Installation Instructions

Bello Zon[®] Chlorine Dioxide Systems, type CDV and CDKa



Edition

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Installation Instructions Bello Zon® Chlorine Dioxide Systems, type CDV and CDKa © ProMinent Dosiertechnik GmbH, 2004

ProMinent Dosiertechnik GmbH Im Schuhmachergewann 5-11 69123 Heidelberg · Germany info@prominent.com www.prominent.com

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Depending on the specific application and the given conditions at the place of installation, the chlorine dioxide system must be equipped with corresponding safety accessories.

Fig. 1: Installation example, Bello Zon® system positioned **below** the level of the metering point.







1 Plant room

In Germany the accident prevention regulations "Chlorination of Water" ("UVV-Chlorung von Wasser"), as well as the guidelines from DVGW (German Association for Gas and Water) 224 and 624 have to be taken into consideration.

The regulations for protection against ground water pollution (§ 19 WHG) are to be considered, too.

The operation chemicals are hazardous materials according to the decree for hazardous materials in Germany. The operating company has to consider this decree as employer especially § 17 (general precaution duties), § 20 (working directive) and § 9 UVV.

In other countries please refer to the local authorities.

The following excerpts show the most important points of the Germain guidelines:

- a) The chlorine dioxide plant shall not be installed outdoors.
- b) The room has to be frost-protected ventilation and locking of this room shall be possible.
 (Note: The room temperature may not drop below 10 °C, since the generation of chlorine dioxide will be slowed down).
- c) It shall not be a room where people work permanently.

Exception:

- The plant is necessary for the process taking place there.
- Only those chemicals are located in the room which are necessary for the process.
- Plant and chemicals are protected against access of unauthorized persons.
- d) The room has to be separated from other rooms so that fire can be inhibited (danger of self – ignition of dried sodium chlorite solution (NaClO₂). Exception:
 - Only diluted sodium chlorite solution (7.5 %) is used.
 - Only small quantities of sodium chlorite are kept at the plant.
 - The chemical tanks are located in safety trays.
- e) In order to eliminate spilled chemicals without danger, a mains water tap and a drain should be located in the plant room. Any spilled chemical should be washed down with water immediately.

Under no circumstances may both chemicals be mixed.

- f) An escape route has to be available.
- g) The plant room has to be marked accordingly, see operating instructions Bello Zon®.
- h) Mobile chlorine dioxide plants can be installed outside lockable rooms if they are protected in an appropriate way against access of unauthorized persons.
- i) The operator of the plant is responsible for observing the regulations.

2 Mounting of the plant

The plant has to be easily accessible for maintenance purposes. According to the accident prevention regulations "Chlorination of Water", maintenance has to be carried out at least once per year. Bello Zon[®] systems type CDV should be serviced every 12 months, CDKa-systems every 6 months.

The start-up has to be done by ProMinent service personnel or an authorized agency.

The water supply to the suction device for the reactor housing cabinet must have a pressure of min. 1 bar and max. 7 bar. The supply has to take place from a pipe that always - even if the system is stopped - contains water. This is not guaranteed if the water is taken from the bypass line. This water shall not contain chlorine dioxide. In case of all CDV and CDKa plants the connection is DN10 in diameter.

Mounting of the chlorine dioxide unit comprises the following:

- · connection of the bypass water line possibly with bypass pump,
- the suction device of the reactor housing cabinet,
- a venting line from the reactor housing cabinet into the open air (CDVa and CDKa) or alternatively the installation of a venting valve (Part No.: 791801) (already fitted as standard in the case of the CDVb)
- and the power supply (normally 230 V AC).

The installation of a slanted seat valve (Part No.: 1001877), and bypass pump, is recommended.

Additionally control signals have to be connected according to the process requirements. The controller has to be adjusted in the configuration menu.

The access code to configure the Bello Zon® controller is "1000".

3 Bypass line

Dosing of chlorine dioxide solution takes place in a bypass which is taken either from the main water line or separately. The diluted chlorine dioxide is then carried to the injection point. The aim of the bypass line is to dilute the reactor concentration approx. 20 g/l (= 20,000 ppm) down to 100 - 200 ppm.

