

Making our world more productive



SOLVOCARB[®]

Neutralising alkaline wastewater from construction sites

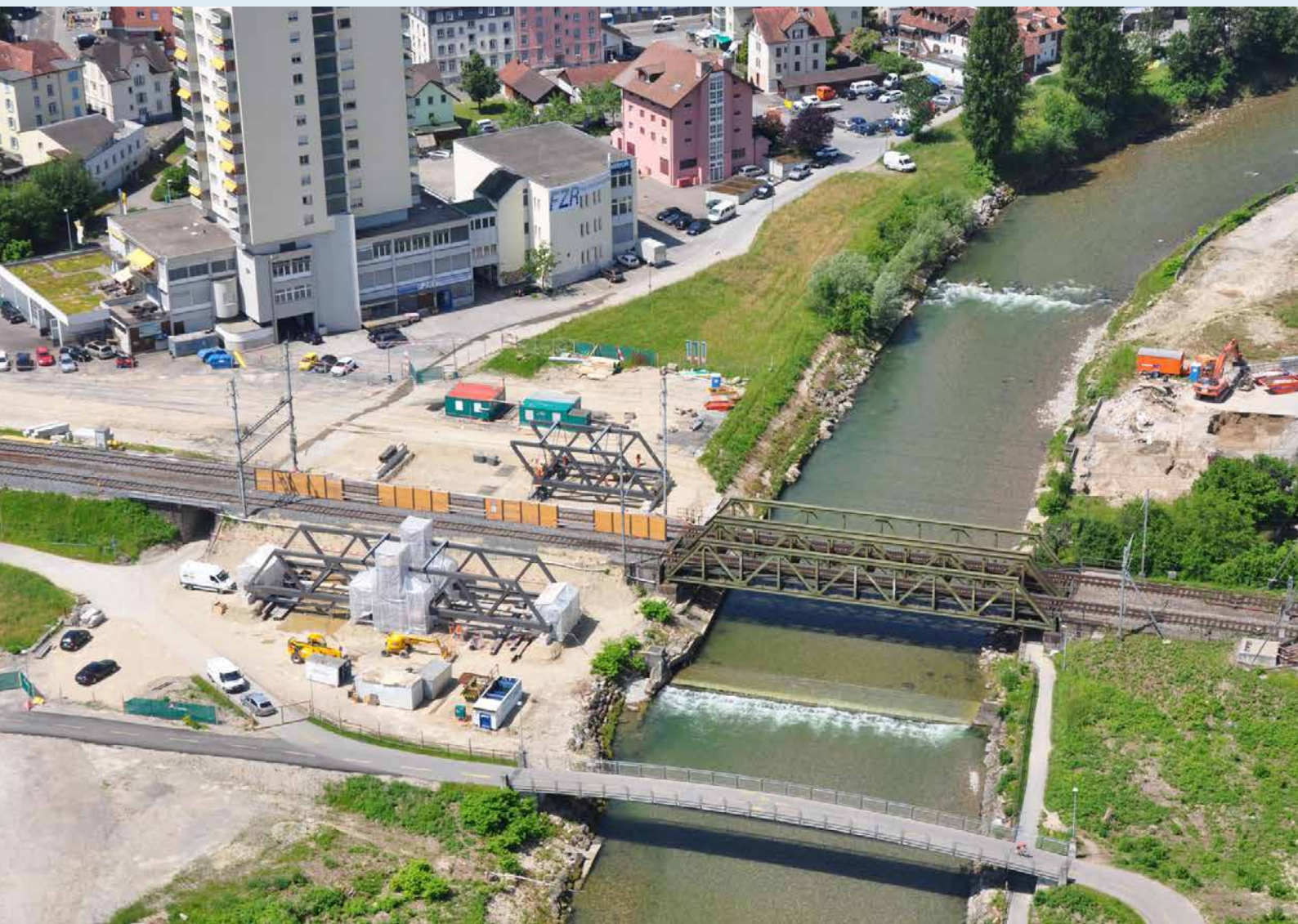


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For the environment's sake

The benefits of carbon dioxide

Government requirements and stricter audits by the authorities reflect the desire of large sections of the population to protect the environment. This means that only wastewater with a pH which is close to neutral may be discharged into the receiving channel or sewerage system.

In the SOLVOCARB® process, the environmental friendly gas carbon dioxide (CO₂) is used to neutralise alkaline wastewater. When dissolved in water, carbon dioxide acts as carbonic acid and reduces the pH to the required value. Carbon dioxide has multiple advantages over mineral acids. For instance, it prevents chlorides, sulphates or other salts from being deposited in the wastewater. Furthermore, it is almost impossible for the wastewater to become too acidic thanks to carbon dioxide's flat neutralisation curve. Using carbon dioxide is also much safer than handling aggressive acids and corrosion problems are largely avoided.

Neutralising alkaline wastewater with carbon dioxide

Carbon dioxide supply

The carbon dioxide (CO₂) is obtained from natural sources or industrial waste gases and subjected to a cleaning process. It is supplied in cylinders or racks in situations where less gas is required. Additional electric heating is needed for a continuous flow of carbon dioxide if external temperatures are below freezing. Carbon dioxide can also be reordered automatically via the supply equipment's monitoring systems, meaning that repeat orders no longer need to be placed manually.

