

## Digital Measuring Systems – Ready for Operation in Aquaculture Facilities

### Simple oxygen and turbidity measurement using optical digital sensors

*To ensure a sustainable aquaculture, continuous measurement of the parameters that define water quality is essential. Using a combination of both JUMO ecoLine O-DO sensors and JUMO ecoLine NTU sensors, together with the JUMO AQUIS 500 RS indicator unit/controller, JUMO is able to offer sturdy and easy-to-use solutions. These systems help to precisely measure and control the dissolved oxygen and turbidity in a fish farm, to optimize the yield, and to reduce the maintenance work required at the measuring points to a minimum.*

An increasing global population, a shift in dietary habits towards consuming more fish and overfishing in the oceans are placing heavy burdens on global food security. As a result, aquaculture (controlled breeding, particularly of fish and shellfish), is an extremely important market in today's world for the production of animal protein. However, in order to run aquaculture facilities in an efficient and ecologically sustainable manner, optimal living conditions are required for breeding. Alongside the quality of animal feed, water quality in the aquaculture facilities is a crucial factor in the growth, health, and therefore in the final quality of the animals as a foodstuff. As a result, it is essential to continuously monitor and regularly check the parameters that control quality, such as temperature, salt content, pH value, oxygen, and turbidity in order to ensure a consistently high water quality. The trend in this field is towards fully automated circulatory systems and as a result, demand is growing for the use of online measuring and control systems. These systems should be, sturdy, low-maintenance, and as easy as possible to operate. The new digital systems by JUMO fulfil all these requirements. They are put to use by clients such as the Dutch company Trintech. This plant manufacturer specializes in automated solutions that are used in fish farming (aquaculture), greenhouses, and in agriculture.

As a systems supplier, JUMO has introduced the new JUMO ecoLine O-DO oxygen sensor and the corresponding JUMO AQUIS 500 RS indicator/controller into its program. Another digital sensor, the JUMO ecoLine NTU turbidity sensor, can also be connected to the same indicator and will be available soon. Both sensors work on the basis of an optical process with digital signal processing. The electronics that are integrated into the sensor head record the measured values and compensate for the necessary influencing factors. Data from the last ten successful calibrations is stored here as well. The advantage of this technology is that the sensors do not have to be calibrated at a specific location and working premises; instead, calibration can be carried out in advance, for example in the laboratory. The pre-calibrated sensors are then ready to be used immediately in the field. The signal is digitally transmitted to the JUMO AQUIS 500 RS indicator/controller by a Modbus RTU protocol and this guarantees unimpeded

measurement. Optical measuring principles are dependent on the sensor type and are explained in more detail below.

### **Optical oxygen measurement with the JUMO ecoLine O-DO**

The measuring principle of the JUMO ecoLine O-DO is based on the luminescence method. With this method, a light-sensitive coating (lumiphore) is applied to the inside of a membrane that is permeable to oxygen, and it is excited with a short-wave light. Once some of this light has been radiated as thermal energy, the lumiphore returns to its basic state again, reflecting a long-wave light after a time delay. If oxygen that is dissolved in the process fluid diffuses through the membrane and encounters an excited lumiphore, the energy is transmitted from the lumiphore to the oxygen molecule with no radiating energy. The intensity and the decay behavior of the luminescent radiation are proportional to the oxygen concentration. The excitation light is technically modulated during the measurement and determines the oxygen concentration from the phase delay between the excitation and luminescent radiation. This is a purely physical time measurement that can be carried out with a high degree of precision. In comparison to amperometric sensors, no oxygen is chemically consumed in this optical measurement. For this reason, no minimum inflow is required for the sensor. It is, however, useful to clean the membrane and protect it against bacteria growth (fouling). No electrolyte is required with the optical method and the sensor does not have any electrodes that could become weakened by electrode poisons, such as hydrogen sulfide. As a result, optical oxygen sensors have a low drift behavior, improved long-term stability, and do not have to be calibrated as often as other sensors. Even the polarization that is usually required can be omitted. Consequently, the sensor is easier to use and the maintenance requirements are considerably reduced. This helps to keep costs down and minimize downtimes of the measuring point during maintenance work. The sturdy sensor with a stainless-steel case has a measuring range of 0 to 20 mg/l and can be used within a temperature range of 0 to 60 °C.

### **Optical turbidity measurement with the JUMO ecoLine NTU**

In the long term, turbid water leads to illness and problems with growth in fish, so turbidity must be reduced to a minimum. It is therefore necessary to continuously monitor the water and the treatment facilities, where the main task is to remove particles from the water, using turbidity measurements.

The JUMO ecoLine NTU is specifically designed for this purpose. The measuring principle of the sensor relies on an infrared measurement that is based on the 90° light scattering theory according to DIN EN ISO 7027. The sensor emits infrared light at a wave length of 880 nm. This light is scattered by suspended particles and the scattered light is then detected by the sensor. The sensor is designed for a measuring range between 0 and 4,000 NTU. It can therefore be used for water with a low to medium level of turbidity. The sensor housing on the JUMO ecoLine NTU is made of PVC and is characterized by its sleek and sturdy design. It can be used at medium temperatures of up to 50 °C. The JUMO ecoLine O-DO and JUMO ecoLine NTU immersion and flow fittings are available as accessories.

