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Automated temperature-controlled recirculation systems

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System initially developed at Louisiana State University

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Seasonal changes in natural aquatic systems determine variations in temperature that impact the system dynamics over time. The study of such systems in a laboratory setting requires the incorporation of computer control technologies that can simulate the temperature regimes of natural aquatic systems.

Technologies for closed recirculation systems have increasingly emerged to improve water quality while minimizing effluent discharges. Temperature control is also needed in such systems to help reduce water and labor costs.

Study setup

With support from the Louisiana Sea Grant College Program, the authors recently conducted a study to develop a design for a central chilling system that will be used for time- and temperature-controlled holding and water quality studies with Eastern oysters (*Crassostrea virginica)*. The objectives were to provide sufficient, faster chilling at a lower and more consistent temperature than the previous system, with the ability to replicate tank conditions.

The system was initially developed at the Louisiana State University Aquaculture Research Station in Baton Rouge, Louisiana, USA, with four individual unit chillers in two central tanks. The recirculation system was used for holding and conditioning Eastern oysters for research on gametogenesis. A second system was designed and installed in the Department of Biological and Agricultural Engineering to enhance water quality studies on a small scale by simulating lightly loaded systems.

Designing a system with a central chiller enhanced chilling and research capacity because replicating experiments in a single process control system minimized variations in the temperatures and chilling rates in the individual tanks.

System testing

Test runs conducted on both chilling systems evaluated the temperature control, and the chilling capacity was determined based on chilling rates over time. The biofilters in the tanks at the research station were preacclimated at a salinity of 20 ppt to develop an active biofilm before use. The biofilters were active in seven days, with ammonia levels as low as 0 ppm and nitrate at 20 ppm. Water quality tests were also performed to determine the nitrification activity of the filters at different temperatures.

Results

The system at the Aquaculture Research Station was tested for sinusoidal regimes. Diurnal temperatures in the tanks over a three-day period were maintained at 10 degrees-C and recorded every three minutes to assess the chilling capability of the improved system. The average daily temperatures in the tanks were maintained within 0.5 degrees-C of the expected temperature.

Tests in the second system showed that chilling rates were slightly different for eight tanks arranged at heights of 0, 45, 90, and 135 cm for temperatures of 10, 20, 30, and 40 degrees-C. The minimum chilling rates were 0.5 degrees per hour at 10 degrees, 1.5 degrees per hour at 20 degrees, 3.0 degrees per hour at 30 degrees, and 7 degrees per hour at 40 degrees.

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