Sectors which produce alkaline wastewater

- Construction sites
- Cement and concrete industry
- Textile industry (laundries and dyehouses)
- Chemical and pharmaceutical industry
- Paper and pulp industry
- Electroplating (surface treatment of metals)
- Leather processing
- Beverage industry (bottle cleaning)
- Dairies and butchers
- Bakeries and confectioners

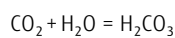
Benefits

- Carbon dioxide is a natural gas
- No statutory charges for increased salinity
- Equipment lasts longer thanks to reduced corrosion
- Wastewater does not become too acidic
- Little space and few staff required
- Low maintenance and operating costs
- Easy to store in sealed pressure vessels

Mode of action of carbon dioxide

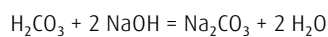
Mode of action of the neutraliser carbon dioxide

In aqueous solution, carbon dioxide is mainly present in the form of a dissolved gas. Small amounts are chemically converted into carbonic acid according to the following formula.



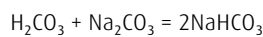
If the pH is greater than 9, carbonic acid dissociates to produce two protons, which are released for neutralisation. Only one proton is produced if the pH is less than 9. Although neutralisation occurs in a continuous process, it can be divided into three stages in terms of the chemistry:

Stage 1: (pH > 11,80)



Here the carbonate ion (CO_3^{2-}) is almost exclusively present.

Stage 2: (8,30 < pH < 11,80)

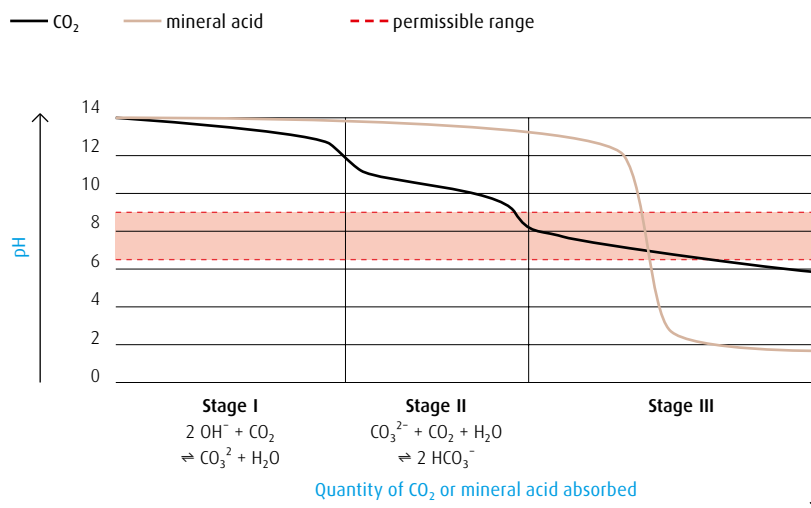


The proportion of hydrogen carbonate (HCO_3^-) rises as the pH drops.

Stage 3: (pH < 8,30)

In the third stage, the proportion of free, dissolved carbon dioxide increases constantly. The neutralisation curve flattens out. Below pH 5, physically dissolved carbon dioxide is almost exclusively present. The third stage is not usually reached as the legally required pH is higher.

Neutralisation curves of sodium hydroxide with carbon dioxide and a mineral acid



The amount required for neutralisation often differs from the stoichiometric quantities shown in the table below because most wastewater contains buffer substances which increase the quantity of acid needed. It is usually easiest to determine precise requirements by conducting tests on site.

Stoichiometric conversion for the neutralisation of unbuffered sodium hydroxide using different acids, e.g. at pH 8,50 (30 % HCl; 96 % H₂SO₄; 65 % HNO₃)

pH	NaOH (kg/m ³)	CO ₂ (kg/m ³)	HCl (kg/m ³)	H ₂ SO ₄ (kg/m ³)	HNO ₃ (kg/m ³)
10	0,004	0,004	0,012	0,005	0,01
10,50	0,013	0,014	0,038	0,016	0,031
11	0,04	0,044	0,12	0,05	0,10
11,50	0,13	0,14	0,38	0,16	0,31
12	0,40	0,44	1,22	0,51	0,97
12,50	1,30	1,39	3,84	1,60	3,10
13	4	4,40	12,20	5,10	9,70
13,50	12,60	13,90	38,40	16,10	30,70
14	40	44	122	51	97

Dimensioning of sedimentation and neutralisation tanks

Nowadays, building site managers are required by the government to comply with the environmental standards set out in the Swiss Water Protection Ordinance.

Building sites are to be drained in accordance with SIA (Swiss Society of Engineers and Architects) recommendation 431. In particular, introducing turbid or alkaline wastewater (containing cement) into any bodies of water, allowing alkaline wastewater to seep into the ground or discharging alkaline wastewater or wastewater contaminated with solids into a sewer (subject to the exceptions in accordance with SIA/VSA 431) is prohibited.

