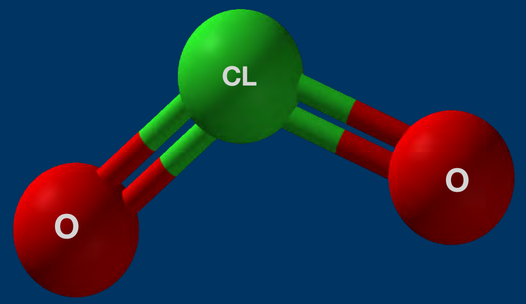
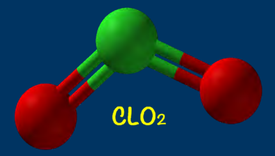
Zoom Meeting: CDL Production in a Clamp-Lid Jar Using a New Technique

Start: 14. January 19:30 2026





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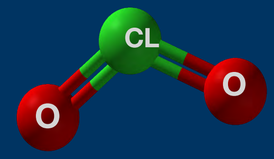
ClO_2 Production in a Clamp-Lid Jar Using a New Technique

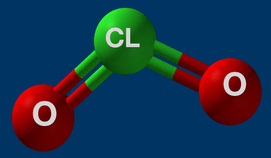
- · Standard clamp-lid jar production, as we have done it until today
- · New findings in 2025
- · Implementation of the new findings in production
- · New clamp-lid jar production method
- · Clamp-lid jar production setup
- Detailed description of the materials used

Materials and starting substances

- · Results of the test series
- • Production video
- · Appendix: Formulas and calculations



Our Starting Situation in the Production of CDL in a Clamp-Lid Jar



1. A small shot glass was often used, which stood somewhat unsteadily in the collection water.
2. Filling the small shot glass was somewhat cumbersome for inexperienced users. Hydrochloric acid and sodium chlorite were not supposed to get into the collection water.
3. Several cycles were often necessary. The total production time was 24–36 hours, and sometimes even longer.
4. Many people left the clamp-lid jar in the room during production, meaning the CDL production was exposed to light for 24–48 hours. Some placed it in a cupboard in the dark.
5. The clamp-lid jars and shot glasses used varied in shape and volume. There were significant differences here.
6. Different total amounts of $NaClO_2$ and HCl were used..
7. The same amount of sodium chlorite and acid was used. (Editor: there's a reason they were the same) (Standard: 5 ml + 5 ml per cycle). (Editor: The author of this article does not know why dual infusion...)
8. The production temperature varied considerably (approx. 19–26°C?).
9. Leaking clamp-lid jars (there is a video for checking the jars).

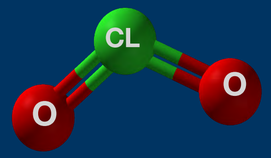
Initial Situation



Results:

The CDL concentration produced and the total production time varied greatly and were not consistent..

New findings in 2025:



Several insights were gained through the series of experiments by Louis Schneider in autumn 2025.
Here are the three most important ones.

1. If light falls on the ironing glass during production, the results will be much worse.
   The concentration and purity of the CDL is also influenced by the incident light.
   For this reason, the production should be covered by a cardboard box or the glass should be in a dark cabinet during the production period

2. Due to the different density of hydrochloric acid and NaClO2, the two liquids form a layer in the shot glass (reaction glass). The larger the filled volume and the smaller the diameter of the shot glass, the greater the stratification. A layer formation means that the chemical reaction in the shot glass runs much slower. An increase in the amount of the starting materials (NACLO2 and HCL) thus brings increasingly worse results, especially with very narrow shot glasses. This is also the reason why Andreas Kalcker originally recommended the production in 2 stages: (No. AK made his CDS video based on the work of CL copied from her website)

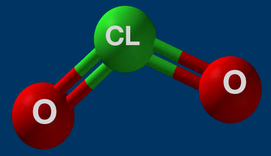
   2x (5 ml HCL, 5ml NACLO2) = 10 ml, compared to when I wanted to achieve this with a pass with a total of 20 ml. With a volume of 20 ml, I automatically have more stratification than if it is only 10 ml and thus a slower reaction.

3. **From calculations we know that we have at least twice as much hydrochloric acid in relation to sodium chlorite**

   for the complete reaction of NACLO2 25% and HCL 4% need.

How can we now use these findings to improve our production results?

Avoiding stratification, but how ?



