are used for measuring the free chlorine contents, it is necessary to calibrate the sensors with the relevant amplifiers. This requires a measurement according to another measuring method (e.g. photometric measuring method).
A water sample is taken directly at the sensor. The contents of free chlorine is determined by the DPD method. Most often a photometer is used for this measurement. The amplifier is calibrated using the manually measured value.
In the case of a first startup the calibration must be repeated after one to two days. During that period of time the electrodes's surfaces will adapt to the chemical and mechanical operating conditions.
The operating instructions of the used photometer must be followed carefully. Ensure cleanliness, since dirty cells or fingerprints at the cell may cause considerable measuring errors.

2. Sensors

2.1 Chlorine sensor CS 120 (open amperometric sensor)

1.1 Measuring method

The free chlorine sensor works according to the principle of depolarization of a galvanic element.
The sensor contains a platinum and a copper electrode. With the sample water acting as the electrolyte, galvanic potential develops between the two electrodes, depending on the electrode material. With non-flowing water the electrodes would polarize and interrupt the current flow (hydrogen gas at the platinum electrode, oxide layer at the copper electrode). The constant flow causes small glass balls inside the sensor to circulate and remove any passivation layer from the electrodes. With these stable conditions, the sensor current increases proportionally to the free chlorine surplus.

Note

Apart from chlorine, all other halogens (bromine, fluorine and iodine can be analyzed. The measurement can also be carried out in sea water or salt water. In this case, however, a sensor with a platinum/silver electrode combination has to be used. The sample water should be grease-free, if possible, or cleaned through a 50µ filter. The sensor must not be exposed to intense light, especially direct sunlight. As the free chlorine contents cannot be measured selectively with the open sensor, a two-point calibration has to be conducted at the controller. For zero-point calibration chlorine-free sample water must be routed through the sensor. Depending on the water quality some µA may flow in the case of chlorine-free sample water (normally 5...15 µA). For further details see MB 4 12 01).

2.2 Potentiostatic sensor PM 01
(open potentiostatic sensor)

Measuring method
The potentiostatic sensor consists of three electrodes and the potentiostat developed for the measurement of the free chlorine contents. These parts form a control circuit the stability of which is ensured by its construction. Depending on the free chlorine surplus, current flows which is analyzed by a special measuring amplifier.
The sensors are accommodated in a transparent multifunction instrument block. The amplifier and the potentiostat electronics are integrated in the electronical measurement and control system TOPAX.
For more details see operating and maintenance instructions BW 2 37 20.

2.3 Chlorine sensor Cl 5.0
(diaphragm-covered potentiostatic sensor)

Measuring method
The diaphragm-covered sensor (Clark type) consists of an 2-electrode system with integrated electronics. The actual working electrode is a gold electrode, the joint counter and reference electrode is a silver electrode with a silver halogen cover. Between these two electrodes a polarization potential is set up. The electrodes are kept in an electrolyte filled chamber. They are in contact with the sample water via a semipermeable diaphragm.

The provided sensor electronics simply require 12VDC. The electronics realize a galvanic separation of the power supply so that the measuring signal is ungrounded. The electronics also incorporate temperature compensation of the measuring signal. The sensor is connected to the amplifier/controller via a special cable (Part No. 77455). This special four-wire cable is equipped with a plug suited to be linked with the sensor.

Note
For sensors according to the potentiostatic measuring method and diaphragm-covered sensors zero calibration is not required. Such a calibration is only necessary if the zero-point of the amplifier changed or if the amplifier requires a zero-point calibration by all means.
Also for these sensors the chlorine measuring amplifier must be recalibrated after one to two days in the case of a first startup. During that period of time the electrodes's surfaces will adapt to the chemical and mechanical operating conditions.

Overall view of chlorine sensors

Type	CS120	PM 01	Cl 5.0
Principle	open amperometric sensor 2-electrode system depolarization sensor with circulating glass balls	open potentiostatic sensor 3-electrode system	diaphragm-covered potentiostatic sensor (Clark type)
Calibration	2-point calibration - zero-point drift possible - activated-carbon consumption	1-point calibration - stable zero-point	1-point calibration - stable zero-point
Electrodes	platinum/copper electrode or platinum/silver electrode	gold electrode, stainless steel electrode, ref. electrode (KCl)	measuring electrode, counter/reference electrode
Measuring range	0.00 ... 0.50 mg/l Cl_2 to 0.00 ... 10.00 mg/l Cl_2 The measuring is adjusted via the amplifier input.		
pH value	must be constant. At a constant pH-value in the range of pH3...6 the total chlorine contents is measured. At pH-values >6 the chlorine which forms HClO acc. to the dissoziation curve is measured proportionally.		pH-value must be constant.
Sample water quantity	approx. 50 l/h at 100 mbar pressure drop through the sensor	approx. 50 l/h	25 ... 40 l/h
Operating pressure	max. 10 bar	pressureless	max. 1 bar
Current ouput at chlorine-free water	approx. 5-15 µA	0 µA	0 µA
Sensor constant	approx. 35 µA per 1 mg/l Cl_2	approx. 50 µA per 1 mg/l Cl_2	approx. 50 µA per 1 mg/l Cl_2
Dependence of measuring signal on flow fluctuations	major dependence - hydrostatic flow control at sampling station SR 500 - flow adjustment using rotameter at sampling station SR600 slight fluctuations possible	minor dependence - hydrostatic flow control at sampling station PM01	minor dependence Flow adjustment using rotameter
Housing material	LURAN	fitted in transparent multifunction instrument block (PMMA)	-PVC and poly-carbonatr Ø 25mm, 175mm long
Selectivity of measurement	no selectivity, there is a combined signal of all oxidizing substances in the water (e.g. Cl, ClO2, O3, H2O2, ClO2-)	partial selectivity, cross sensitivity to chlorine dioxide, other substances are ignored	partial selectivity, minor cross sensitivity to chlorine dioxide, other substances are ignored
Sensitivity to dirt	minor due to self-cleaning	minor due to self-cleaning	- danger of clogging in the case of mananiferous, ferric and calcareous water - sensitive to tensides diaphragm rupture
Use in salt water	special sensor (silver-platinum) slightly higher wear	standard sensor suitable	different sensors for different salt water concentrations other electronics other electrolyte
Dependence on temperature	increase of measured value by approx. 1% per 1°C	increase of measured value by approx. 1% per 1°C	temperature-compensated by integrated electronics
Weight:	approx. 0.2 kg		
Recommended input resistance in amplifier	500 ... 5 kOhm (ajustable)		

Order data

Type	Electrodes	Part No.
open sensor CS120	copper / platinum	**23722968**
open sensor CS120	silver / platinum	**23732271**
potentiostatic sensor (without reference electrode)	gold electrode and stainless steel electrode in multifunction block multifunction block includes - dirt trap - needle valve DN 2.5 - feed pipe with overflow - flow monitor - potential compensating rod multifunction block provides installation holes for - reference electrode for potentiostatic sensor - pH combination electrode - REDOX combination electrode - Pt 100	**34186**
- reference electrode for potentiostatic sensor		**41100060**
- Potentiostat electronics for installation in TOPAX/TOPAX 6		**78140**
- Diaphragm-covered sensor Cl 5.0		**23700600**
- Connecting cable for diaphragm-covered sensor		**77455**