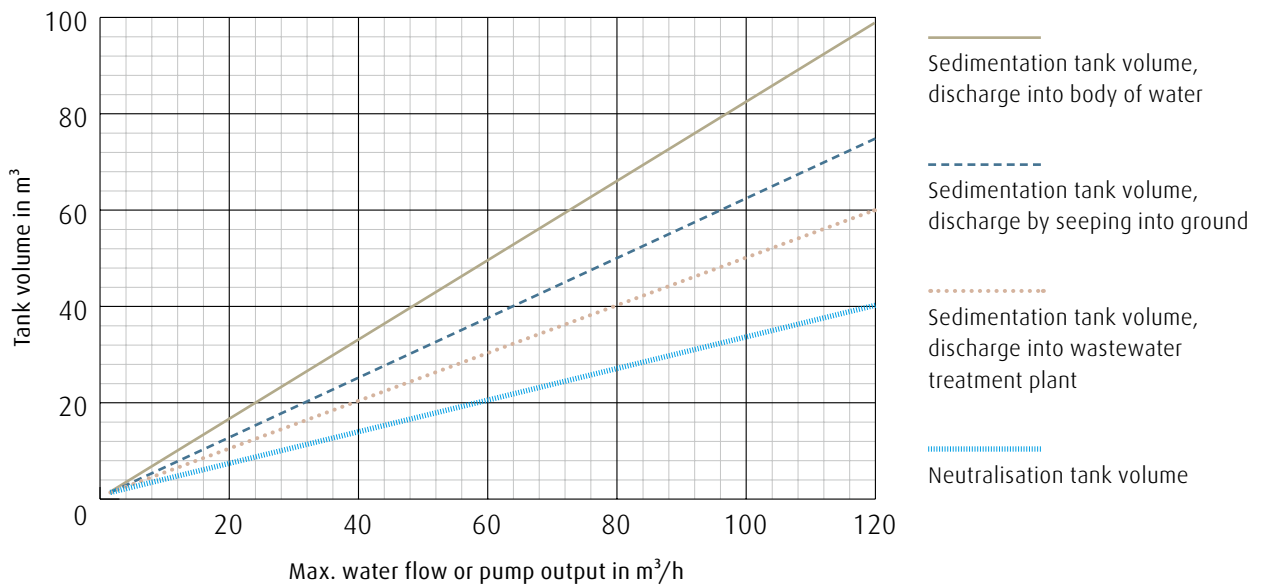
When discharging wastewater from building sites into the sewerage system, it is essential to clarify whether the sewer and wastewater treatment plant have sufficient capacity. A permit is also required to introduce wastewater to the sewerage system or to a body of water.

SIA 431 can be used as a guide for determining the size of the sedimentation container needed to process the alkaline wastewater as effectively as possible. This important aid helps construction companies by providing relevant calculation tools.

The table below shows the sedimentation container volume required for each discharge method (in accordance with SIA 431). It is also important to keep the speed of flow in the tanks as slow as possible to enable suspended material to settle as much as possible.

Based on experience, PanGas calculates the neutralisation volume with an average retention time of 20 minutes for the water in the neutralisation tank. The tank can therefore be designed for a third of the cubic volume which flows through per hour.

Tank volumes for water treatment in accordance with SIA 431, average retention time 20 min neutralisation, minimum tank water level 150 cm



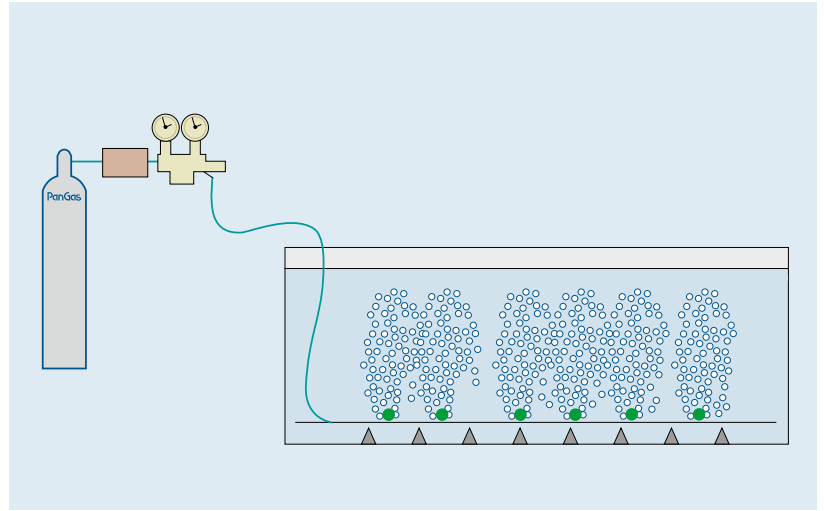
Features of the neutralisation systems

Technical data

	Compact Comfort	Mobil	Mobil Plus	Mini ME	Mini MD	Mini Pro	Combi
System output in m³/h (pH 12 to pH 7,5)	<30 *	<2	<10	<30 *	<100 *	<100 *	<100
Automatic CO ₂ dosage	●	●	●	●	●	●	●
Continuous water treatment	●	●	●	●	●	●	●
Integrated sedimentation tank		●	●				
Integrated neutralisation tank		●	●				●
Container for cylinders and system technology				●	●	●	●
Automatic gas switching					●	●	●
pH measurement	●	●	●	●	●	●	●
Final pH test	Option	Option	Option	Option	Option	Option	Option
Conductivity measurement						Option	
Turbidity measurement						Option	
Water amount measurement						Option	
Electrical pump control unit 380 V → 220 V	Option	Option	Option	Option	Option	●	●
SMS, pH and gas switching alerts	Option	Option	Option	Option	Option	●	Option
Automatic gas ordering					Option	Option	Option

* Depends on the useful volume of the neutralisation tank and the gas supply output

SOLVOCARB® Compact



Brief description

- Manually operated system for neutralisation handled in batches
- No integrated neutralisation tank – to be installed separately

Areas of application

- Building sites with small quantities of wastewater handled in batches (e.g. wash water)