1. 1. First of all, we have enlarged the inner glass (reaction glass, shot glass) in diameter so that the surface area becomes larger and the level of the reaction liquid becomes lower. As a result, already in the Louis series of experiments achieved much better results.

2. 2. In a further step, I was looking for an interior glass that has an even larger surface area and fits exactly into the ironing glass (diameter and height). As a result, a good result could already be achieved in one pass. But here, too, the limit was quickly reached at a higher volume, with more liquid in the reaction glass, the layer formation also limits the process here.



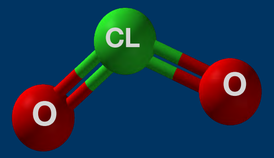
Old production shot glass



New production wake up crash glass higher, wider, heavier

Due to the very high inner glass up to the lid edge of the ironing glass, another positive effect has occurred:

The produced CDL has a much better quality. Only very few substances have passed from the reaction vessel into the collecting water. After production, the conductance of the finished CDL was very low, a maximum of 2-10 us.

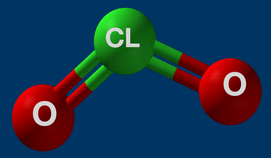


The path from CLO2 gas to large reaction glass

The CLO2 gas rises in the reaction vessel, all the way up to the lid and then comes down through the small gap to our collecting water.



Prevention of stratification



Whenever two liquids with different densities come together, a layer is formed. A chemical reaction takes place only at the interface of these two liquids.

So the effective "reacting area" is very small and our reaction is slow

Now there are several ways to reduce the layer formation in order to accelerate the reaction. These are also used in the chemistry laboratories.

Catalyst: does not work

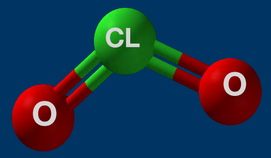
Increase pressure : does not work

Increase temperature: goes up to a limit

Stir mechanically: go √

A set of instructions for accelerating reactions:
The more intense and "finer" the mixing of two substances, the larger the contact area and the faster the reaction proceeds.

Prevention of stratification - the second amendment



2. In a second step, a magnetic stirrer was used, which in the inner glass (shot glass) the reaction-

the liquid is constantly stirred. In the shot glass was then the magnetic stirring rod, which was always kept in motion from the outside by a rotating magnetic field.

This was the absolute breakthrough. The layer formation has been almost eliminated and our production process for CDL production has become faster by a factor of 15-20. In spite of magnetic stirrers, the transferred substances have not increased (uS).





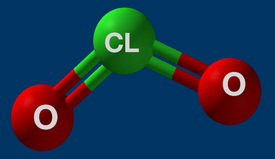
CLO_2-Production with new technology in ironing glass

This is the absolute breakthrough for a fast, good CDL production - we have been waiting for this...



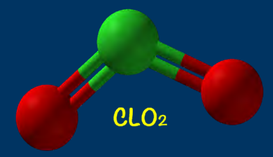
- ✓ ✓ Super easy
- ✓ ✓ Super fast
- ✓ ✓ Top Quality
- ✓ ✓ Top yield
- ✓ ✓ Reproducible
- ✓ ✓ Low cost

Lets go! ....



CLO_2 Production with a new technique !

In just one pass, 3000 ppm in one hour !



+ simple + safe + high efficiency + high quality + stable process + reliable results

To achieve this, the glasses and components must be coordinated with each other.

- The inner glass (reaction glass) should be as high as possible, up to just below the ironed glass lid, and have a large diameter so that the lid just goes over it. The inner glass should fit exactly into it. The lid holds the inner glass on the outer edge, so to speak. The distance between the inner glass and the lid is often only 1- 5mm, depending on the glasses used.

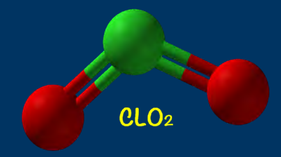
- The total volume of NACLO2 and HCL introduced into the reaction vessel must not exceed a certain volume, depending on the size of the vessels, unless a magnetic stirrer is used. The formation of a layer is avoided with a magnetic stirrer. As a result, larger volumes of NACLO2 and HCL can be introduced and higher concentrations can be made. Furthermore, the production is carried out with a magnetic stirrer around several times faster -> a factor of 15-20. This should now be the standard of any production.

The entire production must not be exposed to light.

- This means that we have to put a cardboard box over the ironing glass production for the entire production period.

