

# Taking Oxygenation to a New Level.

Innovative aquaculture solutions.



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## Who we are

Messer is a global 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. Messer, a world-leading gases and engineering company with over 11,000 employees is present in Europe, Asia and the Americas.

## Messer and aquaculture

The global demand for fish products has doubled over the last 50 years. Today, more than 50% 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 utilization, shortens the growth period and reduces

fish mortality. Appropriate use of oxygen will significantly enhance the fish farm's financial viability and provide additional production stability. With the FARMOX™ water purifying product line, Messer offers the right solution to meet these specific needs. The FARMOX water purifying installation comprises a variety of oxygen dissolution and distribution products and solutions.

## Technology for aquaculture and water treatment

Messer 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. Advanced Oxygenation Solutions from Messer will be key to the development of the sustainable aquaculture of the future. With FARMOX oxygenation installations and solutions, Messer provides a wide range of products to ensure an optimum tank environment. The products and solutions are designed for high energy efficiency, good oxygen utilization, operational reliability and optimum hydrodynamic conditions inside the tank.



## FARMOX low pressure Venturi nozzle

The "FARMOX" series offers a wide range of oxygenation systems for the aquaculture industry, comprising equipment for optimised dissolution of oxygen in water, distribution of oxygenated water to the fish, and dose adjustment applications for smooth and reliable operation. Equipment can be designed and dimensioned for all types of aquaculture facilities.



FARMOX Venturi product series

### FARMOX Venturi: Low-pressure oxygen dissolver for salt water and brackish water

FARMOX low pressure Venturi dissolver is a patented, flexible dissolving unit, usually integrated into the pipe installation, that oxygenates the entire water supply to the tank. In larger tanks, more than one FARMOX low pressure Venturi dissolver unit can be installed in order to achieve optimum distribution of the dissolved oxygen. FARMOX low pressure Venturi dissolver is easy to install and combines high oxygenation efficiency with low energy requirements.

The unique structure of FARMOX low pressure Venturi dissolver removes nitrogen from the water while adding oxygen at the same time. This is important, as fish are vulnerable to nitrogen supersaturation. It is recommended that an installation using the FARMOX low pressure Venturi dissolver be supplemented with a FARMOX Stream device (see following page).



FARMOX low pressure Venturi dissolver installation

### Available sizes FARMOX low pressure Venturi dissolver

Product	Nominal water flow [gal/min.]	Oxygenation capacity* [lbs/hr.]	Length [in.]	Pipe diameter [in.]
FARMOX Venturi 4	17	0.30	7.90	1.50
FARMOX Venturi 6	26	0.51	9.80	2.00
FARMOX Venturi 9	39	0.79	11.80	2.50
FARMOX Venturi 15	66	1.21	9.80	2.50
FARMOX Venturi 24	105	2.10	14.20	3.50
FARMOX Venturi 33	145	2.86	12.20	3.50
FARMOX Venturi 45	198	3.79	15.80	4.00
FARMOX Venturi 54	238	4.61	13.80	4.00
FARMOX Venturi 150	660	14.59	19.70	6.00
FARMOX Venturi 175	793	15.87	27.60	8.00
FARMOX Venturi 250	1,057	21.03	31.50	10.00
FARMOX Venturi 400	1,850	35.71	34.50	12.00
FARMOX Venturi 1100	4,755	79.36	36.80	16.00

\*At a pressure drop of 6.5 ft. of water column at a water temperature of 60 °F

## FARMOX water purifying equipment: FARMOX flow distributor

FARMOX flow distributor contains an integral water-flow indicator for improved oxygen distribution and optimum hydrodynamic conditions in the tank.

FARMOX flow distributor 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.

FARMOX flow distributor is used in combination with oxygenation equipment such as the FARMOX low pressure Venturi dissolver. 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. FARMOX flow distributor is a customized product that can be adapted for required water flow rates ranging from 13 gal/min to 5280 gal/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 utilized.