Output overview

- For small quantities (approx. 20 m³/day)
- Manual CO₂ dosage

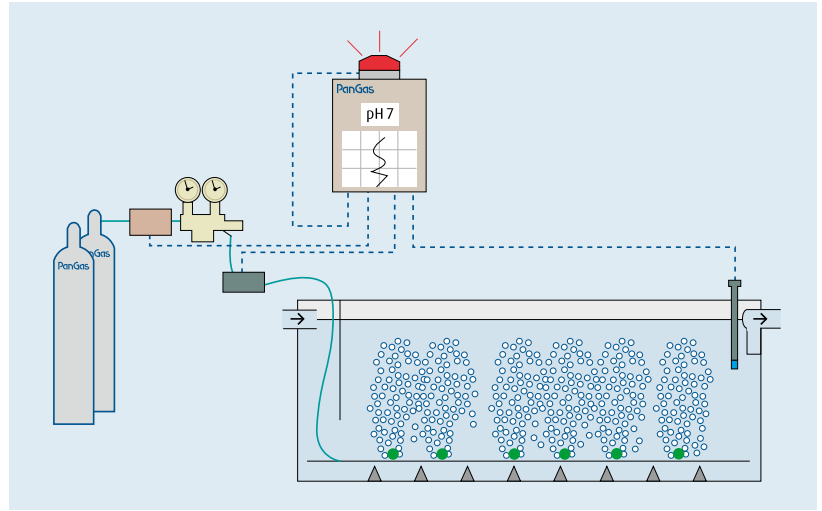
Technical information

Electrical connections: input 230 V
Power consumption: 200 W gas preheater

Note:

- System available from all Gas & More retail stores

SOLVOCARB® Comfort



Example of application with the ANB Vario tank



Brief description

- Upgrade for a purchased SOLVOCARB® Compact system for automatic operation
- Automatic system for a small to medium rate of neutralisation capacity
- Neutralisation tank to be provided on site

Areas of application

- Building sites with small to medium wastewater quantities

Output overview

- Up to a maximum of 30 m³/h can be neutralised from pH 12 to pH 7,50 depending (depending on the volume of the neutralisation tank)
- Continuous water treatment
- pH measurement and recording
- Automatic CO₂ dosage

Options

- Final pH test with recording
- SMS alert
- Electrical pump control unit 380 V → 220 V

Technical information

Control cabinet dimensions: 0,25 × 0,30 × 0,50 m (L × W × H)

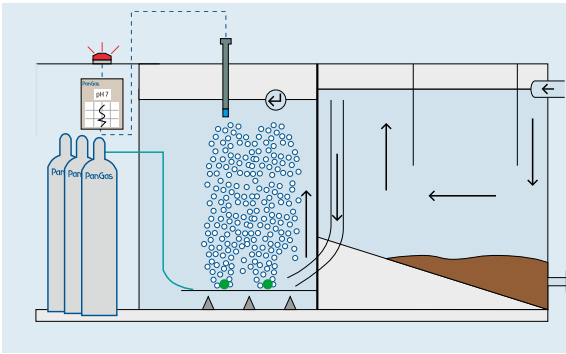
Electrical connections: input 230 V; one 230 V socket for the pump and one for the flashing alarm light (max. 11 A)

Power consumption: 300 W (without pump)

Notes:

- The system comprises the SOLVOCARB® Compact system already purchased for manual operation and the SOLVOCARB® Comfort control element
- The control cabinet and gas supply can be installed in a wooden crate or similar small container provided on site (to improve weatherproofing and protect them from unauthorised access by third parties)
- The need to use a sedimentation tank before the neutralisation process must be assessed on a case-by-case basis

SOLVOCARB® Mobil



Brief description

- Compact automatic system that is easy to transport
- Integrated sedimentation and neutralisation tanks

Areas of application

- Building sites with very small quantities of wastewater such as those performing concrete repair, drilling, milling and removal with ultra-high-pressure water

Output overview

- Flow rate
 - max. 4,2 m³/h (discharge into the treatment system)
 - max. 2,5 m³/h (discharge into surface waters)
 - max. 3,3 m³/h (infiltration)

- Continuous water treatment
- pH measurement and recording
- Automatic CO₂ dosage
- Semi-open compartment on the front for three cylinders and the system controls
- Manual switching to the gas reserve

Options

- Final pH test with recording
- SMS alert
- Electrical pump control unit 380 V → 220 V

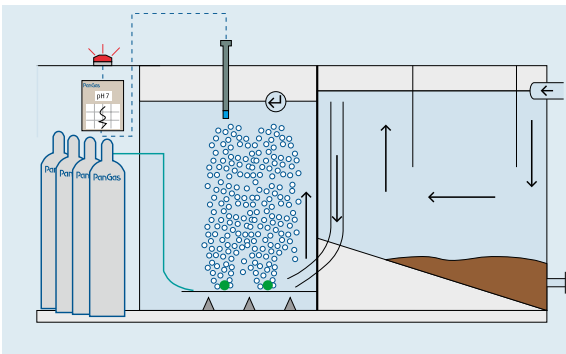
Technical information

System dimensions:	2,60 × 1,00 × 1,80 m (L × W × H)
Weight:	590 kg (without gas cylinders)
Operating weight:	2600 kg incl. three gas cylinders
Volume:	Sedimentation tank 1,40 m ³ , neutralisation tank 0,60 m ³
Electrical connections:	input 230 V; one 230 V socket for the pump (max. 11 A) and one for the flashing alarm light
Power consumption:	300 W (without pump)

Note:

- The need to use a sedimentation tank before the neutralisation process must be assessed on a case-by-case basis

SOLVOCARB® Mobil Plus



Brief description

- Compact automatic system that is easy to transport
- Integrated sedimentation and neutralisation tanks

