

Innovative aquaculture products and solutions.

Product portfolio.



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SOLVOX® is The Linde Group’s registered trademark for water oxygenation equipment.

Who are we?

The Linde Group is a globally leading supplier of industrial gases. Our customers are the manufacturing industry, as well as the food, process and oil industries. We also provide speciality gases for laboratories, and medical gases for hospitals. The Linde Group, a world-leading gas and engineering company with over 60,000 employees is present in around 100 countries all over the world.

The Linde Group has located its international Innovation Centre for Aquaculture and Water Treatment in Ålesund, Norway. This is where

the products and solutions offered to fish farming and aquaculture, nationally and internationally, are developed and enhanced.

BOC is a member of The Linde Group and utilises the significant knowledge that has been developed globally over a number of years to offer optimum solutions locally.



The Linde Group’s innovation centre for aquaculture and water treatment, in Aalesund – Norway

BOC and aquaculture.

The global demand for fish products has doubled over the last 50 years. Today, more than 45% of the world's seafood comes from land- or offshore-based fish farms. These fish farms cultivate fresh water or marine species in controlled environments. These facilities face the challenge of maintaining optimum fish farming conditions: appropriate nutrition, prevention of diseases and maintaining a stable and healthy aquatic environment. The most important factor to ensure healthy fish is a constant supply of fresh, clean water. Controlling the oxygen concentration in the water is therefore, of vital importance to the fish farm.

Maintaining the right oxygen level in the water improves feed utilisation, reduces the growth period and fish mortality. Appropriate use of oxygen will significantly enhance the fish farm's financial viability and provide additional production stability. With the SOLVOX® product line, Linde offers the right solution to meet these specific needs. SOLVOX® comprises a variety of oxygen dissolution and distribution products and systems.



The best technology comes from the new Innovation Centre for Aquaculture and Water Treatment.

The Linde Group is the leader within oxygenation technology for fish farming. We have worked with fish farming since the early days of this industry. Our extensive experience and ongoing research and development allow us to deliver the latest technology and know-how to our customers.

Fish farms are growing larger and more complex, and the trend is for more farming to take place onshore, or in closed systems. The new Innovation Centre for Aquaculture and Water Treatment is our basis for developing gas technology for the aquaculture of the future. Advanced oxygenation solutions will be key to the development of the sustainable aquaculture of the future. With SOLVOX® oxygenation solutions, BOC provides a wide range of products to ensure an optimum tank environment. The products and solutions are designed for high energy efficiency, good oxygen utilisation, operational reliability and optimum hydrodynamic conditions inside the tank.

The centre is built to conduct trials with sea water, fresh water and brackish water. The same applies to testing involving the recirculation, through-flow or heating of water. Any water quality that a fish farmer might normally encounter in a fish hatchery or fish farm can be simulated here.

The Linde Group's Innovation Centre for Aquaculture and Water Treatment is also used for training activities. Our customers can view demonstrations and presentations of our products and solutions. Our own employees from Norway and abroad attend courses on a regular basis. BOC's service technicians receive product updates, ensuring that service agreements with our customers are performed correctly and professionally. There is also close cooperation with BOC's training department, whose programme includes gas safety courses for our customers at hatcheries and fish farms.



Technical hall at innovation centre in Aalesund

SOLVOX® product line.

The SOLVOX® product line offers a wide range of oxygenation systems for the aquaculture industry. The SOLVOX® family comprises equipment for optimised dissolution of oxygen in water, perfect distribution of oxygenated water to the fish, and dose adjustment applications for smooth and reliable operation. With the SOLVOX® line, we can serve all types of aquaculture facilities.

SOLVOX® A: Low-pressure oxygen dissolver for salt water and brackish water

SOLVOX® A, patented by BOC, is a flexible dissolving unit that is usually integrated within the pipe installation, in order to oxygenate the entire water flow entering the tank. In larger tanks, more than one SOLVOX® A unit can be installed, to achieve optimum distribution of the dissolved oxygen. SOLVOX® A is easy to install and combines high oxygenation efficiency with low energy demand.