In special cases, e.g. multiple dosage systems, the concentration can be increased up to 1 g /l.



DANGER

During the commissioning of the system, the air volume in the reactor is displaced by water through the bypass line. An unpressurized outlet is required for this. (e.g. the enclosed rinsing unit) which must not be closed during commissioning. Otherwise, the reactor might burst.

3.1 Water quality in the bypass line

The bypass water may have any water quality, however, particles that may cause blockages in the bypass monitoring system or in the subsequently installed mixer, have to be avoided.

As material for the bypass PVC shall be used. The thickness shall be min. pressure range PN 10, better PN 16 (bar).

Туре	bypass line	diameter	bypass flow (m ³ /h)
CDV 15 - CDV 600	DN25	32	1 - 4
CDKa 150 - CDKa 420	DN25	32	1.5 - 3
CDKa 750	DN32	40	3 - 4
CDKa 1500, CDVa 2000	DN40	50	6 - 10
CDKa 6000, CDKa 10000	DN50	63	8 - 10



ATTENTION

The installation of the system has to done in such a way that under all conditions (operation, standstill, abnormal occurance) the effect of a partial vacuum on the bypass line is out of the question. The bypass line has to be installed in a way that a partial vacuum can never occur!

There is a danger that chemicals may be drawn through the reactor out of control, and in this way a gas phase could occur which is cabable of explosion.

This is especially important if the water flow stops:

- if the main water pipe or the bypass pipe ends in a reservoir below the water level.
- if in a main water pipe (with a big diameter) the flow direction is reversed (non return flap valves are never 100 % sealed).
- when the chlorine dioxide is placed obove the main water line or the reservoir.

Installations with a long bypass line are dangerous, too, especially if the line is going downwards and the dosage point is below the level of the Bello Zon[®] generator.

In the case of doubt, a pressure holding valve (version free of backpressure effect, i.e. the function is retained also at increased backpressure levels) should be fitted at the end of the bypass line just before the metering point.

Installation of a vent valve (Part No.: 1001260) is additionally necessary at the highest point in the bypass line (see Fig. 1 and Fig. 2).

The flow of the bypass line must be monitored; if there is no bypass flow, the chlorine dioxide dosage must stop immediately. Bello Zon[®] systems have a bypass flow rotameter with min.-contact already pre-mounted on the console (corresponding to the respective identity code version).

3.2 Bypass flow generation

To generate a flow in the bypass line, one of the following options may be chosen:

- Installation of a throttle valve in the main water line.
- Installation of a spring or weight loaded non-return valve in the main water line.
- Installation of a bypass water pump in the bypass line, before the Bello Zon[®]. The bypass pump is connected to the Bello Zon[®] controller. This way it will be interlocked with the chlorine dioxide generation, too.

3.3 Dosage point

In order to minimise corrosion at the metering point in the main water line the installation of an injection fitting is recommended. This injection fitting (material PVC) is available in two sizes: • Up to a main water line diameter of DN 80 \rightarrow Part No.: 1018754

- DN 100 and bigger
- → Part No.: 1018753

The immersion pipe is supplied as a complete unit with a DN 25 ball valve, Tangit glue and cleaning agent.

3.4 Pressure in the bypass line

DANGER

The permissible maximum pressure in the bypass line according to the following table may not be exceeded. Otherwise, the reactor may be damaged and chlorine dioxide solution in a dangerous concentration may escape in an uncontrolled way.

Туре	CDVb	CDVa	CDVa	CDKa	CDKa	CDKa	CDKa	CDKa	CDKa
	15-220	400	600	150	420	750	1500	6000	10000
max pressure	8 bar	10 bar	8 bar	10 bar	8 bar	8 bar	8 bar	2 bar	2 bar



3.5 Flushing device

For maintenance work the Bello Zon[®] reactor content has to be emptied. Usually this amount of chlorine dioxide cannot just be dumped into the system without increasing the concentration above the desired limits. Thus, the rinsing unit has to be installed in the bypass line downward of the Bello Zon[®] system.

It is recommended to replace the chemical container by a container of water (e.g. bucket) in time before starting the maintenance work. The chlorine dioxide will thus be flushed automatically without exceeding the desired concentration in the treated water.