We use twice as much acid in our production in relation to sodium chlorite.

Utensils used for the CLO2 productions





Clamp-Jar

Silicone gasket



Weck Reactor Glass Jar



Magnetic Stir Bar



Magnetic Stirrer

Description and sourcing of the utensils used

 Version 1	Rossmann Fido, Made in Italy, Bormiolo Rocco ca. 450 ml , rund. Bezug von Rossmann. Hier passt genau das WECK-Sturzglas, Mündung: Rundrand Volumen: 140 ml Farbe: klar. Bezug von Weck oder flaschenland.de. (In this configuration, the reaction glass has about a 3–4 mm gap from the clamp-lid jar lid when closed.)
 Version 2	**Bügelglas:** 550 ml Drahtbügelglas, quadratisch, Drahtbügelverschluss, klar. Bezug von flaschenland.de Hier passt exakt das **WECK-Sturzglas, Mündung: Rundrand Volumen:** 160 ml **Farbe: klar.** Bezug von Weck oder flaschenland.de. (In this configuration, the reaction glass has about a 2 mm gap from the clamp-lid jar lid when closed.)
 Magnetic Stir Bar	**Anzeser Magnetrührer mit Magnetrührstab,** Rotation speed range **2-60 U / Sekunde.** Bezug von Amazon oder Onlineshop. Any other magnetic stirrer is also possible or even better. Magnetic stirrers with a small adjustable speed (Bp. the lower speed is 2-4 revolutions per second.)
	Silikonring Weck Silikonring BG70 UNiTWIST 70 x 92.5 mm (Innen Durchmesser 70 mm, Aussen Durchmesser 92.5 mm). https://www.weckglaeser.com/

All of the following productions were carried out using the lowest rotation setting, approximately 2–4 rotations per second, and with the supplied magnetic stir bar (externally coated with plastic, PTFE). A high rotation speed is not necessary for our small volume and could even have negative effects.

To determine which undesired substances pass into the collection water (conductivity), double-distilled water was used as the starting water for the experiments (0 µS).

Magnetic stirrer, clamp-lid jar, and reaction glass together cost about €31, depending on the shop.

Additional possible clamp-lid jars and inner glasses for larger production quantities

Glasses shown here are only ideas! These glass combinations have not yet been tested!



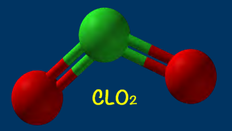








Ergebnisse Bügelglasproduktion mit nur einem Durchgang



Datum	Collection-water: double-distilled (0µS)	NACLO2	HCL	Production duration	Concentration CLO2	Conductivity of the finished ClO_2	Produktion	ca. Temp Reaktions-Flüssigkeit	Geschmack 2 ml auf 100 ml Wasser	Glas-Version
12.12.2025	200 ml	5 ml	10 ml	20 h	2450	5 uS	Normal-production without a magnetic stirrer	18,5 °	mild	1
17.12.2025	200 ml	5 ml	10 ml	2 h	2550	6 uS	With a magnetic stirrer in the reaction glass	18,5°	mild	1
19.12.2025	200 ml	5 ml	11,2 ml	2 h	2760	10 uS	With a magnetic stirrer in the reaction glass	18,5°	mild	1
20.12.2025	200 ml	6 ml	12 ml	70 Min	2785	8 uS	With a magnetic stirrer in the reaction glass	18,0°	mild	1
23.12.2025	200 ml	6 ml	12 ml	70 Min	2841	5 uS	With a magnetic stirrer in the reaction glassy	19,0°	mild	1
26.12.2025	200 ml	6 ml	12 ml	70 Min	2852	6 uS	With a magnetic stirrer in the reaction glass	19,0°	mild	1
28.12.2025	200 ml	6 ml	12 ml	65 Min	2805	4 uS	mit Magnetrührer Im Reaktionsglas	19,0°	mild	1
05.01.2026	200 ml	6 ml	12 ml	70 Min	2846	2 uS	With a magnetic stirrer in the reaction glass	19,0°	mild	2

Production parameters:

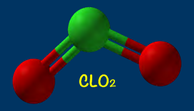
Completely in the dark (cardboard box placed over the production setup)
Initial water temperature: 16–18°C
$NaClO_2$ and HCl at room temperature: 18–19°C
After production, place in the refrigerator to cool down. Then open and bottle.
Glass combination used: see right column, Version 1 and 2
Achieved yield: 70–75%
(With the old production technique, the yield was 45–60%.)