The unique structure of SOLVOX® A removes nitrogen from the water, while adding oxygen. This is important, since fish are sensitive to nitrogen supersaturation. It is recommended to supplement a SOLVOX® A installation with a SOLVOX® Stream device.



SOLVOX® A product line



Installation SOLVOX® A

Available sizes SOLVOX® A

| Product | Nominal water flow [l/min] | Oxygenation capacity* [kg/h] | Length [mm] | Pipe diameter [mm] |
|----------------|----------------------------|------------------------------|-------------|--------------------|
| SOLVOX® A 6 | 100 | 0.23 | 300 | 50 |
| SOLVOX® A 9 | 150 | 0.36 | 350 | 63 |
| SOLVOX® A 15 | 250 | 0.55 | 300 | 63 |
| SOLVOX® A 24 | 400 | 0.94 | 400 | 90 |
| SOLVOX® A 33 | 550 | 1.30 | 350 | 90 |
| SOLVOX® A 45 | 750 | 1.70 | 450 | 110 |
| SOLVOX® A 54 | 900 | 2.10 | 400 | 110 |
| SOLVOX® A 150 | 2,500 | 6.60 | 500 | 160 |
| SOLVOX® A 175 | 3,000 | 7.20 | 700 | 200 |
| SOLVOX® A 250 | 4,000 | 9.50 | 800 | 250 |
| SOLVOX® A 400 | 7,000 | 16.0 | 850 | 280 |
| SOLVOX® A 1100 | 18,000 | 36.0 | 1100 | 400 |

* At a pressure drop of 2m water column and 15°C water temperature.

SOLVOX® OxyStream low-pressure oxygen dissolver.

SOLVOX® OxyStream is a low-pressure oxygenation system for sea-water, brackish water and fresh-water tanks. The system is a patented all-in-one product that both oxygenates and sets the flow in the tank. The product is equipped with an integrated water flow indicator that gives an overview of each tank’s water consumption.

SOLVOX® OxyStream is mounted inside the fish tank. The design of the patented solution allows that, even for the largest units, the water circulation in the tank can be adjusted easily by rotating the external pipe.

The microbubbles produced in SOLVOX® OxyStream are active in both the inflow pipe and the tank. This reduces the nitrogen and the total gas pressure in the water, which reduces or even removes the need for external degassing of the water source.

SOLVOX® OxyStream is installed easily by connecting it to the water inlet pipe and fixing the unit to the bottom of the tank. A retrofit to existing tanks is therefore very simple and cost efficient. SOLVOX® OxyStream is designed to achieve stable operation and requires minimal maintenance, reducing operating costs. If there is a high water

requirement or high variation in the water flow, it can be an advantage to use two dissolver units per tank.

SOLVOX® OxyStream is fully effective from a salinity of approximately 15 per mill, and normally only requires a pressure of between 0.05 and 0.2 bar to oxygenate, strip the nitrogen, and create optimal hydrodynamic conditions inside the tank, matched to the facility’s production. The low pressure requirement means that external pumps or extra energy for oxygenation and degassing of the water are normally not required. In fresh-water installations, SOLVOX® OxyStream is normally used for supplementary oxygenation of the water, in combination with SOLVOX® C.

SOLVOX® OxyStream can be adapted to most tank sizes in the market today, and covers water flows from 100 l/min to 20,000 l/min per intake.

Linde recommends that an installation with SOLVOX® OxyStream is supplemented with a SOLVOX® F gas dosaging cabinet, for optimum operation and oxygenation. SOLVOX® F can be easily connected to the facility’s existing control system, for automatic oxygen dosing.



SOLVOX® OxyStream



SOLVOX® OxyStream in operation

SOLVOX® C oxygenation cone.

SOLVOX® C is an oxygenation cone, mainly used for fresh water. On standard operation, the oxygenation efficiency is close to 100%. The operation of the cone is simple: as water and gas enter from the top, the water jet forces the water to mix intensively with the oxygen bubbles.

