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Tox Protect II

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*Tox*Protect II

Fish as guardians
of water quality

✔ Continuous monitoring

✔ Poison alarm –
detection and validation

What is the *Tox*Protect II?

## The *Tox*Protect II is a device for the rapid detection of harmful substances in water and water supply systems

TASKS AND PERFORMANCE

▶ Water quality monitoring

▶ Determination of acute toxicity

▶ Rapid detection of pollutants

▶ Use of proven test organisms

▶ Automated online processes

Pollutants contaminate the water and endanger health and the environment. In order to avert dangers, suitable instruments are necessary that safely indicate a pollutant effect. The *Tox*Protect II is an automatic biomonitor that detects acute toxicity caused by pollution in water supply systems and triggers an alarm. Short response times and high sensitivity are a MUST for a modern biomonitor in water monitoring. This is ensured by the combination of a biological component – fish, and technical components – an aquarium with light barriers and software for triggering alarms and signal processing.

The fish are the heart of the *Tox*Protect II. The selection of the appropriate test organism is based on the requirements for toxicity assessment. With low concentrations of substances and mixtures, the fish must be affected before these concentrations pose a risk to human health. Photoelectric sensors in the aquarium register the movements and distribution of the fish. The influx of harmful substances leads directly to the fish's reaction. They avoid staying at the inflow point and change their activity pattern. The *Tox*Protect II contains an alarm system with adjustable threshold values and alarm evaluation. This reduces costly false alarms to a minimum while maintaining a high level of responsiveness.
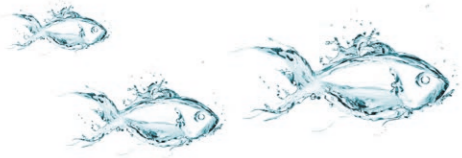
The simple design of the *Tox*Protect II allows very safe handling with little effort. This is reflected in an affordable purchase price compared to other bio monitors and low follow-up costs.

The *Tox*Protect II is used in drinking water treatment, drinking water monitoring and environmental monitoring of rivers in measuring stations. The *Tox*Protect II is the second generation of a surveillance system that has been tried and tested for 10 years.

## How does *Tox*Protect II determine toxicity?

Online monitoring of movement activities

The principle of the system is based on the continuous monitoring of the movement behavior of fish in an aquarium. Fish act as biological sensors within the instrument. Rapid changes in behavior indicate acute toxicity and are reliably detected by analyzing the movement patterns. The alarm evaluation system is part of the software and works online.

The swimming movements are automatically determined and evaluated by a series of 64 light barriers distributed throughout the aquarium. The interruptions per unit of time are counted and multiplied by the number of fish. It is used to determine swimming activity or, in short, activity. The result is compared internally with a preset threshold. Values below generate an alarm, which is shown in the display and on the red traffic light at the top of the device.