Materials used:

HANSE PRO 2025:
4% ig HCL
25% ig $NACLO_2$



Results of ClO_2 Clamp-Lid Jar Production with Tap Water & Mineral Water



Datum	**NACLO$_2$**	**HCL**	**Produktions-Abbruch nach**	**Auffangwasser** uS gemessen vor Produktion	**Umgebung 18 °** Temperatur Auffangwasser Im Bügelglas	Leitwert vom fertigen CLO_2	**Konzentration CLO_2 ppm**	**PH Wert vom fertigen CDL (grob L-Papier)**	**Produktion**	Geschmack 2 ml auf 100 ml Wasser	Glas-Kombination
12.12.2025	6 ml	12 ml	70 Min	Tapwater gefiltert 595 uS	18 °	597 uS	**2726**	6,0-6,5	mit Magnetrührer Im Reaktionsglas	mild	1
01.01.2026	6 ml	12 ml	70 Min	Mineralwater 498 uS	12 °	499 uS	**2163**	ca. 6	mit Magnetrührer Im Reaktionsglas	mild	1
02.01.2026	6 ml	12 ml	70 Min	Mineralwater 511 uS	19,3 °	528 uS	**3008**	ca. 6	mit Magnetrührer Im Reaktionsglas	mild	1

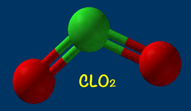
The reaction vessel stands in the collection water. Therefore, after a short time, the temperature of the collection water also determines the temperature of the reaction liquid in the reaction vessel.
It can be clearly seen that at a lower temperature of the collection water, the process takes longer, or the CDL concentration produced within the same time is lower (2nd row).

Mineralwater:

A standard mineral water was used: Adelholzener, bottling year 2023 (still / "Naturell") from a glass bottle.
Information from the internet: Conductivity: = 536 uS / °dH = 17,44 / —> hard water / pH = ?

Tapwater:

The local tap water was used: waterworks analysis: Conductivity 637 uS / pH 7,43 / °dH = 17,5 —> hard Water
The water was filtered before use with the KINI pitcher filter from the brand Maunawai: https://www.maunawai.com/de_DE



Summary – The following can be used as a guideline:

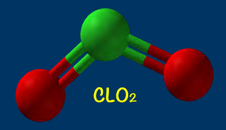
To produce a very good CDL in a clamp-lid jar in about 70 minutes in a single run with approximately 3000 ppm, we need::

- Glass combination Version 1 or 2, or an alternative with similar proportions between the two glasses
- **6 ml Natriumchlorit (25%)**
- **12 ml** Hydrochloric acid **(4%)**
- Starting water **200 ml ca. 18,5 - 20,5** celsius
  Osmosis water, still mineral water, filtered tap water, or double-distilled water
- **Production in the dark, covered with a cardboard box**
- **Magnet**stirrer

It is better to always produce small amounts of fresh CDL rather than large quantities that often remain in the refrigerator for too long, causing the CDL to gradually degrade over time.
With a production time of only about one hour and minimal effort, this should no longer be a problem!

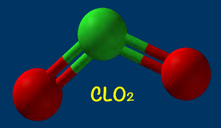


Formulas, Numbers, Chemistry, Basics, Hazards



* Basics of CDL production, formulas, terminology: page 18
* **Explosion properties of ClO_2 gas during production: pages 19–22**
* Chemical reaction formula and calculations: pages 23–25

Please do not confuse the terms!





Sodium chlorite $NACLO_2$ Salt

Sodium chloride NACL Table salt

CDS = CDL CLO_2

Chlorine dioxide solution: The gas ClO_2 is dissolved in water → yellow color.

Sodium hypochlorite NACLO

Sodium chlorate $NACLO_3$

Sodium carbonate NA_2CO_3

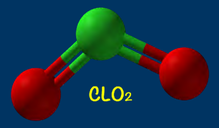
Sodium hydroxide NAOH

Attention:

Sodium chlorite, with the molecular formula $NaClO_2$, is the sodium salt of chlorous acid. This is the starting material (dissolved in water at 25%) from which we obtain our CDL..

Please do not confuse this with our table salt, sodium chloride (NaCl).—> Pay attention to the ending “t” or “d”. !