As the cone widens, the velocity is reduced. Small gas bubbles that are not yet fully dissolved rise in the cone against the downward water flow, so only water free of gas bubbles leaves the cone at the bottom. It is important that there is sufficient pressure in the downstream pipe network to ensure that the oxygen remains dissolved up to the tank.

Since the SOLVOX® C cone is operated at elevated pressure, the dissolved oxygen concentration can be increased significantly above normal saturation level. Thanks to their high reliability, efficiency and simple installation, oxygenation cones are used widely in aquaculture. SOLVOX® C cones are made from fibreglass-reinforced plastic (GRP) and are provided with CE certification mark.

Technical data

| | SOLVOX® C 60 | SOLVOX® C 110 |
|-------------------------------------|--------------|---------------|
| Water flow | 60 m³/h | 110 m³/h |
| Inlet and outlet connection | DN 100 | DN 150 |
| Max. working pressure | 3.8 bar (g) | 3.0 bar (g) |
| Max. oxygen dosing capacity at 10°C | 6.3 kg/h | 9.4 kg/h |
| | 8.9 kg/h* | 12.9 kg/h* |

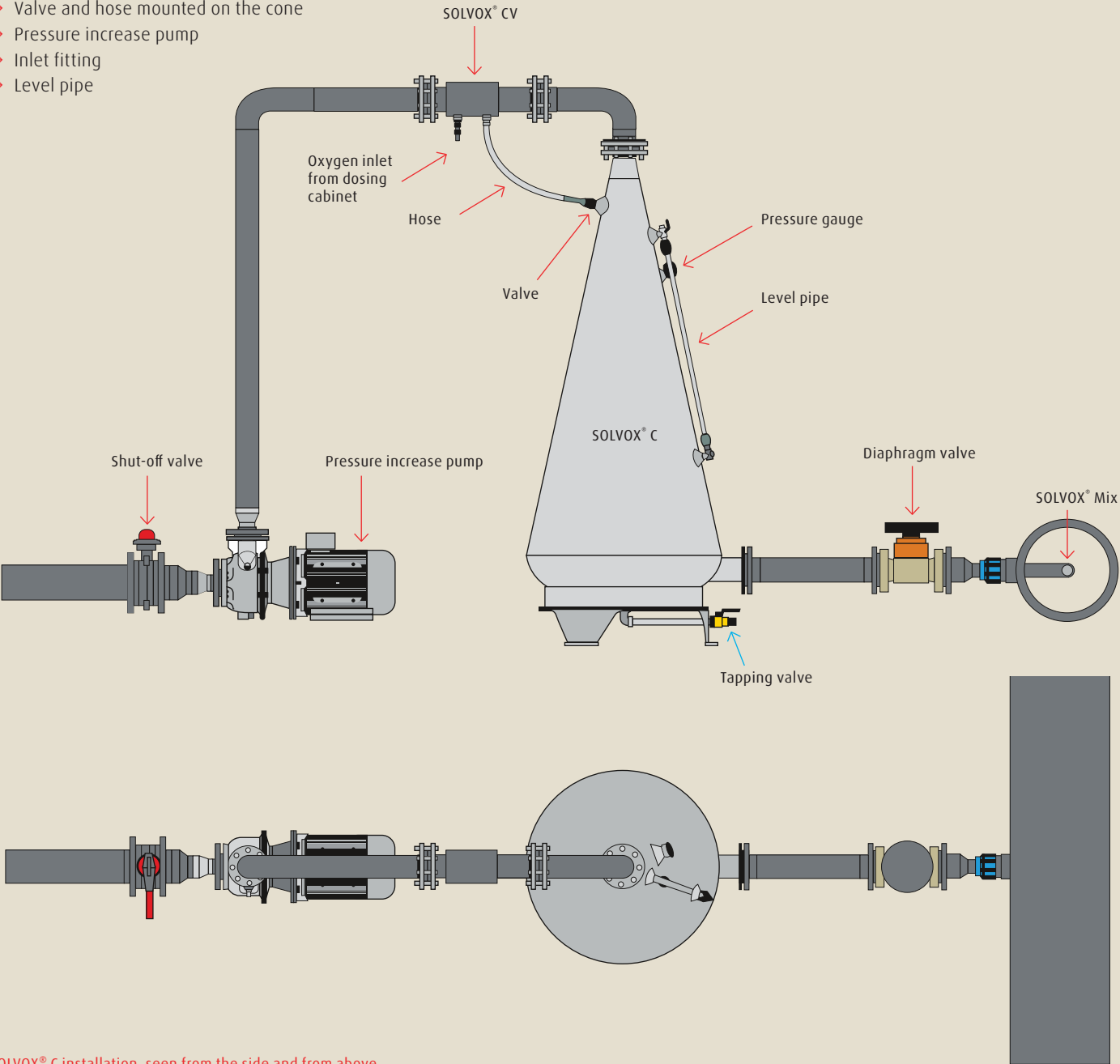
* including SOLVOX® CV



SOLVOX® C

A complete SOLVOX® C installation consists of:

- SOLVOX® CV installed on the inlet pipe
- SOLVOX® C oxygenation cone
- SOLVOX® Mix return to main water flow
- Valve and hose mounted on the cone
- Pressure increase pump
- Inlet fitting
- Level pipe



SOLVOX® C installation, seen from the side and from above

SOLVOX® C auxiliaries.

SOLVOX® CV

SOLVOX® CV is an additional system to boost the oxygenation capacity of SOLVOX® C cones, allowing up to 50% higher oxygen dosing capacity. SOLVOX® CV uses a venturi nozzle system to recirculate undissolved oxygen that collects in the top of the cone.

The installation can be performed without prolonged shutdown. The SOLVOX® CV is flanged directly onto the cone’s water feed pipe.



SOLVOX® CV

SOLVOX® Mix

SOLVOX® Mix is a specially-adapted nozzle unit used in combination with installations of SOLVOX® C oxygenation cone. It is used when pressurized, high-oxygenated water from SOLVOX® C is returned to a water flow at a lower pressure.