MEASUREMENTS

▶ Online monitoring of fish activity

▶ Measurement of the light barrier interruption

▶ Activity measurement

▶ Measurement of specific activity

▶ Automatic alarm triggering
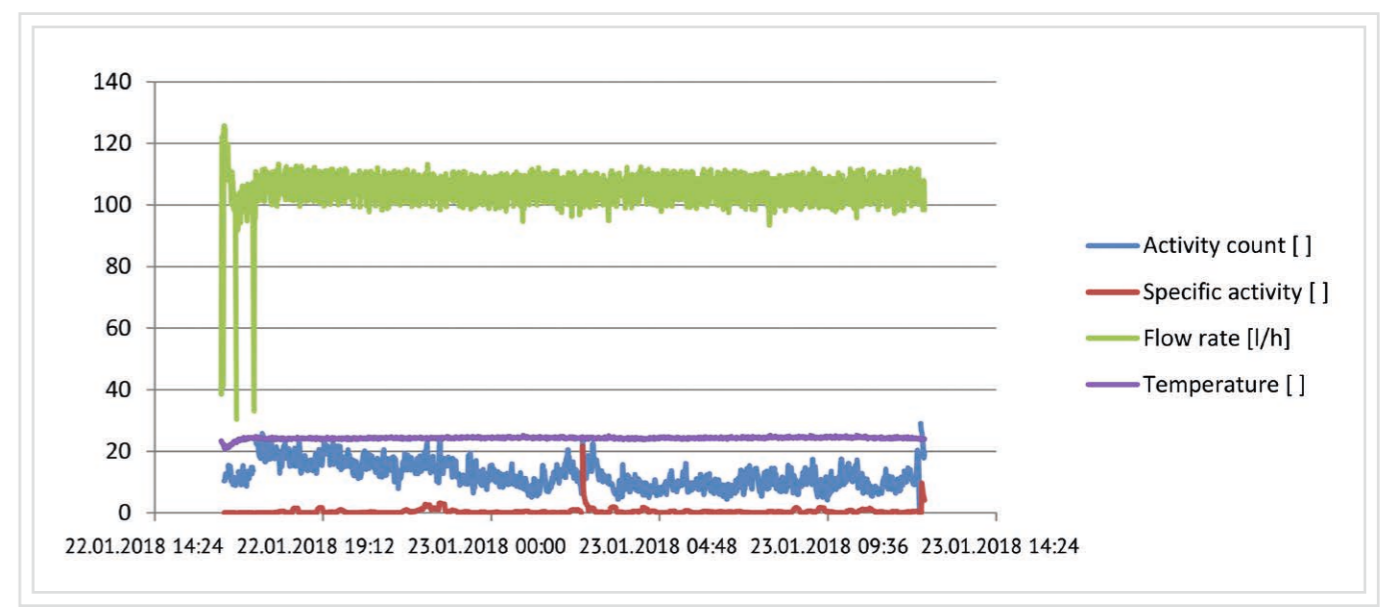
Parameters that serve to effectively determine an alarm condition.
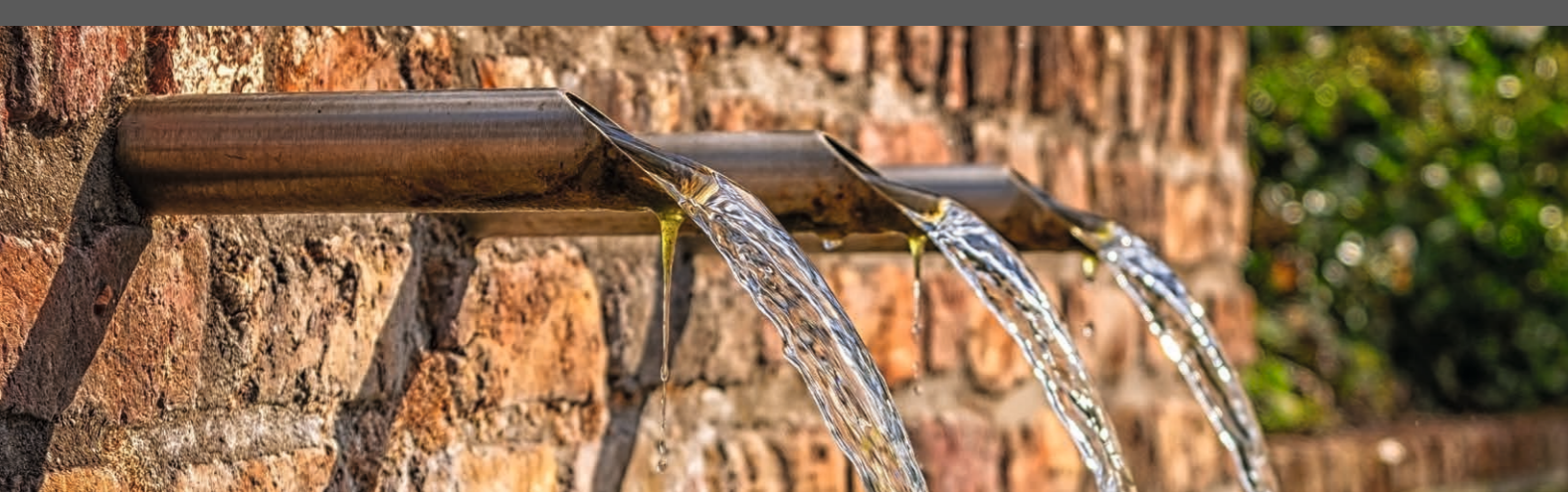
The activity is determined for the largest area of the aquarium with the exception of the upper part near the water surface. Low-motion or motionless fish on the surface indicate massive damage to the fish, which is detected separately by a series of 15 light barriers. Mathematical formulas are stored in the software, by means of which an alarm value is calculated. If this exceeds a previously defined threshold value, an alarm is triggered.