ClO_2 Solubility in Water



The complete solubility in water is:

3,01g/l at a partial pressure of 45,4 mbar 25°C —> 3000 ppm

7, 5 g/l at a partial pressure of 100 mbar 20 °C —> 7575 ppm

11, 5 g/l at a partial pressure of 100 mbar 10 ° C —> 11462 ppm

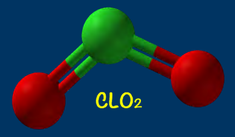


A higher concentration than 3000 ppm can be achieved easily under pressure and at lower temperatures.
Possible dangers at very high concentrations—which are far above the CDL we produce—are described on the following pages.



O'Neil, M.J. (Hrsg.). The Merck Index – Eine Enzyklopädie der Chemikalien, Arzneimittel und Biologika. Cambridge, Großbritannien: Royal Society of Chemistry, 2013., S. 372. + *IUCLID-CD-ROM, Year 2000 edition; European Commission, Joint Research Centre, Institute for Health and Consumer Protection, European Chemicals Bureau; Ispra, Italy, GESTIS-Stoffdatenbank*

Explosion Properties of CDL!



Aqueous ClO_2 solutions are not explosive,

as long as they cannot produce a chlorine dioxide–air mixture containing more than 9.5% chlorine dioxide by volume. *(see diagram on the following pages).*

The lower concentration limit for the explosive decomposition of chlorine dioxide gas is 9.5% in a ClO_2–air mixture ([ClO_2]/[air]).
The explosion pressure increases as the concentration of chlorine dioxide gas increases.

In mixtures above 9.5 vol.%, or at a partial pressure above 100 mbar, the mixture is highly explosive. An explosion can be triggered by almost any form of energy, such as sunlight, heat, sparks, or mechanical shocks.

(https://pubchem.ncbi.nlm.nih.gov/compound/Chlorine-Dioxide#section=Firefighting-Hazards)

Vapor Pressure Above ClO_2 Solutions

The vapor pressure that forms in the air space above the ClO_2 solution should not exceed the limit of 9.5 vol.%.
The vapor pressure depends on the existing ClO_2 concentration and the temperature.

To ensure that this limit is maintained, it requires a concentration limit (ppm) of the ClO_2 solution of a maximum of 1% by weight.

Our produced and used CDL with 3000 ppm contains only 0.3% by weight, and is therefore still far below a critical concentration.



Chlorine dioxide solutions with a chlorine dioxide content of < 3 g/L are therefore not subject to labeling requirements under the Hazardous Substances Ordinance..

https://www.aquintos-wasseraufbereitung.de https://www.chemie.de/lexikon/Chlordioxid.html