SOLVOX® Mix makes it possible to mix water with high oxygen concentration into a main water flow, without degassing and reduced efficiency. The unit is costed and specially adapted for each project and installation.

SOLVOX® Mix can be installed individually for each tank, or in the facility’s main water supply, providing basic oxygenation.

SOLVOX® Mix is normally part of a complete fresh-water oxygenation solution.



SOLVOX® Mix

SOLVOX® Stream flow distributor.

SOLVOX® Stream flow distributor for improved oxygen distribution and optimum hydrodynamic conditions in the tank

SOLVOX® Stream ensures that oxygenated water is homogeneously distributed throughout the fish tank’s water volume. It is designed to achieve an optimal circulation speed in the fish tank, depending on the fish species and fish size.

SOLVOX® Stream is used in combination with oxygenation equipment such as SOLVOX® A. This combination of equipment guarantees that the required environmental conditions in terms of hydrodynamic conditions and oxygen concentration can be set individually for each fish tank. SOLVOX® Stream is a customised product that can be adapted for required water flow rates ranging from 50 l/min to 20,000 l/min. For larger water flows, two or more inlets per tank are recommended, ensuring greater operating flexibility.

An important feature is the water flow indicator, which helps the fish farmer to control the water flow into each tank. Available water resources can thus be optimally utilised.

Standard sizes SOLVOX® Stream

| Product | Average water flow [l/min] | Diameter outer/ inner pipe [mm] |
|------------------|----------------------------|---------------------------------|
| SOLVOX® Stream 6 | 100 | 110/50 |
| SOLVOX® Stream 6 | 150 | 110/63 |
| SOLVOX® Stream 6 | 250 | 125/75 |
| SOLVOX® Stream 6 | 400 | 140/90 |
| SOLVOX® Stream 6 | 550 | 160/90 |
| SOLVOX® Stream 6 | 750 | 200/110 |
| SOLVOX® Stream 6 | 900 | 250/125 |
| SOLVOX® Stream 6 | 2500 | 280/160 |



SOLVOX® Stream installed in a tank

SOLVOX® B perforated hose.