The water supply determines the preferred residence of the fish in the lower part of the aquarium, where fresh water enters. The supply of contaminated water (poisons) forces the fish to dodge upwards, in an area with (even) better water quality along with increased swimming activity. The specific activity is determined every 10 minutes. An alarm is triggered above a threshold. This means that 3 parameters are available which are used to effectively determine an alarm status.

Is the triggered alarm real?

⚠ ALARM
VERIFICATION

▶ Change of lighting

▶ Activity behavior

Due to the natural and random behavior of the fish, the alarm threshold values can occasionally be reached and exceeded during the monitoring process. Although this is rarely the case, it is important to avoid false alarms, it is therefore necessary to check the alarm situation. This is achieved by switching off the lighting in the aquarium after an alarm. If the fish are in good condition - not poisoned - this leads to a dramatic increase in activity and a threshold for alarm verification to be exceeded. After completion of the check, the activity returns to normal behavior. The fish do not react under poison conditions: the activity continues to decrease. It is therefore automatically determined whether the alarm condition is real and false alarms can be excluded with a high degree of certainty.

Verified pre-alarm – real alarm (red light)

Pre-alarm discarded – not a real alarm

Structure and components of the *Tox*Protect II

How is the *Tox*Protect II structured?

The 9 liter aquarium forms the core of the *Tox*Protect II. There is space for up to 20 fish. There are 2 perforated stainless steel sheets on both sides of the aquarium, which separate the swimming area from the water supply and drain and distribute the inflow and outflow. This creates a flow through the tank that enables the fish to react quickly when toxic substances enter. At the same time, the incoming water is aerated in the area of the inlet, the temperature is measured and, if necessary, heated according to the default settings. The inflow and outflow are equipped with valves for maintenance work. A flow meter is installed in the supply line to detect interruptions (hardware errors). The 2 lighting elements and the automatic feeder are attached to the lid of the aquarium. The light barrier elements in front of and behind the aquarium are evenly distributed over the surface and record all relevant movements of the fish.

The evaluation of the behavior patterns and the toxicity is provided by a powerful touchscreen industrial PC in the upper area of the housing. The interfaces and the USB port are also housed here. For the visual communication of an alarm, a traffic light (red / yellow / green) sits atop the device and shows the current status from a distance.