Areas of application

- Building sites with very small quantities of wastewater such as those performing concrete repair, drilling, milling and removal with ultra-high-pressure water
- Linear building sites which are moved frequently

Output overview

- Flow rate
 - max. 5,3 m³/h (discharge into the treatment system)
 - max. 3,2 m³/h (discharge into surface waters)
 - max. 4,2 m³/h (infiltration)

- Continuous water treatment
- pH measurement and recording
- Automatic CO₂ dosage
- Semi-open cabinet on the front for four cylinders and the system controls
- Manual switching to the gas reserve

Options

- Final pH test with recording
- SMS alert
- Electrical pump control unit 380 V → 220 V

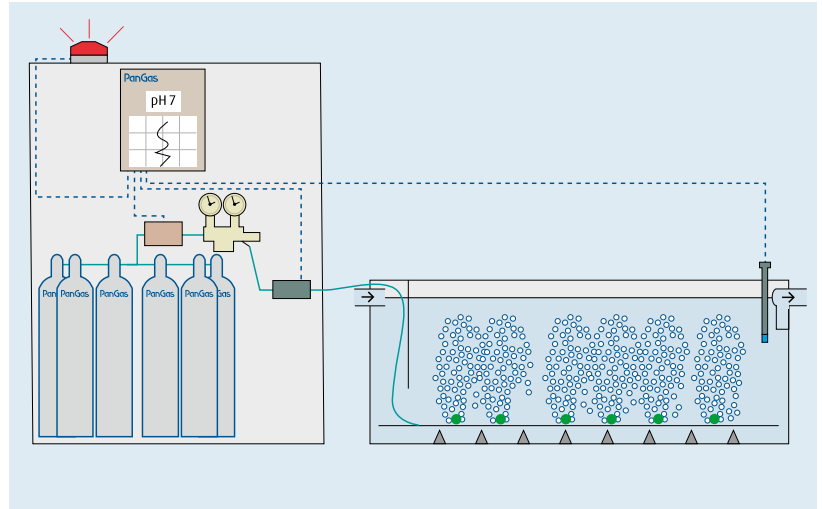
Technical information

System dimensions:	3,10 × 1,52 × 2,10 m (L × W × H)
Weight:	760 kg (without gas cylinders)
Operating weight:	8600 kg incl. four gas cylinders
Volume:	Sedimentation tank 4,90 m ³ , neutralisation tank 2,50 m ³
Electrical connections:	input 230 V; one 230 V socket for the pump (max 11 A) and one for the flashing alarm light
Power consumption:	300 W (without pump)

Note:

- The need to use a sedimentation tank before the neutralisation process must be assessed on a case-by-case basis

SOLVOCARB® Mini ME



Brief description

- Automatic system with a medium rate of neutralisation capacity
- Lockable container for six cylinders with controls
- Neutralisation tank to be provided on site

Areas of application

- Building sites with small to medium wastewater quantities
- Building sites without perimeter fencing in public places with little space available

Output overview

- Up to a maximum of 30 m³/h can be neutralised from pH 12 to pH 7,50 (depending on the volume of the neutralisation tank and the length of the gas supply hose installed)
- Continuous water treatment
- pH measurement and recording
- Automatic CO₂ dosage
- Manual switching to the gas reserve

Options

- Racks can be connected outside the container
- Final pH test with recording
- SMS alert
- Electrical pump control unit 380 V → 220 V

Technical information

Control container dimensions: 1,45 × 1,50 × 2,40 m (L × W × H)

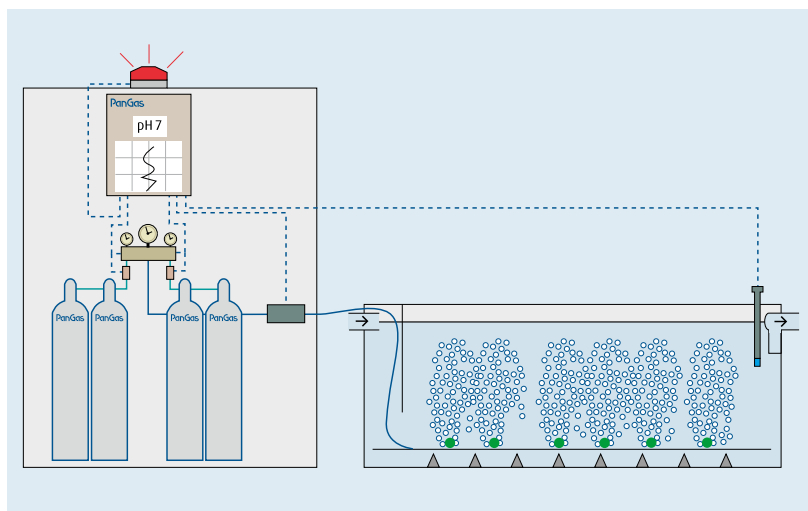
Electrical connections: input 230 V; one 230 V socket for the pump (max. 11 A) and one for the flashing alarm light

Power consumption: 300 W (without pump)

Note:

- The need to use a sedimentation tank before the neutralisation process must be assessed on a case-by-case basis

SOLVOCARB® Mini MD



Brief description

- Automatic system with a medium to high rate of neutralisation capacity
- Lockable container for four cylinders with controls
- Neutralisation tank to be provided on site

Areas of application

- Building sites with medium to large wastewater quantities
- Building sites without perimeter fencing in public places with little space available