### FARMOX flow distributor

Type	Average water flow [gal/min]	Coupling / external diameter [in.]
FARMOX flow distributor 4	17	1.5/3.5
FARMOX flow distributor 6	26	2.0/4.0
FARMOX flow distributor 9	39	2.5/5.0
FARMOX flow distributor 15	66	3.0/5.5
FARMOX flow distributor 24	105	3.5/6.5
FARMOX flow distributor 33	145	4.5/7.0
FARMOX flow distributor 45	198	5.0/8.0
FARMOX flow distributor 54	238	5.5/9.0
FARMOX flow distributor 150	660	9.0/12.0
FARMOX flow distributor 175	793	9.0/12.0
FARMOX flow distributor 250	1,057	11.0/16.0
FARMOX flow distributor 400	1,850	14.0/20.0
FARMOX flow distributor 1100	4,755	22.0/28.0

FARMOX flow distributor is delivered without the mounting flange



FARMOX flow distributor with flow indicator

## FARMOX low-pressure sidestream injection for circular tanks

FARMOX low pressure sidestream injection is a low-pressure oxygenation system for seawater, brackish water and freshwater tanks. The system is a patented all-in-one product that both oxygenates the water and creates flow in the tank. The product is equipped with an integrated water flow indicator that provides an overview of the water consumption in each tank.

Even mounted in the largest tanks, due to its design and patented solution the FARMOX low pressure sidestream injection system allows the easy adjustment of water circulation in the tank by rotating the external pipe.

The microbubbles produced in the FARMOX low pressure sidestream injection system are active in both the inflow pipe and the tank. This reduces nitrogen levels and the total gas pressure in the water, which reduces or even removes the need for external degassing of the water source.

A FARMOX low pressure sidestream injection system can be installed easily by connecting the product to the tank pipe and fitting the unit to the base of the tank. This also makes the product suitable for simple retrofitting in existing tanks. It is designed for stable operation and minimal maintenance, reducing operating cost. If very large water bodies are operated or high variations occur in the water flow, each tank can be equipped with an additional dissolver unit.



FARMOX low pressure sidestream injection system

FARMOX low pressure sidestream injection system is fully effective from a salinity of approximately 15 ppm, and normally only requires a pressure of between .75 and 3 psig to oxygenate, strip the nitrogen, and create optimal hydrodynamic conditions inside the tank, adapted to the facility's production. The low-pressure requirement leads to external pumps or extra energy for oxygenation and degassing of the water normally not being required. In freshwater installations, FARMOX low pressure sidestream injection system is normally used for supplementary oxygenation of the water, in combination with the FARMOX cone.

FARMOX low pressure sidestream injection system can be adapted to most tank sizes available on the market today, and covers water flows from 26 gal/min to 6600 gal/min per intake.

For optimum operation and oxygenation, Messer recommends that an installation using the FARMOX low pressure sidestream injection system is supplemented with a FARMOX flow control skid gas dosing cabinet. The FARMOX flow control skid can be easily connected to the facility's existing control system for automatic oxygen dosing.



Close-up of FARMOX low pressure sidestream injection system

## FARMOX flow control skid oxygen dosing cabinet

### Dosing cabinet

Fish grow best when the level of oxygen in the tank is kept constant. However, oxygen consumption varies depending on biomass, feeding regime, temperature, etc. The dose of oxygen required in order to maintain the optimal oxygen level in each individual tank will vary. Messer's oxygen dosing cabinet is designed for precisely this purpose. Constructed with the emphasis on gas safety, only approved components are used. The cabinet includes an integrated emergency oxygen function; 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.

### FARMOX cone cabinet

The FARMOX dosing cabinet for cones is used for dosing gas to pressure dissolvers and can communicate with most control systems. Messer dosing cabinets are designed to maintain an even oxygen level in the pressure dissolver, with the emphasis placed on a simple, flexible construction and maximum safety.

All cabinets are delivered UL marked and adapted to the specific installation's oxygen needs.



FARMOX flow control skid cabinet with outlets to four tanks with operational and emergency oxygen supplies



FARMOX flow control skid provided with a separate pressure regulator, for emergency oxygenation

## FARMOX oxygenation cone

FARMOX cone is an oxygenation cone specifically designed to increase the oxygen content of fresh water. Thanks to continuous product improvement, efficiency approaches 100% during standard operation. FARMOX cone is the most efficient freshwater oxygen dissolver currently available on the market.

The cone is easy to operate, with water and gas introduced through the top of the cone, pressurized and mixed with oxygen bubbles.

As the cone widens, water 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 FARMOX cone is normally operated at elevated pressure, the concentration of dissolved oxygen may be significantly above normal saturation levels. Thanks to their high reliability, efficiency and simple installation, these cones are used widely in aquaculture. FARMOX cones are made from glass-reinforced plastic (GRP) and are delivered with UL marking.