We recommend the optional passive dechlorination for chlorinated drinking water. Even in low concentrations, chlorine and chlorinated amines are poison for fish. Dechlorinating agent (ascorbate or thiosulfate) is administered from a 30 l tank into the sample stream using an extra hose pump.
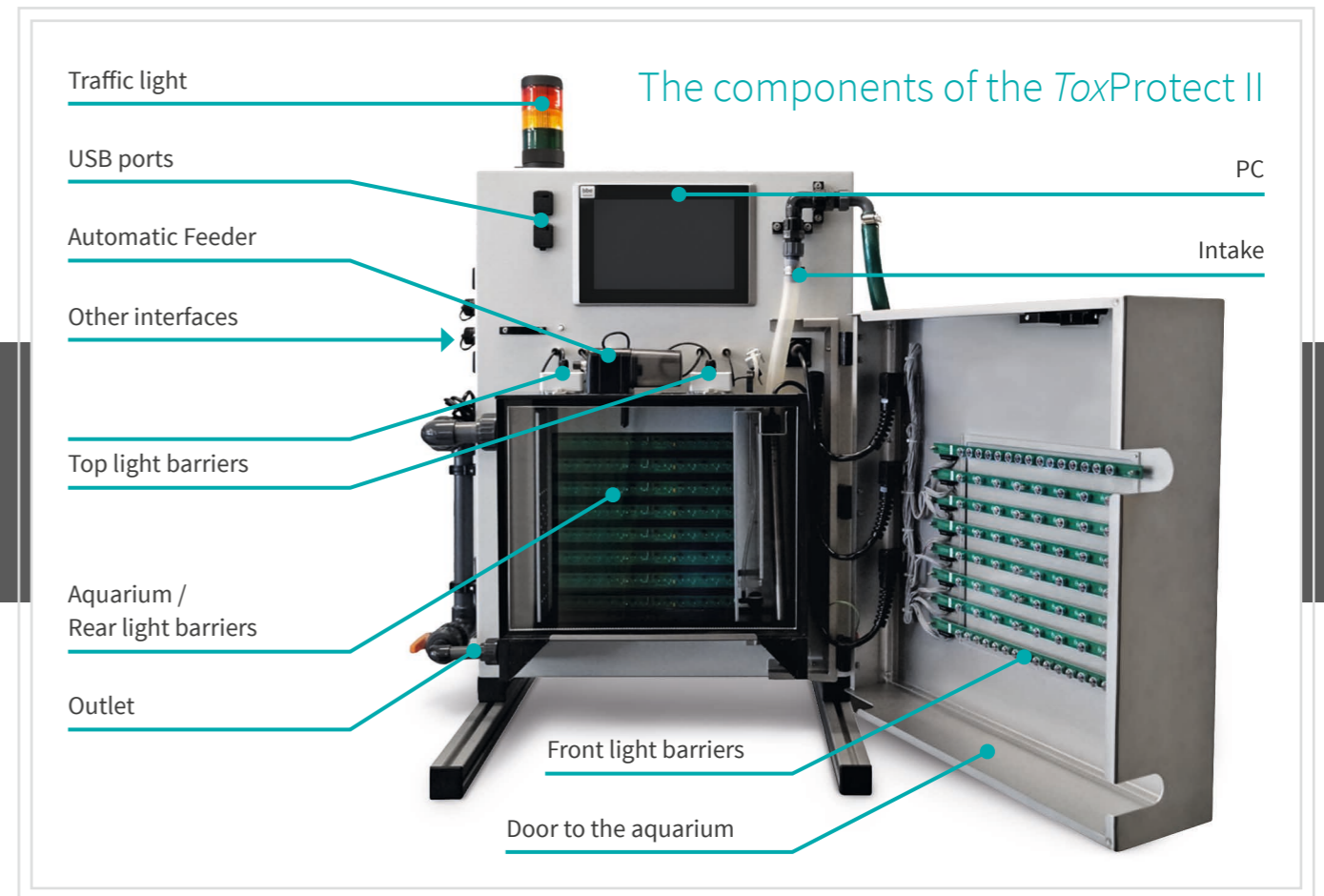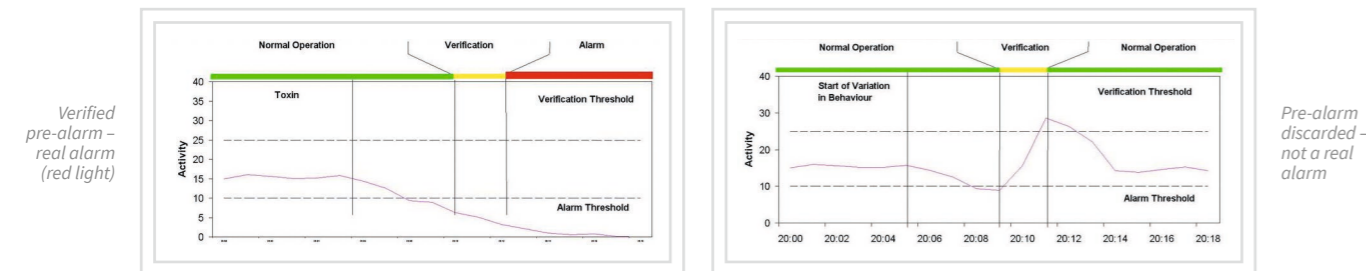
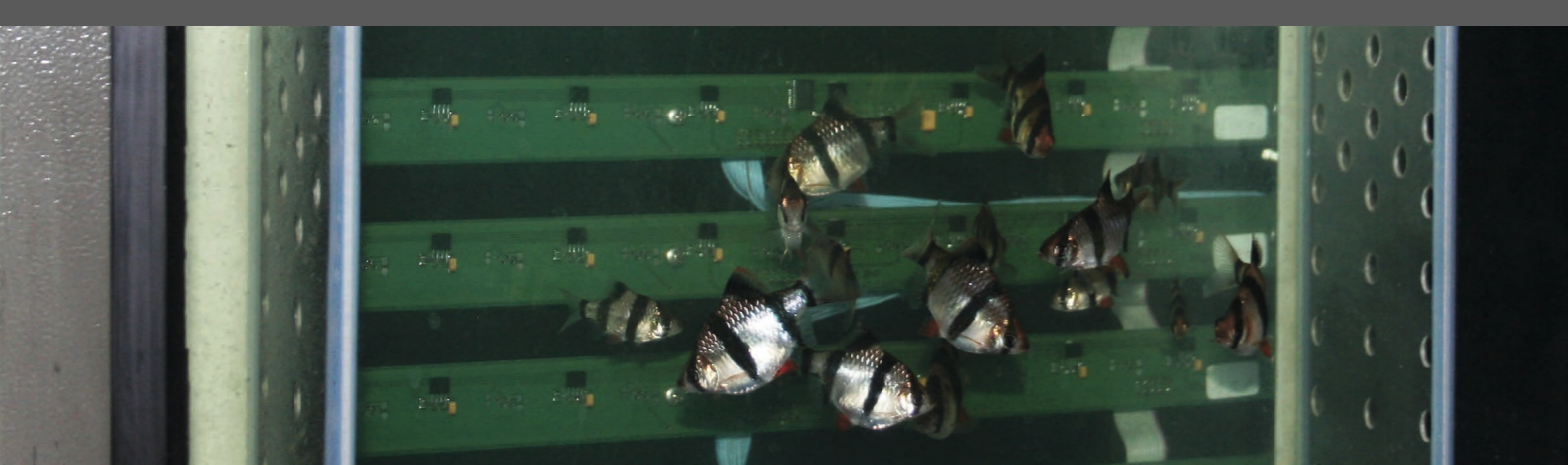## The components of the *Tox*Protect II