Output overview

- 30 m³/h to max. 100 m³/h can be neutralised from pH 12 to pH 7,50 (depending on the volume of the neutralisation tank and the length of the gas supply hose installed)
- Continuous water treatment
- pH measurement and recording
- Automatic CO₂ dosage
- Automatic switching to the gas reserve

Options

- Racks can be connected outside the container
- Final pH test with recording
- Automatic gas reordering
- SMS alert
- Electrical pump control unit 380 V → 220 V

Technical information

Control container dimensions: 1,45 × 1,50 × 2,40 m (L × W × H)

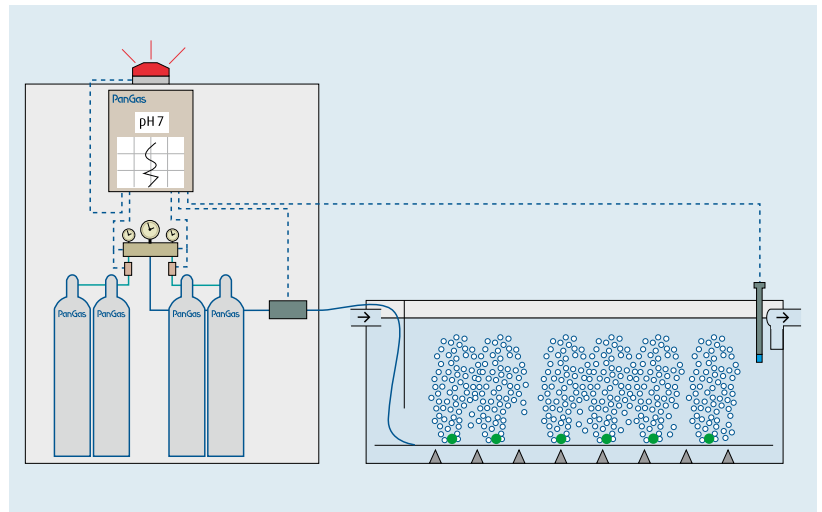
Electrical connections: input 230 V; one 230 V socket for the pump (max. 11 A) and one for the flashing alarm light

Power consumption: 300 W (without pump)

Note:

- The need to use a sedimentation tank before the neutralisation process must be assessed on a case-by-case basis

SOLVOCARB® Mini Pro



Brief description

- Automatic system with a medium to high rate of neutralisation capacity
- Lockable container for four cylinders with controls
- Neutralisation tank to be provided on site

Areas of application

- Building sites with medium to large wastewater quantities
- Building sites without perimeter fencing in public places with little space available
- Gas can be provided to two neutralisation tanks

Output overview

- 30 m³/h to max. 100 m³/h can be neutralised from pH 12 to pH 7,50 (depending on the volume of the neutralisation tank and the length of the gas supply hose installed)
- Continuous water treatment
- pH measurement and recording
- Automatic CO₂ dosage
- Automatic switching to the gas reserve
- SMS/e-mail alert of pH and gas switching
- Remote access to the system

Options

- Racks can be connected outside the container
- Final pH test with recording, conductivity measurement, turbidity measurement, water amount measurement
- Automatic gas reordering

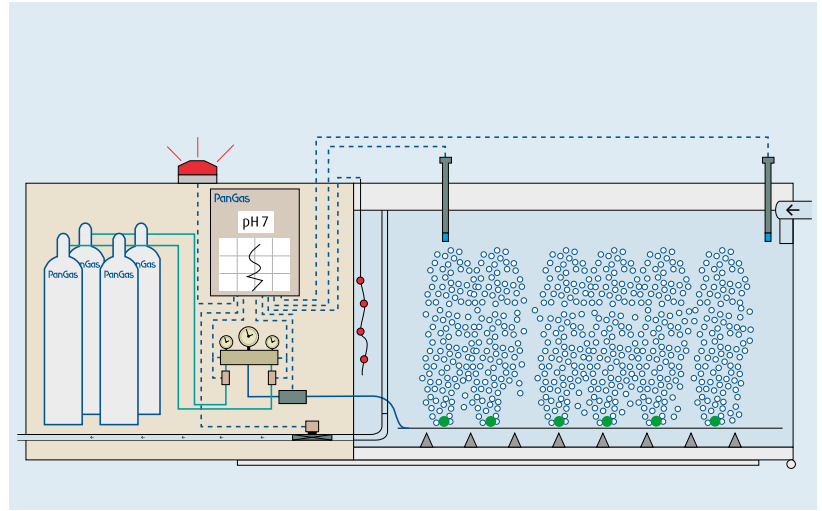
Technical information

Container system dimensions:	1,45 × 1,50 × 2,40 m (L × W × H)
Electrical connections:	input 230 V or 400 V 16 A (rotary field control integrated) one socket 230 V or 400 V for the pump (setting range motor protection switch 1,30 A–6,30 A)
Power consumption:	300 W (without pumps)

Note:

- The need to use a sedimentation tank before the neutralisation process must be assessed on a case-by-case basis

SOLVOCARB® Combi



Brief description

- Automatic system with a high rate of neutralisation capacity
- Integrated neutralisation tank (20 or 25 m³)
- Constructed as a «roll-away container» for quick positioning or moving (MULTILIFT)

Areas of application

- Linear building sites with large quantities of wastewater where the system is moved frequently
- Large building sites with little space available
- short-term emergency operations with large amounts of waste water

Output overview

- Up to a maximum of 100 m³/h can be neutralised from pH 12 to pH 7,50
- Continuous water treatment
- pH measurement and pH recording
- Automatic CO₂ dosage
- Automatic switching to the gas reserve