## **A digital team: JUMO AQUIS 500 RS indicator/controller with JUMO ecoLine O-DO or NTU sensor**

The JUMO AQUIS 500 RS is a new innovation on the market and has been developed to connect digital sensors with a Modbus RTU interface. The device is designed as a single-channel device in which the sensor type that is attached is irrelevant. The transmitter's automatic sensor recognition feature is a particular highlight. A search routine independently detects whether a JUMO ecoLine O-DO oxygen sensor or a JUMO ecoLine NTU turbidity sensor is connected and automatically selects the corresponding communication parameters. This also enables users with little training to commission a measuring point quickly and easily. Designed as a field device with protection type IP 67 for use on site, it can also be fitted in a control cabinet if required. Plain text displays make operation easy and backlighting enables the display to be read even in low lighting. The transmitter is equipped with two relays that enable it to perform switching, monitoring, and control tasks. For example, the monitoring of two limit values for oxygen content in aquacultures has been proven in practice. As soon as the value for the dissolved oxygen falls below a set limit value, the first relay contact on the JUMO AQUIS 500 RS opens a valve and oxygen-enriched water is able to flow through into the breeding tank. In contrast, if an emergency situation arises and the oxygen content falls below a critical safe limit value (perhaps caused by a pump failure), the second relay contact ensures that the replacement pump is switched on and can supply additional oxygen to the tank. The measured value for the dissolved oxygen and the temperature are forwarded to a parent system via the two current outputs. This enables documentation of the water quality for farming purposes and documentation of the influence of fish farming on the environment.

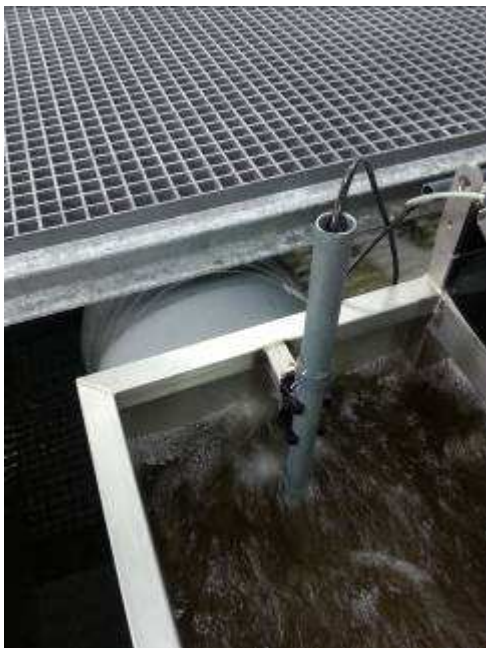
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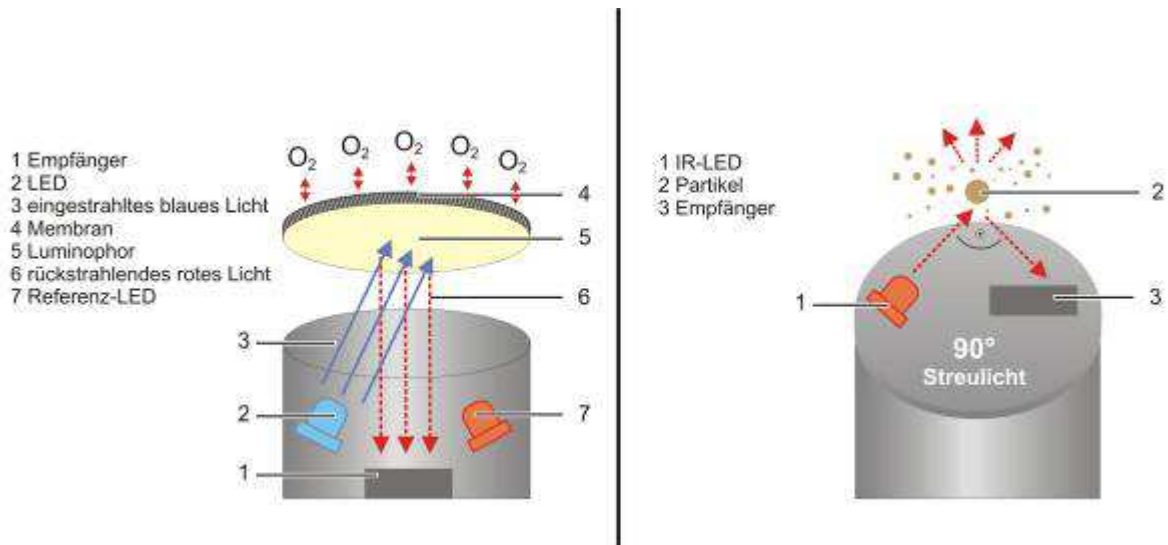
**Image 1: photo of an aquaculture with the different tanks in which fish are bred.**



**Image 2: the installation situation for JUMO sensors in the aquaculture.**



**Image 3: the two new JUMO sensors for measuring oxygen (left) and turbidity (right).**



**Image 4: diagram showing the measuring principles for the oxygen sensor (left) and the turbidity sensor (right)**





**Image 5: The JUMO AQUIS 500 RS can be used as an indicator/controller for both sensors.**