Traffic light

USB ports

Automatic Feeder

Other interfaces

Top light barriers

Aquarium / Rear light barriers

Outlet

PC

Intake

Front light barriers

Door to the aquarium

The alarm indicator

The alarm display (traffic light) shows the current status:

- ▶ **Red:** alarm
- ▶ **Yellow: alarm check**
- ▶ **Green:** normal operation
- ▶ **No light:** on-call duty
- ▶ **Flashing green:** start
- ▶ **Flashing yellow:** error

Monitoring instrument malfunctions

The *Tox*Protect II is equipped with internal sensors for monitoring and reporting device malfunctions:

- ▶ Insufficient sample flow
- ▶ Drain blocking
- ▶ Temperature deviation
- ▶ Ambient light
- ▶ Empty storage vessel: dechlorination reagent
- ▶ Accidental / unauthorized exposure of the test chamber

Inputs and outputs
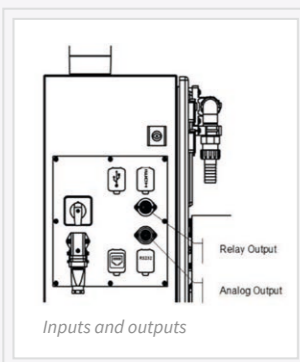
⇄ INTERFACE

- ▶ Ethernet
- ▶ 3 USB
- ▶ 2 relay outputs
- ▶ 2 analog outputs 4 - 20 mA
- ▶ RS232
- ▶ Modbus TCP / IP
- ▶ others on request

## Advantages of the *Tox*Protect II

What advantages does the *Tox*Protect II offer for toxicity detection?

Water is the most important natural resource in our world and therefore essential for our existence and that of our descendants. Access to adequate quality water is part of basic human rights. Classic valuation methods use the biological or chemical oxygen demand of an aqueous sample to set the standard for water quality. That is not enough if there are toxic substances in the aqueous sample that can cause damage to consumers and the environment. Fish help here as a pollutant indicator or biosensor because of their physiological response to the presence of pollutants. Fish are particularly suitable indicators. As vertebrates, they are evolutionarily closer to humans than often-used test organisms such as daphnia or mussels.

Physiological processes are comparable in fish and humans. Additionally, they possess a highly developed nervous system which is also extremely sensitive to neurotoxins. Only the toxicity is evaluated, i.e. the damaging

effect on the organism due to contact with a toxic or harmful substance. The *Tox*Protect II detects acutely significant toxicity, which becomes evident after only a short exposure time.

