

monitoring, and predictive tools are advancing quickly, but some reviews note that many machine-learning systems are still validated mainly in smaller tanks rather than fully commercial RAS scales (Gupta et al., 2024).

RECIRCULATING AQUACULTURE SYSTEM (RAS)

System Configuration and Water Treatment Pathway

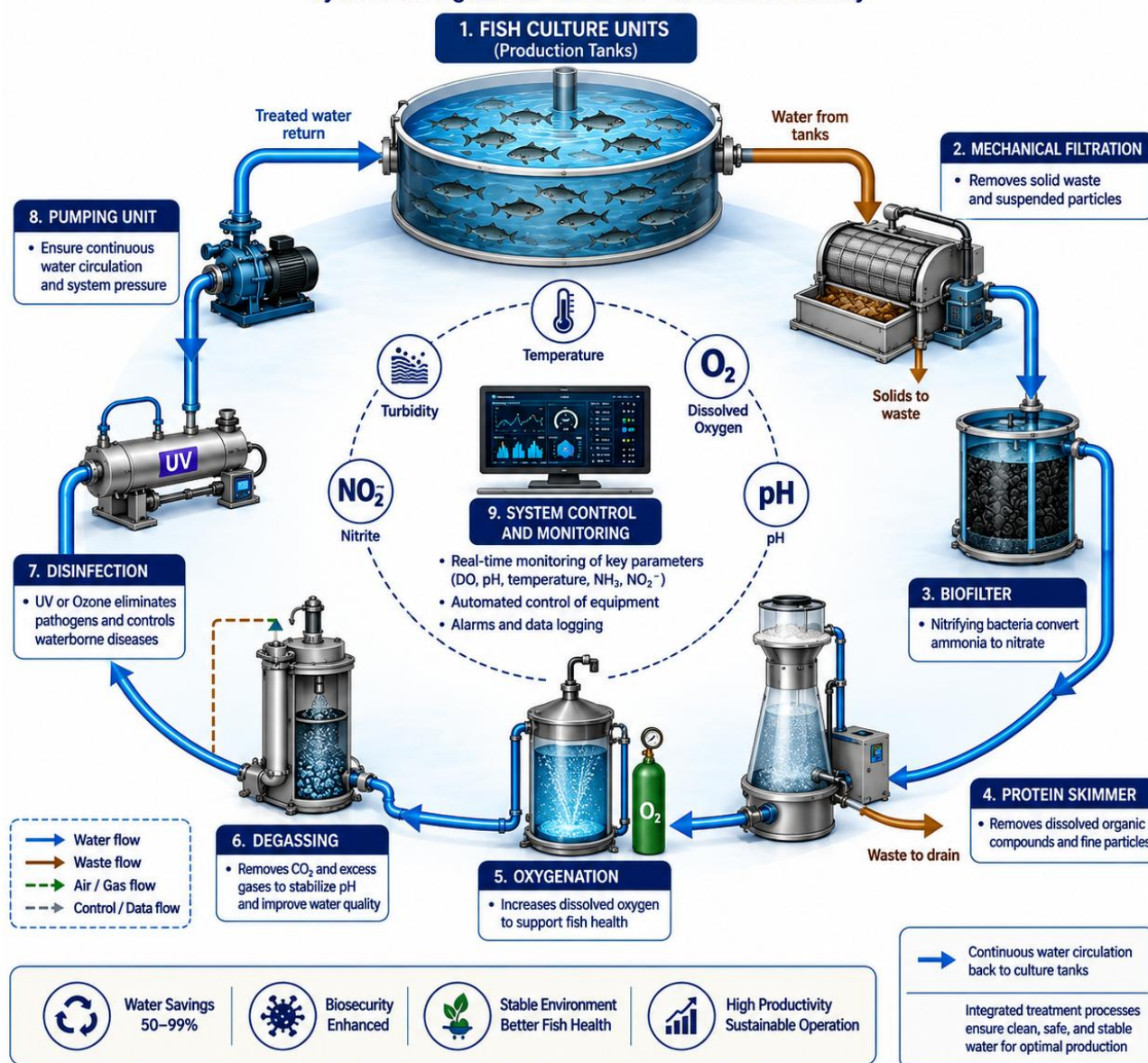


Figure 2 Structural configuration and water treatment pathway of a commercial recirculating aquaculture system

7 Intelligent Technologies and Future Development of RAS Management

7.1 Artificial intelligence and predictive modeling for aquaculture management

Artificial intelligence is becoming a core tool in RAS management because water quality control increasingly depends on predicting system change before biological stress or equipment failure occurs. Recent RAS-focused work argues that future water status must be forecast in advance to support control strategy generation in multi-unit systems, while broader AIoT reviews show that predictive models such as LSTM and related methods are already being used to monitor dissolved oxygen, pH, and temperature for real-time intervention (Yang et al., 2023). This shift matters because predictive management turns monitoring from passive observation into active decision support, allowing farmers to anticipate instability rather than merely respond to it after thresholds are crossed (Huang and Khabusi, 2025).