Tauchrohr ab DN 100

Tauchrohr bis DN 80



3.6 Pre-mixing

In circulation systems a premixer in the bypass line is usually not necessary. For all "oncethrough" systems a premixer is recommended, **especially if the dosage is going into a main water line without any further reservoir as reaction vessel.** Eventually an additional mixer is necessary in the main water line.

Plant types CDVb 35 to CDVb 120 have a pre-mixing device (corresponding to the respective ident code version) already pre-mounted on the console.

Bello Zon [®]	Volume	Part No.
CDVb 220 / CDKa 150	1.5	740649
CDVa 400 / CDKa 420	4.5 I	740650
CDVa 600 / CDKa 750	7.0	740832
CDKa 1500	13.4	1001000
CDVa 2000, CDKa 6000 und CDKa 10000	13.4	1003121

In case of plant types CDVb 220 to CDVa 600 and CDKa 150 to CDKa 1500 the pre-mixers are delivered loose and have to be installed separately into the bypass line.

4 Reactor Cabinet

As an additional safety measure the air in the reactor cabinet is exchanged every 10 minutes with an injector and a solenoid valve *connected to the bottom of the reactor cabinet.

The injector needs a **separate** water supply (water pressure 1-7 bar, water quality: drinking water, free of particles, see chapter 2, Installation).

On the top side of the reactor cabinet there is a connection (DN 16 /d 16) for the venting pipe to the outside. If too far away, substitute a vent valve (part no.: 791801), already fitted as standard in the case of the CDVb.



5 Controlled Dosage

5.1 Drinking water treatment: "once-through"-systems

In this case flow proportional dosing is necessary.

Control is made by means of a contact-type water meter, an inductive flow meter (with an analog output signal) or pump motor switch (operating parallel using the remote pause contact).

When dosing controlled by a contact signal, the following values for the contact spacing and the related issues should be noted:

plant type	approx. addition (ppm)	max. flow (m³/h)	recommended pulse spacing (liter)
CDVb 15	0.3	50	10
CDVb 35	0.3	150	25
CDVb 60	0.3	240	50
CDVb 120	0.3	430	50
CDVb 220	0.3	750	100
CDVa 400	0.3	1330	150
CDVa 600	0.3	2000	300
CDVa 2000	0.3	6600	1000
CDKa 150	0.3	500	75
CDKa 420	0.3	1400	200
CDKa 750	0.3	2500	350
CDKa 1500	0.3	5000	700

If the flow is very small a minimun pulse frequency of one pulse every 10 seconds is required. If the flow varies considerably the pulse range should be 1 pulse every 1 to 10 seconds.

Proportional dosing to a 0/4...20 mA signal from an inductive flow meter is also possible.



ATTENTION

If the water flow to be treated is missing or interrupted the dosage of chlorine dioxide needs to be interrupted automatically! (UVV 7, 2).

In case of a constant flow the chlorine dioxide plant can be operated parallel to a pump or a valve using the remote pause option for interlocking. Here the Bello Zon[®] plant works on a manually adjusted internal frequency.

5.2 Circuit water systems

In this case the dosage needs to be controlled by a timer or by an on-line measurement to avoid high chlorine dioxide residuals and eventually low pH-values in the circuit water systems. This is not relevant for a circuit water when the chlorine dioxide consumption potential is always higher than the applied dosage.

For the measurement-controlled dosage there are several options:

clean water (drinking water)	DULCOTEST [®] CDE (sensor) DULCOMETER [®] D1C - CIO ₂ (controller)
circuit water systems	DULCOTEST [®] CDP * Pt 100 (temperature sensor) DULCOTEST [®] D1C- CIO ₂ with temperature compensation
dirty water	ORP-sensor or timer-controlled dosage

* = This sensor can also be used at the cold water zone of a bottle washing machine, where the water contains surfactants.

For all measurement-controlled systems a second sensor (ORP-sensor) is recommended for safety reasons.

For every gram of chlorine dioxide 1.8 grams hydrochloric acid are dosed. Therefore in a circuit water system with weakly buffered water the pH may be lowered below the limit value critical for corrosion.

If in doubt the pH value shall also be monitored and the plant must be switched off, if the pH value drops below the limit value.