The SOLVOX® B oxygenation hose is fixed on a support or a rack which is placed at the bottom of a tank. No auxiliary energy is required to operate SOLVOX® B. This qualifies SOLVOX® B as an emergency oxygenation system. When no oxygen addition is needed, the pores close tightly, so the hose remains ready for operation at any time.

The hose is highly-resistant to UV, and will therefore not become brittle due to sunlight exposure. It is flexible and therefore easy to work with, and also a low-cost, easy-to-install solution.



SOLVOX® B



SOLVOX® B in operation

SOLVOX® CD ceramic diffuser.

SOLVOX® CD ceramic diffuser stones are a well-known oxygen dissolver. The flat plate design ensures uniform bubbles across the entire surface and minimises bubble coalescence. SOLVOX® CD is mainly used for additional oxygenation and emergency oxygen supply.

SOLVOX® CD is delivered in cartons of 12 items.

| Specifications | |
|---------------------------------------|----------|
| Stone size (L x W) [mm] | 610 x 63 |
| Weight [kg] | 2.0 |
| Maximum working pressure [bar] | 3.0 |
| Maximum oxygen dosing capacity [kg/h] | 1.0 |



SOLVOX® CD



SOLVOX® CD in operation

SOLVOX® F oxygen dosing cabinet.

Fish grow best at a constant oxygen level in the tank, but the oxygen consumption varies with the stocking density, feeding regime, temperature, etc. In order to keep the oxygen level as constant as possible, different amounts of oxygen must be provided at different times.

The oxygen dosing cabinet is designed for precisely this purpose. There is emphasis on gas safety during construction, and use of approved components. The emergency oxygen function is integrated in the cabinet. In the event of a power outage the emergency solenoid valves will open automatically. The oxygen flow rates for each state are pre-set via dosing valves.

Increased safety with a back-up cabinet

Aquaculture is one of the industries that is most at risk in the event of oxygen supply problems. Production is becoming more and more intensive, which further increases this risk. Safety is therefore a key concern.

Should any problems occur with the oxygen distribution, the reaction time is short! Gas supply from a liquid oxygen tank is considered to be the safest gas supply method available. However, it is always advisable to have a backup solution in place to cover all eventualities. This is usually achieved by storing some compressed oxygen in cylinders or manifolded cylinder packs.

Guidelines for oxygen levels

| Oxygen saturation | Effect on salmonids (e.g. salmon, trout) |
|-------------------|--|
| 85 % | No indication of negative effect |
| 75 % | Reduction in appetite |
| 60 % | Negative impact on appetite, possible mortality |
| 40 % | No appetite and high mortality |
| 30% | Massive mortality |



SOLVOX® F cabinet with outlets to four tanks with operational and emergency oxygen supplies



SOLVOX® F provided with a separate pressure regulator, for emergency oxygenation



BOC – turning ideas into solutions

BOC is a member of The Linde Group, the leading global gases and engineering company. BOC is the UK's largest provider of industrial, specialist and medical gases, as well as related products and services. As a leader in the application of technology, we are constantly looking for new ways to provide our customers with high quality products and innovative solutions.

At BOC we help our customers to create added value, clearly discernible competitive advantage and hence greater profitability. To achieve this we have a comprehensive range of products and services, and technical support which can be customised to meet the individual requirements of our clients.

To keep ahead of the competition in today's market, you need a partner for whom quality, service, process and productivity optimisation are an integral part of customer support. We are there for you and with you, helping to build your success.

BOC's reputation has been forged through partnerships – with customers, with relevant regulatory authorities and with key suppliers. In this way, we deliver comprehensive and consistent benefits to you.

BOC – world-leading knowledge and resources adapted to local requirements.

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