A standard FARMOX cone installation generally includes a FARMOX Venturi nozzle (see page 9).

### Technical data

	FARMOX cone 60	FARMOX cone 110
Water flow	264 gal/min.	484 gal/min.
Total height	8.0 ft.	8.9 ft.
Volume	161 gal.	308 gal.
Diameter footprint	45 in.	53 in.
Weight (empty)	375 lbs.	463 lbs.
Weight (water-filled)	ca. 1654 lbs.	ca. 2976 lbs.
Inlet coupling	4 in.	6 in.
Outlet coupling	4 in.	6 in.
Maximum working pressure	55 psig	43 psig

### Capacity

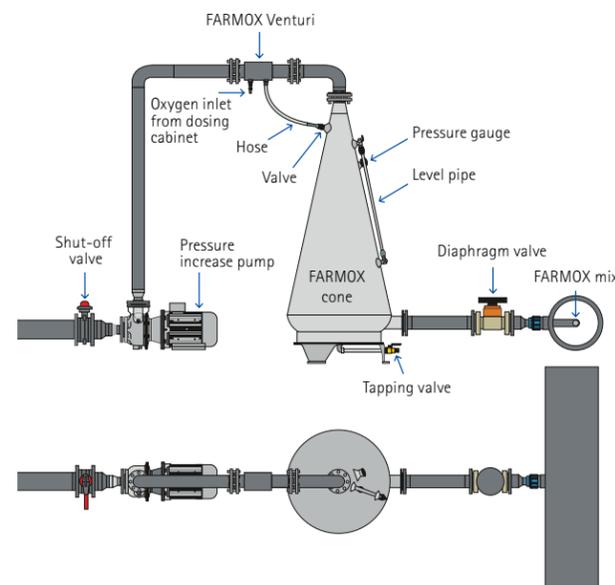
FARMOX cone 60 with CV 60* at max. working pressure 55 psig						
Water temp. °F	41	50	59	68	77	86
lbs./hr.	23.6	22.2	20.5	19.2	18	17
FARMOX cone C 110 with CV 110* at max. working pressure 43 psig						
Water temp. °F	41	50	59	68	77	86
lbs./hr.	34.8	32.4	30	28.2	26.5	24.9

\*Oxygenation capacity in lbs./hr. in fresh water at nominal water flow.



### A complete FARMOX cone installation consists of:

- FARMOX Venturi installed on the inlet pipe
- FARMOX oxygenation cone
- FARMOX mix return to main water flow
- Valve and hose mounted on the cone
- Pressure increase pump
- Inlet fitting
- Level pipe



FARMOX cone installation, seen from the side and from above

## FARMOX Venturi nozzle – for increased FARMOX cone oxygenation capacity

### FARMOX Venturi

The FARMOX Venturi is an additional system to boost the oxygenation capacity and efficiency of FARMOX cones, allowing up to 50% higher oxygen dosing capacity. FARMOX Venturi uses a Venturi nozzle system to recirculate undissolved oxygen that collects at the top of the cone.

The installation can be performed without prolonged shutdown. The FARMOX Venturi is flanged directly onto the cone's water feed pipe. This allows an increase in the water flow to the cone of up to 25%, which then provides a further 25% increase in oxygen capacity.



FARMOX Venturi

## FARMOX mix

FARMOX mix is a specially-adapted nozzle unit used in combination with FARMOX oxygenation cone installations. FARMOX mix is used when pressurized, high-oxygenated water from the FARMOX cone is returned to a water flow at a lower pressure.

FARMOX mix makes it possible to mix water with a high oxygen concentration into a main water flow, without degassing and reducing efficiency. The unit is designed and specifically adapted for each project and installation.

FARMOX mix can be installed individually for each tank or in the facility's main water supply, providing basic oxygenation.

FARMOX mix is generally used as part of a complete freshwater oxygenation solution.



FARMOX mix

## FARMOX perforated hose for additional oxygen without an external power supply

The FARMOX oxygenation hose is fixed on a support or rack which is placed at the bottom of a tank. No outside power source is required to operate the FARMOX hose, making it suitable as an emergency oxygenation system. When no additional oxygen is required, the pores close tightly, leaving the hose ready for operation at any time.