If a water circuit has little fresh water addition, the installation of a conductivity measurement is recommended as it is used in cooling tower systems for the cycles of concentration.

Above a chloride level of 150 ppm pit corrosion can begin to occur with stainless steel¹.

With measurement-controlled dosage: daily checks of the measurement and control devices are recommended to see whether the control mechanism is working as required for the safety of the process.

Some circuit water systems might contain other chemicals that can consume chlorine dioxide. At bottlewashing machines or in cooling tower systems phosphonic acids are used to avoid precipitation of hardness.

ATMP (Amino-tri-methlene-phosphonic-acid) consumes chlorine dioxide.

HEDP (1-Hydroxo-ethan-di-phosphonic-acid) and

PBTC (Phosphoni-butane-tri-carbon-acid) do not consume chlorine dioxide.

(check with the chemical manufacturer for any interferences, if necessary)

6 Reaction time

In order to guarantee safe disinfection of drinking water applications, a reaction time of a minimum of 10 - 15 minutes should be given. Proper mixing of the CIO_2 solution into the water to be treated is a pre-condition.

For this purpose the metering should take place before an intermediate tank. Metering "clouds" can be distributed using a static mixer in the bypass and /or main water line.

7 Chemicals and Safety

The supply of chemicals for the generator is the responsibility of the user. In order to avoid unnecessary risks especially when operating with concentrated chemicals, please read thoroughly the following sections According to the guidelines relevant in Germany (UVV) an operating directive containing the handling and safety instructions needs to be established by the acting manager for the operating personal.

Any questions and deviations from our recommendations are to be discussed in any case with ProMinent Heidelberg, the local ProMinent subsidiary or representative.



DANGER

Avoid confusion when refilling or exchanging the component tanks.

If sodium chlorite gets into the hydrochloric acid tank (or viceversa), large quantities of chlorine dioxide gas will emerge immediately. Chlorine dioxide is unstable and tends in the gas phase to an explosive decomposition at a concentration of more than 10 vol% (= 300 g/m³). An explosin is still possible even after 15 or 30 minutes.

In order to avoid a confusion, a definite marking (labeling, colour) of the component tanks, the safety tubs, storage tanks, storage area is to be made (acid = red, sodium chlorite = blue). Systems, particularly tank systems, can be made safer by using different connecting systems and by fitting an online pH meter in the filler line. The operating staff must be trained for the responsible handling of the chemicals.

Literature recommended:

¹⁾ Chlorine Dioxide Doses in Water Treatment - Dr. Lauer, ProMinent Dosiertechnik

Concentrations of the chemicals for CDV systems, diluted chemicals

Hydrochloric acid	9 % (tolerance + 1.5 %)
Sodium chlorite	7.5 % (tolerance +/- 0.3 %)

Risk of explosion if higher concentrations of sodium chlorite are connected.

Concentrations of the chemicals for CDKa systems, concentrated chemicals

Hydrochloric acid	30-33 % (in accordance with DIN EN 939 or equivalent)
Sodium chlorite	24-25 % (300 g/l, in accordance with DIN EN 938 or equivalent)

Hydrochloric acid (30-33 %) with a low purity should not be used as this will cause a high rate of wear on sealing rings and PVC parts. "Hydrochloric acid with a low" purity is usually a waste product from chemical processes. It is slightly yellow and very often contains chlorinated organic compounds (e.g. THMs, AOX). These substances corrode even Viton[®] B within a short time (a few weeks). Moreover the PVC-pieces are attacked, too. They become glassy and break easily.

Hydrochloric acid with a concentration of 38 % should not be used either. The acrylic-material of the dosing head will be damaged after a few months.

Diluted chemicals for the operation of CDV systems must be manufactured using demineralised water from concentrates whose quality complies with DIN EN 939 and/or 938.

Viton[®] is a registered trademark of DuPont Dow Elastomers.

7.1 Suction pipe to the Bello Zon[®] pumps

In order to avoid problems with the performance of the pumps and the flow monitors, the suction line should be kept as short as possible, and the suction height of the pumps should not be exceeded.

The chemicals should be placed underneath of the Bello Zon[®], so that the suction pipe has a constant slope upwards to the pump. This way any gas bubbles occuring will not result in a pump failure. The suction line diameter needs to be selected according to the data given for the relevant pump type. At the end of the suction line (in the tank) a foot valve is necessary.

