Instran®

AUTOMATIC WATER QUALITY CONTROL IN FISH FARMS

Background

According to the Food and Agriculture Organization of the United Nations (FAO), aquaculture produces 50% of the world's food fish and the figures are expected to continue to rise.

China, the world's largest fish producer, produced 48,246,000 tonnes in 2019. In Europe, Norway is the largest producer with 1,453,000 tonnes, while Chile, with a production of 1,385,000 tonnes, is the largest producer in the Americas. For its part, Spanish production stood at 342,900 tonnes.

Recirculation Aquaculture Systems (RAS)

RAS have great advantages in aquaculture centres, as they allow a better use of space and efficient management of the waste generated. Furthermore, in freshwater fish farms, where the consumption of water from rivers, etc. is controlled, it allows for the reuse and saving of water. Finally, Recirculation Systems make it possible to control the variables that determine water quality. This last section is key, because the higher the quality of the water, the higher the production density (increasing the farmer's operating yield) and the quality of the final product.

Water quality

As mentioned in the previous section, water quality plays a critical and crucial role in the aquaculture operation of the plant and the achievement of the highest possible yield. The main parameters that determine water quality, as well as the maximum recommended values, are shown below. It should also be noted that some parameters may vary depending on the species of fish treated.

Temperature

The temporary temperature of fish depends on the temperature of the water in which they are kept. Very cold water temperatures slow down their growth, but an excessive increase in water temperature can cause pathologies, even death, in the animals. In turn, it is required that even within the established ranges, temperature variations should be less than 5°C. Moreover, temperature has negative indirect effects on parameters such as oxygen, reducing its solubility in water, or on the amount of ammonium, which is highly toxic for fish.

Dissolved oxygen (DO)

Dissolved oxygen has two main functions. On the one hand, it is the gas necessary for respiration and further development of the animals. Concentrations below 2 mg/l DO are incompatible with life, although concentrations above 5 ppm are recommended in culture tanks. On the other hand, oxygen is necessary for the nitrification process so that the bacteria can eliminate the nitrogenous compounds.

pH – Alkalinity – CO2

Maintaining a stable pH in the water tank (between 6 and 8.5) optimises the respiration process of the fish. However, as will be explained below, pH plays a major role in the amount of ammonia in the water. In addition, pH also affects the nitrification process, with pH 7 - 8 being the optimal range, and with a pH value below 6, nitrification has no effect.

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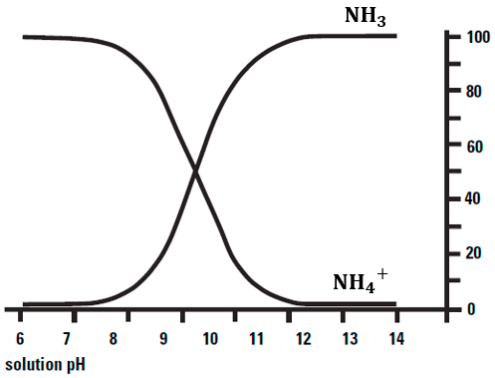
CO_2 is a residual compound resulting from fish respiration. When it reacts with water, carbonic acid is formed, which, by releasing protons, reduces the pH of the sample. To avoid its adverse effect, the alkalinity of the water plays a key role. The alkalinity of water is related to its buffering capacity. The higher the alkalinity of the water, the lower the effect of CO_2 on sudden pH variations. The continuous neutralisation of the protons produced by CO_2 will use up the alkalinity and need to be replenished.

Nitrogen waste products: ammonia - ammonium - nitrite - nitrate

Nitrogen compounds, generated by the decomposition of feed and animal faeces, are pollutants for fish, although some of these compounds are more toxic and harmful. The ammonium - ammonia generated as waste is subjected to a nitrification process, whereby it is first converted to nitrite and then to nitrate, the least toxic state, which is eliminated by renewing the water. In terms of its effects, high concentrations of NO_2 affect the animal's respiratory capacity (animal disease), accumulations of NO_3 directly affect the appetite of the fish, thus requiring a longer fattening time, affecting the productive yield and high concentrations of NH_3 reduce fecundity (production) and affect the nervous and immune system, which can lead to death, thus being the most toxic and critical state of nitrogen.



Ammonium (NH_4^+) is the fourth form in which nitrogen can occur. This state is relatively non-toxic. However, as the graph shows, the amount of NH_3 - NH_4^+ is directly related to the pH. It is therefore necessary to control its concentration, in order to avoid possible changes to NH_3.

The following levels are therefore recommended for the different substances:

	NH_3	NH_4^+	NO_2^-	NO_3^-
Recommended level	< 0,05 ppm	< 5 ppm	< 0,5 ppm	< 50 ppm

Online quality control

Given the important effect that the aforementioned parameters have on the development and growth of fish, maintaining automatic control of the water conditions means that it is possible at any time to act accordingly on the fish rearing tanks through closed loops that optimise the system and productivity. Furthermore, as has been mentioned, the economic benefits for the producer or company are significant, as the fish grow faster, **increasing productivity**, and in better conditions, **with a higher quality product**, meeting market demands. Closed loops also allow **economic savings in the precise and optimal dosing of bicarbonates to replenish alkalinity**.

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Instran online analyser®

The Instran online analyser is an analyser that allows the concentration of various parameters to be monitored over time, including ammonium, nitrate or nitrite, with a frequency of 10 to 15 minutes depending on the parameter in question.
The equipment's specific cleaning systems allow it to deal with dirty water from wastewater treatment plants, without affecting the measurements with cross-interferences in subsequent analyses or obstructing the fluid circulation systems. Its simple design means that plant operators quickly become familiar with the equipment and its maintenance is very low, reducing the inconvenience caused by analyser maintenance. All these features make the Instran a unique analyser on the market with exceptional performance for the control of nitrogen components in wastewater treatment plants and its consequent economic savings, as well as complying with current legislation.

Ammonium Instran®

The ammonium analyser is characterised by a simple method that allows no sample parameter to interfere with the measurement except amides. In addition, the known addition system used as a measurement technique allows the correction of possible variations that may occur in the sample matrix in each analysis. **Its ability to measure saline water allows the analyser to be used perfectly in seawater fish farms**. Finally, the low reagent consumption (0.5 mL/analysis) for each of the two reagents used makes the Ammonium Instran® the best online analyser on the market.

Nitrate Instran®

The presence of nitrite in treated waste water makes the measurement of nitrate difficult as it is interfering. The measuring probes, because they cannot condition the sample, cannot avoid the adverse effect of nitrite. However, the *Nitrate Instran®* adds a pre-reagent that allows the sample to be conditioned, eliminating chloride and nitrite interference, giving it a unique reliability in nitrate analysers. On the other hand, by using the same measuring method as the *Ammonium Instran®*, it also allows for further constant correction of sample matrix variations.

Nitrite Instran®

The colorimetric measurement system on which its operation is based is not affected by the colour of the sample due to the correction that the analyser makes before each analysis. In addition, the intense pinkish colour that develops when nitrites react with the reagents makes it a very sensitive method to NO2- concentration. Once again, the low reagent consumption (0.4 mL/analysis) for each of the reagents used makes the *Nitrite Instran®* a simple and excellent choice for nitrite control in the sample.

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Alkalinity Instran®

The analyser's dosing system, which allows precise dosing down to 0.01 mL, is key to the titration process used to determine the alkalinity of water, obtaining a unique repeatability and precision that make the *Alkalinity Instran®* the best option on the market for online alkalinity control. In addition, the simplicity of the reagents required and its low consumption are a further incentive for its functionality.

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