The type of active substance cannot be determined with a bio monitor. Therefore it is recommended to use a sample collector in conjunction with the *Tox*Protect II for advanced chemical analysis.
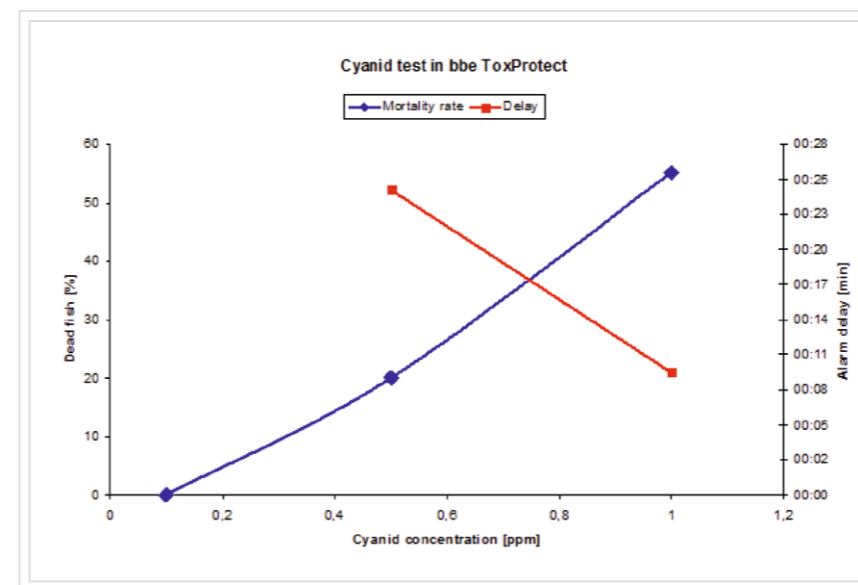
Test run of the bbe ToxProtect with cyanide

The use of suitable fish in the *Tox*Protect II

In principle, all fish that are constantly moving and do not behave aggressively towards their peers are suitable. Schooling fish with a size of 4-6 cm are recommended. The environmental conditions determine whether a cold water fish (<15 ° C) or a warm water fish (> 15 ° C and <30 ° C) is used. Decreased temperatures decrease the movement activities of the fish and thus the sensitivity of reactions to incoming toxins. The use of a heater with a thermostat stabilizes the temperature range and ensures an optimal environment for the fish. In addition to the availability, the reproduction rate and ease of care determine if the test fish is suitable as a sensitive biosensor. Some fish species are well represented in the scientific literature.

The table below lists some of these fish with their recommended temperature range.

FISH TYPE	WATER TEMPERATURE
Sunbleak (Leucaspius delineatus)	10-20 °C
Minnow (Phoxinus phoxinus)	10-20 °C
Sheepshead minnow (Cyprinodon variegatus variegatus)	15-20 °C
Tiger barb (Phoxinus phoxinus)	20-28 °C
Zebrafish (Danio rerio)	18-26 °C

+ BENEFITS

- ▶ Continuous recording of fish movements in the entire aquarium
- ▶ Alarm-relevant signals
- ▶ Reduction of false alarms
- ▶ Low maintenance effort
- ▶ Simple maintenance
- ▶ Reliable data analysis
- ▶ Add-ons

⏻ APPLICATIONS

- ▶ Municipal drinking water intake and distribution
- ▶ Hotels and leisure centers
- ▶ Hospitals and medical facilities
- ▶ Housing estates and public buildings

Technical details of the *Tox*Protect II

DESCRIPTION	VALUES
Sensors	An array of 78 light barriers to detect fish movements; 30 (15 top & 15 bottom) light barriers to detect immobile fish
Measured values	activity (total, separated by series); interrupted light signals
Sample temperature	5 - 28 °C (depending on fish species)
Ambient temperature	5 - 30 °C
Sample flow	50 - 150 l/h
Transmission	max. 40 FTU
Weight	50 kg
Dimensions (H x W x D)	1125 x 858 x 600 mm
Protection class	IP54
Outputs	Modbus TCP / IP, Ethernet, 2 USB, 2 relay outputs, 2 analog outputs 4 - 20 mA*
Fish feeding	automatic feeding unit with interval setting
Recommended species	minnow, zebra fish, bitterling, tiger barb (tests for other local fish on request)
Number of fish	10 - 15
Fish length	4 - 6 cm
Fish replacement	approx. every 6 months
Volume of the aquarium	9 l
Maintenance interval	> 7 days

others on request

SCOPE OF DELIVERY

- *Tox*Protect II (230 V oder 115 V)
- Hose set

- Pressure regulator
- Food (100 ml)
- Fishnet
- Fuses
- USB extension
- Manual
- Software bbe ++
- External heater (on request)
- Dechlorination system (on request)

Do you have any questions? Please contact us!

Your local representative

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