The Bello Zon[®] controller is configured to accept signals (potential-free contact, N.C.) from a twostage level switch in the chemical tank. The first level will result in a warning (e.g. "acid level low"), but the Bello Zon[®] will not stop. As soon as the second level is reached, the Bello Zon[®] will stop and the display will show an alarm message (e.g. "acid tank empty"). In the first case the message will disappear, if the tank is refilled, in the second, the reset-button will need to be pressed to restart the system.



ATTENTION

The chemical tanks should not be placed above the Bello Zon®.

If tanks cannot be installed below the level of the Bello Zon[®] system or if large quantities of chemicals are to be connected the supply lines must be hydraulically separated from the tank store by the use of intermediate tanks.

Otherwise, due to the fluid level in the tank store, a positive admission pressure may occur in the intake line that can cause throughflow, or incorrect metered quantities can occur at different levels.

The back-pressure valve at the outlet of the Bello Zon[®] reactor (1.5 bar) is not a tightly closing shut off device and therefore offers insufficient protection against syphoning.

In these cases, the installation of intermediate tanks is necessary for safety reasons.

If the installation requires long suction lines for the chemicals, a suction air accumulator (for CDV: Part No.: 1001820, 1001821) should be installed at chemical of the Bello Zon[®] system.

Additionally a backpressure valve at the end of the bypass line before the metering point is recommended, too.

CDVb 15BT4a 10001.86/4037006924557CDVb 35BT4a 10012.06/4037006924557CDVb 60BT4a 10022.56/4037006924557CDVb 120BT4a 10053.06/4037006924557CDVb 220BT4a 10083.08/5037008914193	142074 142074 142074 142074 142074 142074
CDVb 35BT4a 10012.06/4037006924557CDVb 60BT4a 10022.56/4037006924557CDVb 120BT4a 10053.06/4037006924557CDVb 220BT4a 10083.08/5037008914193	142074 142074 142074 142074 142074
CDVb 60 BT4a 1002 2.5 6/4 037006 924557 CDVb 120 BT4a 1005 3.0 6/4 037006 924557 CDVb 220 BT4a 1008 3.0 8/5 037008 914193	142074 142074 142074 142074
CDVb 120 BT4a 1005 3.0 6/4 037006 924557 CDVb 220 BT4a 1008 3.0 8/5 037008 914193	142074 142074 142074
CDV/b 220 BT4a 1008 3.0 8/5 037008 914193	142074 142074
0DVD 220 DT10 1000 0.0 0,0 001000 011100	142074
CDVa 400 G/5 - 1310 1.9 8/5 037008 914193	
CDVa 600 Vario 12017 7.0 20/15 037020 809464	142074
CDVa 2000 SICa 12050 7.0 DN 15	
CDKa 150 G/4 - 1602 1.7 6/4 037006 924557	142074
water pump G/5 - 1605 1.3 * * * *	*
CDKa 420 G/4 - 1001 0.9 6/4 037006 924557	142074
water pump Vario 12017 7.0 * * * *	*
CDKa 750 G/5 - 1605 1.3 8/5 037008 924562	142074
water pump Vario 12026 7.0 * * * *	*
CDKa 1500 G/5 - 1310 1.9 8/5 037008 924562	142074
water pump SIC 12090 7.0 * * * *	*
CDKa 6000 Vario 09039 4.0 DN 10	
water pump SICa 07220 5.0	
CDKa 10000 Vario 05075 3.0 DN 15	
water pump SICa 04350 5.0	

Table: Bello Zon[®] systems, pump types, suction height and suction line diameter

* = included in delivery of CDKa

7.2 Suction lances for Bello Zon[®] systems

For Bello Zon[®] systems there are available a set of suction lances, containing foot valve, two-stage level switch and a suction line (length 5 m).

There could also be a flexible suction assembly available that can be adjusted to varying containers.

		Flexible Suction		
Туре	30 I tank	200 I tank	500 l tank	(length 5m)
CDVb 15-120	790650	791563	791612	792195
CDVb 220	791237	791567	791613	1000132
CDVa 400	791237	791567	791613	1000132
CDVa 600	*	*	*	*

* For CDVa 600 and CDKa 6000 the suction lance Part No.: 790387 can be used.