Gas volume % above a solution in water

g/L ClO_2 — chlorine dioxide in water

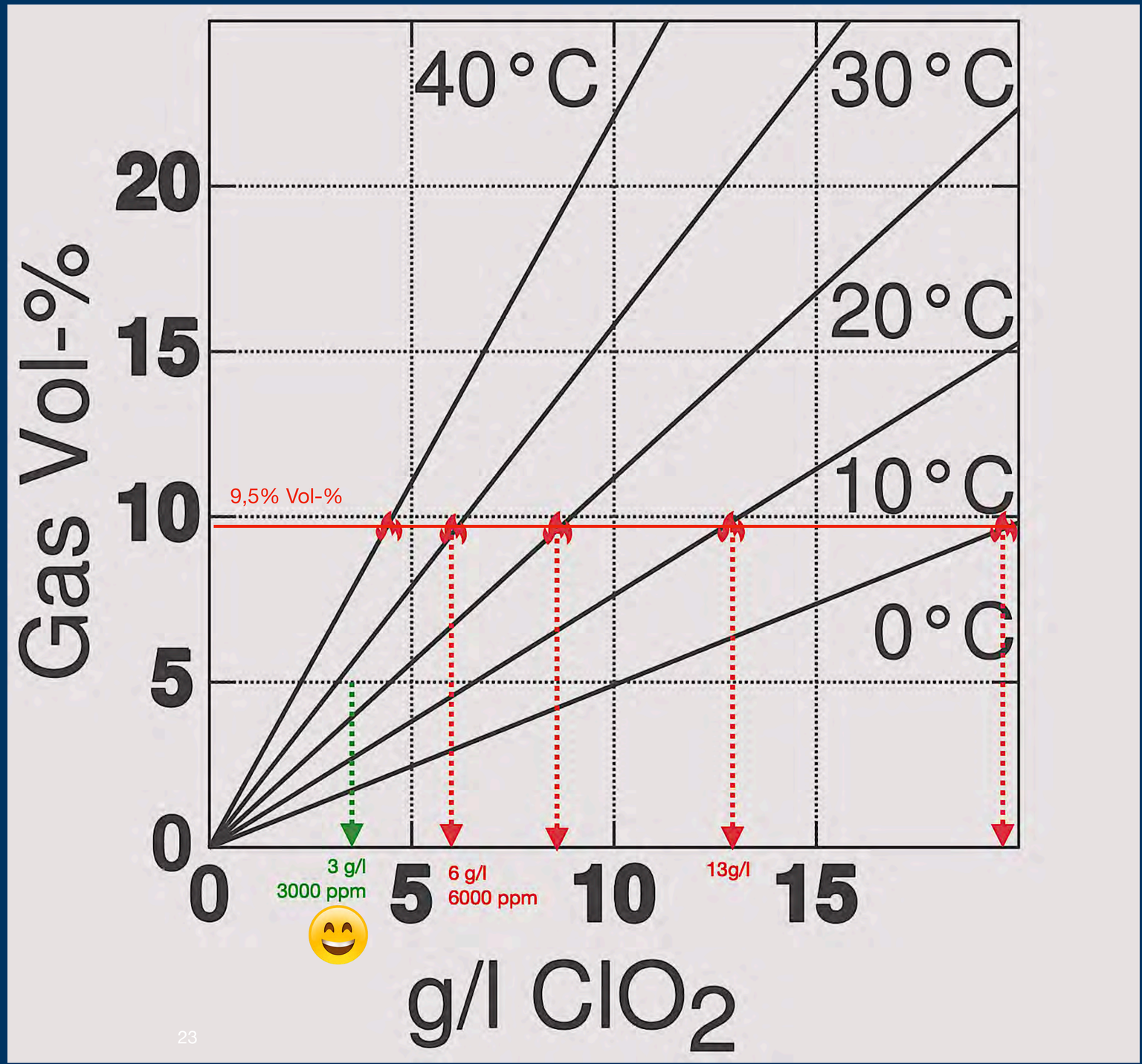
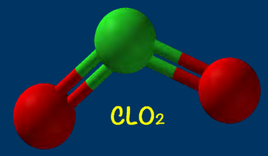


Diagram: Percentage of chlorine dioxide in the gas above a solution in water vs. grams per liter of chlorine dioxide in water.

Daten ausgelesen von "W.W Eckenfelder, J.A. Roth, A.R. Bowers Chemical oxidation--technologies for the nineties Technomic Publishing Company 1996" page 172 und davon ähnliche Graphik erstellt.

Calculation Basics for ClO_2 Production in a Clamp-Lid Jar – Part 1



Material	Molar mass (Wikipedia)
Sodium chlorite NACLO2	90,44 g/mol
Hydrochloric acid HCL	36,46 g/mol
Chlordioxid CLO2	67,45 g /mol
Sodium chloride NACL	58,44 g /mol
Water H_2O	18.02 g/mol

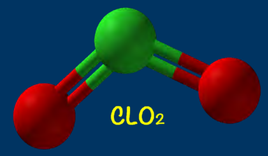
According to the reaction equation below, chlorine dioxide is generated in the shot glass (reaction vessel). During the breakdown of sodium chlorite, chlorine dioxide (ClO_2), table salt (NaCl), and water are formed.
Side reactions caused by impurities are not taken into account here.

$5\ NaClO_2$	$+\ 4\ HCl$	=	$4\ ClO_2 +$	$5\ NaCl +$	$2\ H_2O$
5 x 90,44 g	4 x 36,46 g	=	4 x 67,45 g	5 x 58,44 g	2 x 18,02 g
452,2 g	145,84 g	=	**269,8 g**	292,2 g	36,04 g
Total = 598,04g		=	*Total = 598,04g*		

Ratio: 269,8g CLO_2 / 452,2 g $NACLO_2$ = 0,597 ≈ 60 %

This means that only 60% of the $NaClO_2$ material we use can be chemically converted for chlorine dioxide production.

Calculation Basics for ClO_2 Production in a Clamp-Lid Jar – Part 2



How much hydrochloric acid is required for complete conversion?