The hose is highly UV resistant, and will therefore not become brittle due to sunlight exposure. Flexible and easy to work with, it provides a cost-effective, easily installed solution.



FARMOX hose

## FARMOX stone ceramic diffuser

Ceramic diffusers are used to stabilize oxygen levels directly in the fish tank. In addition, the diffusers can be used for emergency oxygenation. FARMOX stone ceramic diffusers produce gas in the form of microbubbles that start dissolving at low pressure and can also help produce an aeration/stripping effect for unwanted gases.

Designed with ultra-fine ceramic pores, the diffuser provides an even and stable oxygen supply across its entire surface. The efficiency of ceramic diffusers varies with water depth, salinity and gas pressure/amount. The FARMOX stone ceramic diffuser is simple to install and operate. Efficiency is maintained by undertaking standard recommended maintenance.

### Specifications:

Dimensions [W x L]	3 in. x 26.5 in.
Surface area [W x L]	2.5 in. x 24 in.
Weight	4.4 lbs.
Max. working pressure	43 psig
Dosing capacity	2.2 lbs.



FARMOX stone

## FARMOX drop-in

Today's seawater fish farming requires increasing levels of oxygenation. This applies both to various forms of delousing (using lice shields/skirts), and in holding pens and other enclosed/partially enclosed forms of production. Here, oxygen levels are often reduced due to the unavailability of sufficient new water – with a resulting decline in the fishes' appetite, growth and wellbeing.

Today's solutions, utilizing diffusion hoses, are often cumbersome and require many operators to deploy. They are also prone to leaks or blockage and often require that the oxygen supply is turned on even before the hoses are deployed in cages.

In FARMOX drop-in, Messer has developed an entirely new product specifically designed to oxygenate large volumes of water in enclosed or partially enclosed ocean production facilities.

In size and design, FARMOX drop-in is reminiscent of a gas cylinder. It consists of an electric pump plus a patented oxygen dissolver and distribution nozzles. Water is sucked into the lower part of the unit and the oxygenated water is dispersed through four nozzles at the top of the unit.

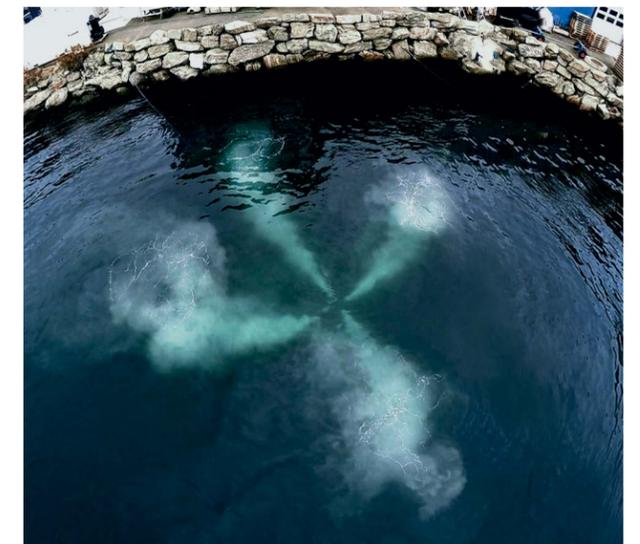
With the aid of the oxygen dissolver, oxygen is added to the water in the form of small bubbles, known as micro-

bubbles. These bubbles have a large surface area in relation to their volume and therefore a low speed of ascent. This leads to bubbles remaining in the water longer, optimizing oxygenation even at low pressures and depths. Water is dispersed into the surrounding water through the distribution nozzles, where the oxygen continues to dissolve and the oxygen saturation in the body of water increases.

FARMOX drop-in is designed for ease of operation and handling as well as increased efficiency. It is therefore constructed to be as light and compact as possible, weighing only around 88 lbs. When in use, the device is hung vertically from a buoy to the desired depth.

FARMOX drop-in is connected to a multicable that provides power, oxygen and sensor signals to the device. An oxygen sensor registers oxygen saturation in the pen and a control system starts the pump as required, dosing oxygen to the desired pre-set saturation level.

If no oxygen is required, the device will not consume any energy or oxygen. Automated monitoring and operation are important in situations such as feeding in cages equipped with lice shields, where oxygen values within the pen can vary greatly. FARMOX drop-in can then adjust the oxygen dose in order to maintain the optimal oxygen levels in the cage.



FARMOX drop-in in operation



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