The length can be adjusted on site, max. 1340 mm (200 I - 1000 I tanks). For an additional two stage level switch the following set can be used: Part No.: 790321.

For small CDKa systems a special suction lance (Part No.: 740049, for 60 liter tank) has been developed to overcome corrosion problems due to vapours from the hydrochloric acid. This lance is gastight and has a venting connection that should be connected to the reactor housing, so that the vapours are being taken away by the suction system.

For CDVa 2000 and CDKa 10000 the suction lance Part No.: 790391 and level switch Part No.: 790318 can be used.

CDVb systems are supplied with the appropriately sized suction lances in certain identity code versions.

7.3 Connection of the water tank for Bello Zon[®] systems, type CDKa

In the standard delivery of a CDKa-system an intermediate storage tank for the dilution water supply is included. This tank has two-level switches.

The bottom switch starts the refilling process. In the Bello Zon[®] controller (Configuration Menu) the preset filling time of 20 sec. can be adjusted oriented on the demand. The dilution water should be free of particles and has to meet drinking water standards. The pressure before the refilling solenoid valve should be adjusted so that sufficient water flow is guaranteed.

The following details should be considered:

If the water level is above the bottom level switch, the contact is N. O. (= normally open, the float is in the upper position). When the tank level is going down, this contact closes (= N. C.) and that way the solenoid valve for refilling opens. At the same time a timer starts. If after 20 % of the preset refilling time the contact has not changed to N. O. again, an alarm will be generated. In this case a failure of the water supply is most likely.

The upper level switch is a safety level switch to avoid an overflow of the water tank. This level switch is connected to the same terminals (37, 38) in the Bello Zon[®] controller as the bottom level switch.

If the water level is between both switches both contacts are open (N.O.).

However, when the water level is above the upper switch, it changes to N. C. and the same procedure as if water is missing is started. The solenoid valve for refilling opens and if after 20 % of the pre-set refilling time the contact has not changed to N. O. again, an alarm will be generated since the N. C. status can not be reversed in this case.

7.4 Storage tank systems for Bello Zon[®] systems with large capacity

The direct connection of large containers to the suction side of the Bello Zon[®] pumps is not recommended for the following reasons:

Either the filling level of large containers (> 1 m³) is above the metering place (-> danger of uncontrolled syphoning), or the empty level is close to the suction height of the metering pumps (-> start-up problems of the pumps). In any case, after an operating time of several months there will be different filling levels in the acid tank and the chlorite tank; and therefore varying flow rates of the chemical pumps. Consequently the folw sensors will have problems and 1:1 volume ratio will not be guarateed.

Additionally the calibration is not correct any more the actual flow volumes might be higher and due to that the reactor concentration can rise above the admissible safety level.



DANGER

If the chemical pump at the Bello Zon[®] plant has a positive hydrostatic pressure on the suction side and the suction line breaks away, or if there is a leakage, very large quantities of chemicals will flow out.

30 % hydrochloric acid is very etching and produces toxic and pungent trails of fumes. There is the danger of lung damage.

Sodium chlorite is toxic, harms plants and animals. If discharged into rivers and lakes in large quantities it could damage the aquaculture. The dried solution in contact with organic substances may cause strong reactions or even fire. Therefore released sodium chlorite solution must be washed away immediately with plenty of water.

The use of intermediate containers in chlorine dioxide plants is an excellent solution for these problems and guarantees optimum operation safety.

Storage tanks must each be placed in a safety bund or enclosure. This must stand on a solid ground or concrete floor, or it may consist of a wall surrounding the storage tank on solid ground or concrete floor. According to the German WHG-regulation this safety bund is to be fitted with leakage monitoring.

There should be a floor drain close to the safety bund or enclosure.

8 Properties of Chlorine Dioxide

8.1 Gaseous Chlorine Dioxide

Gaseous chlorine dioxide has an orange-yellow colour and a pungent smell. Chlorine dioxide is unstable and decomposes at a concentration of 10 vol% (= 300 g/m³) explosively into chlorine and oxygen. Dilution reduces the explosiveness; at concentrations under 10 vol% in gases, which chlorine dioxide does not react with (e.g. air, nitrogen, carbon dioxide) there is no explosion hazard.