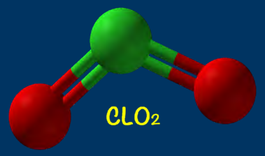
From the previous page	Molar masses of the reaction	Ratio		Calculation
Sodium chlorite $NACLO_2$	452,2 g	1		**10ml** $NACLO_2$ (25%) are used 10 ml (25%) $NACLO_2$ ≈ **3 g** pure $NACLO_2$ (10 cm^3x12,5g/cm^3 x 0,25%)
Hydrochloric acid HCL	145,84 g	0,322		How many ml of HCl (4%) do we need for the complete activation? We need the factor 0,322 = 3g x 0,322 = 0,97g pure HCL. For 0,97 g HCL (4%ig) we need (0,97g /(0,04 x 1,081g/$cm^{3)}$ = **22,4 ml** Hydrochloric acid.

In the following productions, double the amount of hydrochloric acid was used. According to the reaction formula above, the required amount of hydrochloric acid would actually be a factor of 2.24 in order to convert the entire sodium chlorite.
So, as a rule of thumb, for 5 ml $NaClO_2$ (25%) we need about 10 ml HCl (4%).
In the information provided by Andreas Kalcker, the same amount of $NaClO_2$ and acid is used as a simplification.
However, we are now using an optimized arrangement of the two glasses (the clamp-lid jar and the inner glass) and a magnetic stirrer.

Summary :

- As a rule of thumb, under optimal conditions for clamp-lid jar production:
- To produce 200 ml of ClO_2 (3000 ppm), approximately 6 ml of $NaClO_2$ (25%) and 12 ml of HCl (4%) are required.
- To produce 400 ml of ClO_2 (3000 ppm), approximately 12 ml of $NaClO_2$ (25%) and 24 ml of HCl (4%) are required.

Calculation Basics for ClO_2 Production in a Clamp-Lid Jar – Part 3



Example:
Clamp-lid jar: 1 × 6 ml $NaClO_2$ (25%). These 6 ml $NaClO_2$ (25%) weigh about 7.5 g. This corresponds to 1.875 g pure $NaClO_2$ (100%) (7.5 g × 25% = 1.875 g).
The molar ratio of sodium chlorite to ClO_2 is 0.745 (Na = 22.99 g/mol, ClO_2 = 67 g/mol).
Thus, we have 1.875 g × 0.745 = 1.397 g pure ClO_2 in our 6 ml sodium chlorite solution.
As shown on the previous page, only part of the $NaClO_2$ is converted into ClO_2 in the reaction, approximately 60%.
60% of 1.397 g = 0.838 g.
So, from 6 ml $NaClO_2$ (25%), a maximum of 0.838 g ClO_2 is available.

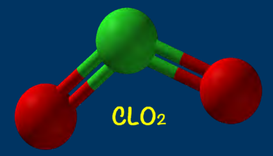
Calculation of the Yield from a Production:



If we had 200 ml of collection water in the clamp-lid jar (in the reaction vessel: 6 ml $NaClO_2$ + 12 ml HCl = 18 ml) and achieved 2850 ppm, then a total of
(218 ml × 3.01 g / 1000 ml × 2850 / 3000) = 0.7015 g ClO_2
was dissolved in the total water volume.

This corresponds to a yield of approximately 74% from the $NaClO_2$.

Purity of the finished CDL – how to test it?



A rough indicator is the electrical conductivity in µS. Conductivity increases with the number of dissolved substances (impurities) in the solution. The pH value also plays a role here. Therefore, conductivity measurement serves only as a rough guideline.

Chlorine dioxide itself is said not to increase or decrease the conductivity, since it does not dissociate in aqueous solution. However, during storage some ClO_2 decomposes.

To determine whether other substances or impurities dissolve into the starting water during production, the collection water (osmosis water or double-distilled water) should have a low and known conductivity (0–5 µS).

After production, you can then observe how the initial conductivity has changed. Once this has been determined and no changes are made to the production process, you can also use filtered tap water, spring water, or suitable still mineral water. Depending on the water, the conductivity there is often between 200–1000 µS.



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Conductivity Reference (Guideline)

Double-distilled water	0 -1 uS
Osmosis water (without added minerals)	0 - 5 uS
Tap water	300 - 1500 uS
Mineral water	300 - 2500 uS