Options

- Racks can be connected outside the container
- Final pH test with recording
- Automatic gas reordering
- SMS alert

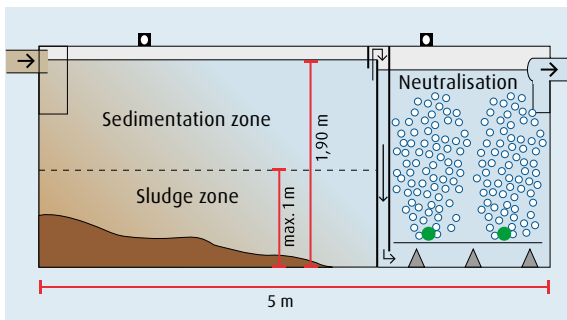
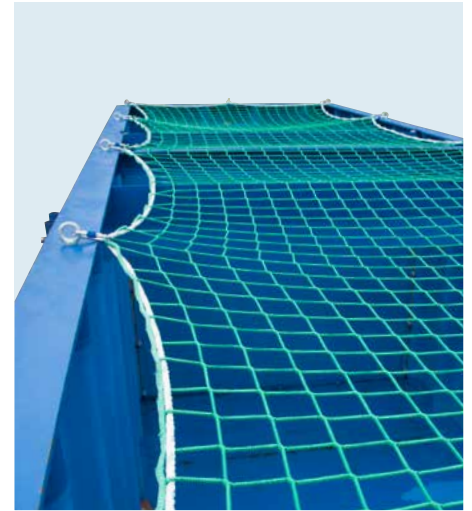
Technical information

Container system dimensions:	6,50×2,40×2,50 m (L×W×H)
Weight when empty/full:	5/30 t
Area required:	2,50×6,50 m
Electrical connections:	input 400 V 32 A; two sockets for pumps
Power consumption:	300 W (without pumps)

Note:

- The need to use a sedimentation tank before the neutralisation process must be assessed on a case-by-case basis

Sedimentation/neutralisation tank ANB Vario 23



Brief description

- Two-in-one sedimentation and neutralisation tank
- Size as recommended in SIA 431
- Safety net
- Removable baffle for use purely as a sedimentation or neutralisation tank

Areas of application

- Building sites with alkaline water contaminated with suspended material
- Building sites with little space available

Output overview

- Flow rate max. 23 m³/h (discharge into the treatment system)
- max. 14 m³/h (discharge into surface waters)
- max. 18 m³/h (infiltration)

Options

- Washing area with railings
- Available with all SOLVOCARB® systems

Technical information

Volume	23 m ³
Length	5 m
Width	2,40 m
Height	2,10 m
Weight	app. 3500 kg
Input connections	2 × Storz NW 75
Output connection	1 × ø 159 mm

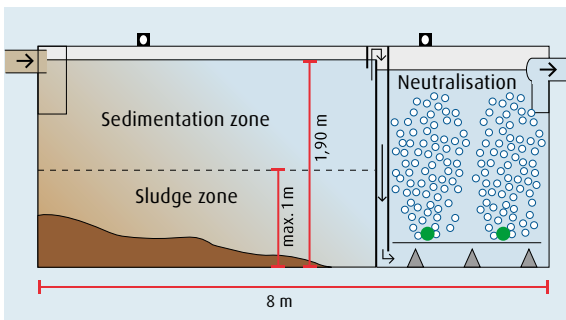
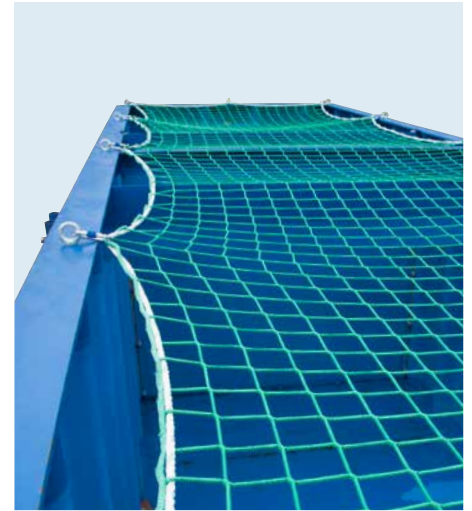
Note:

- Other tank sizes available upon enquiry
- Pre-installed gas supply hose

Example of application with washing area with railings



Sedimentation/neutralisation tank ANB Vario 35



Brief description

- Two-in-one sedimentation and neutralisation tank
- Size as recommended in SIA 431
- Safety net
- Removable baffle for use purely as a sedimentation or neutralisation tank

Areas of application

- Building sites with alkaline water contaminated with suspended material
- Building sites with little space available

Output overview

- Flow rate max. 35 m³/h (discharge into the treatment system)
- max. 21 m³/h (discharge into surface waters)
- max. 28 m³/h (infiltration)

Options

- Washing area with railings
- Available with all SOLVOCARB® systems

Technical information

Volume	35 m ³
Length	8 m
Width	2,40 m
Height	2,10 m
Weight	app. 4600 kg
Input connections	2 × Storz NW 75
Output connection	1 × ø 194 mm

Note:

- Other tank sizes available upon enquiry
- Pre-installed gas supply hose

Example of application with washing area with railings



Safety instructions for handling carbon dioxide

Hazards associated with gaseous CO₂

Risk of suffocation/CO₂ poisoning

- Gaseous CO₂ displaces oxygen and has a narcotic effect. The maximum workplace concentration (MAK) is therefore 5000 ppm (0,50 vol.%).
- With a concentration of 10 vol.% CO₂ in the air, the oxygen content is still a sufficient 19 vol.%. However, at this concentration of CO₂, cramps, fainting, respiratory arrest and death can occur. In this case, the cause is not oxygen displacement, but rather carbon dioxide directly intervening in people's breathing process.
- By means of sufficient ventilation (natural or artificial) and/or by CO₂ monitoring, this hazard can be minimised.