It should be remembered that the concentration in the gas phase above aqueous chlorine dioxide becomes critical with a solution strength over 8 g/l chlorine dioxide (at a temperature of 20°C).

An intense, even explosive, reaction also takes place with oxidable substances.

In order to avoid dangers for the operating staff and the environment, one should see to it that in no case the chemicals are mixed up when exchanging the chemical tanks or during the refilling process.

8.2 Aqueous Solutions of Chlorine Dioxide

Without a gas space above, chlorine dioxide solutions are explosive starting from a concentration of more than 30 g/l, i.e. they are able to decompose by themselves without any influence as heat, sparking, dirt or rust.

Chlorine dioxide is stable for several days in an aqueous solution, when the solution is kept in the dark, the pH-value is less than 7, and the temperature is less than 25 °C.

Chlorine dioxide cannot be stored or transported either as a gas or as a concentrated aqueous solution due to its explosiveness. Therefore it is produced only as an aqueous solution in specially designed generators for the immediate use.

Bello Zon[®] chlorine dioxide systems are designed for a safe reactor concentration of 20 g/l. With CDV-systems this concentration results from the concentration of the used diluted chemicals (hydrochloric acid 9 % and sodium chlorite 7.5 %) and with CDKa-systems by adding dilution water to the concentrated chemicals (hydrochloric acid 30-33 % and sodium chlorite 24-25 %). With a CDKa-system the volume flow of the water pump is 5.5 times as big as that of a chemical pump.

Direct at the reactor outlet the Chlorine diode solution is diluted and is then carried to the injection point. The amount of the bypass water needs to be adjusted so that a concentration 100-200 ppm is reached in the bypass line.

8.3 Measures for Accidents

If an uncontrolled combination of the concentrated chemicals occurs, an intense chemical reaction starts immediately releasing large quantities of chlorine dioxide gas and heat.

If concentrated chemicals were combined uncontrolled or if chlorine dioxide gas emerged, the place of the accident should immediately be cleared. Chlorine dioxide is instable and tends to an explosive decomposition starting from a concentration of more than 10 vol% in the gas phase. It is even possible that the critical gas concentration will be reached only after some time.

Released gas can be reduced with spray water. Spilled chlorine dioxide solution can be neutralised by sodium thiosulfate solution, afterwards diluted with plenty of water and rinsed off into the drain.

The installation of the GMA 36 gas detector (part no.: 1023156) enables prompt detection and alerting of inadmissible gas leaks.

8.4 Measures in case of fire

Chlorine dioxide itself is not combustible, it may however stimulate fire. **Above a concentration 10** % (vol.) explosive decomposition is possible. There is no restriction for any fire extinguishing substances in case of ambient conflagrations.

8.5 Health Protection

- MAK-value (maximal concentration at a working place) = 0.3 mg/m³
- Odour limit: from approx. 15 mg/m³
- Breathing equipment: gas mask filter B/grey
- Eye protection: safety glasses, face protection
- Hand protection: rubber gloves

A chlorine dioxide gas concentration of more than 45 mg/m³ causes trouble in breathing and gives irritations of the mucous membranes, taste irritations and headache.

In general chlorine dioxide causes strong irritations of the mucous membranes of the eyes and respiratory organs. Depending on the concentration and duration of the action upon the person, there may be danger of suffocation, coughing, nausea, conjunctivitis and bad headache. In the worst cases there may even be pulmonary oedema with difficulty of breathing, lack of oxygen and circulatory collapse. In case of a short exposure at very high concentrations there is danger of glottis cramp or even cardiac arrest.

8.6 First Aid

Remove clothing which has come in contact with chlorine dioxide immediately, wash the skin thoroughly with soap and plenty of water. Splashes into the eyes have to be washed for several minutes under running water with open eyelid. After breathing in chlorine dioxide, you must supply fresh air, immobilize absolutely, lay down horizontally and keep warm. A doctor has to be informed promptly, even if symptoms are not immediately apparent. If necessary, transport the patient to hospital quickly but gently.