A frequent mistake is only measuring the oxygen content and not the carbon dioxide concentration. With CO₂, such a mistake can be fatal.

CO₂ accumulations

- As a result of the high specific weight of the gas (1,50 times heavier than air), emerging CO₂ can accumulate in lower spaces, cavities or depressions. A critical carbon dioxide concentration can thus accumulate unnoticed and remain for a relatively long period of time.
- Carbon dioxide must not be stored or used in poorly ventilated rooms (e.g. cellars).
- In mechanical ventilation systems, the extraction must take place at ground level.

Gaseous carbon dioxide

CO₂ cylinder for extracting gas (without a rising pipe)

In the case of a CO₂ cylinder without a rising pipe, carbon dioxide is extracted directly from the head of the gas cylinder. When the cylinder valve is opened, the pressure in the gas cylinder decreases. CO₂ continuously evaporates from the liquid phase and is discharged in the form of a gas.

The following points must be taken into consideration when using gaseous CO₂:

- CO₂ cylinders without a rising pipe must be operated with a pressure regulator for gas extraction in order to reduce the pressure to the measurement permitted for the intended use.
- CO₂ cylinders without a rising pipe must also be operated upright for gas extraction. Liquid CO₂ would be discharged from a horizontal cylinder, which could lead to the extraction device being clogged by CO₂ snow.
- The speed of extraction from CO₂ cylinders without a rising pipe is limited because the CO₂ has to evaporate from the liquid phase. For this purpose, heat is absorbed from the environment, that is to say that the gas cylinder and in particular the valve can freeze over as a result of the cooling. The operability of the valve is thus compromised. To avoid this, when more CO₂ is required, multiple gas cylinders are to be operated in parallel, or the gas cylinder is to be heated with warm water (no higher than 50 °C). Under no circumstances should the gas cylinder be heated with a flame.

Measures in the workplace

The following safety measures are advisable:

- Inform your colleagues of the particular hazards associated with CO₂.
- Colleagues who work in the area of CO₂ applications are to be provided with appropriate training and instructions so that these alerts and detections can be interpreted correctly.
- Create a detailed job description and hazard analysis for areas in which carbon dioxide is used.
- CO₂ systems are to be kept leak-proof, any leaks are to be sealed immediately.
- CO₂ waste gases from an application technology system or from a safety valve are to be discharged into the atmosphere.
- Rooms with CO₂ systems must have effective ventilation, especially at lower levels. These ventilation systems must be regularly monitored and maintained.
- In rooms with CO₂ systems, a carbon-dioxide monitoring and alert system is to be installed. The monitoring and alert systems are to be monitored regularly, and maintenance is to be carried out periodically by the installation company.
- When CO₂ is suddenly discharged, low-down spaces/rooms (pits, cellars) in particular must be evacuated immediately, since the risk of CO₂ accumulation is particularly high there.
- Rooms in which relatively large amounts of CO₂ have accumulated may be entered only when using a self-contained breathing apparatus. This applies even when people in the room have been in an accident and require urgent assistance.

- Stationary CO₂ extinguishing systems may be used for testing or in an emergency only when there are no people in the area at risk. If the carbon dioxide can reach other rooms through ducts, wall openings, ventilation or air-conditioning systems, these rooms are also part of the area at risk.

Conclusion

The safety data sheets (SDS) provide information about the safety-related properties of carbon dioxide. PanGas AG is available to answer any additional questions that you may have.

Carbon dioxide does «not only cause suffocation», carbon dioxide poisoning can occur even when there is still sufficient oxygen in the ambient air.

Scope of application/delimitation

This document replaces the existing IGS safety instructions «Sicherheit im Umgang mit Trockeneis» («Safety when handling dry ice») IGS-TS-009 / 06. The area of application of these safety instructions includes compressed gas containers (gas cylinders) and cryogenic containers, which are used as transport and storage containers for gases. This documentation cannot be used for gas tanks.

Further documents (not exhaustive)

- SUVA publication entitled «Grenzwerte am Arbeitsplatz» («Limit values in the workplace») No. 1903.d
- EIGA safety information «Carbon dioxide physiological hazards» No. 24/11/E

List of sources:

- IGS safety instructions «A07 Umgang mit Kohlendioxid» («Handling carbon dioxide»)
- PanGas safety information «Umgang mit Kohlendioxid»

Getting ahead through innovation

PanGas, a subsidiary of the global leader Linde Group, is playing a pioneering role in the global market with its future-oriented product and gas supply concepts. As a technology leader, our task is to constantly raise the bar. Driven by our entrepreneurial spirit, we are constantly working on new high-quality products and innovative processes.

PanGas offers more. We create added value, clearly discernible competitive advantages, and greater profitability. Each concept is tailored specifically to meet our customers' requirements – offering standardized as well as customized solutions. This applies to all industries and all companies regardless of their size.

If you want to keep pace with tomorrow's competition, you need a partner by your side for whom top quality, process optimization, and enhanced productivity are part of daily business. However, we define partnership not merely as being there for you but being with you. After all, cooperation forms the core of commercial success.

PanGas – ideas become solutions.