Wastewater management in the seafood processing industry

The following article is a part of FIFP webinars conducted on 23rd October, 2021 on the topic "Wastewater management in the seafood processing industry"

Note from the Chief Editor:

Wastewater management in the seafood processing industry was the topic of FIFP webinar conducted on 23rd October 2021. Globally, wastewater management has become a major environmental and public health concern. The seafood processing industry, being highly water intensive, has a significant responsibility in reducing environmental pollution through effective wastewater treatment and sustainable water management practices. Wastewater treatment is not only a compliance requirement but an essential component of sustainable seafood processing. In this context, Ms. Chithra's presentation on wastewater management is highly relevant. She covered major aspects of wastewater management in seafood processing industry that included objectives of wastewater treatment, its characteristics, designing a treatment plant, treatment technologies, treatment process and optional advanced treatment processes. Through her presentation, Ms. Chithra highlighted the importance of sustainable wastewater management in the seafood processing industry.

Introduction

Water is one of the most critical resources in the seafood processing industry. It is extensively used for washing raw materials, cleaning equipment, icing, cooking, glazing, and maintaining hygiene standards throughout processing operations. However, along with production efficiency comes the challenge of managing large volumes of wastewater generated during various stages of seafood processing.

According to UN Water (2021), nearly 80% of wastewater worldwide flows back into the ecosystem without adequate treatment or reuse. Untreated sewage, agricultural runoff, and industrial discharges have significantly degraded water quality and contaminated freshwater resources. It is estimated that around 1.8 billion people rely on contaminated drinking water sources.

Global Sustainability Goals and wastewater management

The United Nations Sustainable Development Goals (SDGs), particularly Goal 6, emphasize the importance of ensuring availability and sustainable management of water and sanitation for all. Under the UN Agenda for Sustainable Development, the target for 2030 includes aspects like improving water quality; reducing pollution; eliminating dumping of untreated waste; minimizing the release of hazardous chemicals and materials; halving the proportion of untreated wastewater;

and increasing recycling and safe reuse of treated water. These goals highlight the urgent need for industries, including seafood processing facilities, to adopt efficient wastewater treatment systems and environmentally responsible practices.

Characteristics of wastewater in seafood processing

Wastewater generated from seafood processing contains a variety of organic and inorganic contaminants. The composition and strength of the effluent depend on factors such as type of seafood processed; processing methods employed; water consumption levels; cleaning and sanitation practices; and seasonal production variations.

Typical contaminants present in seafood processing wastewater include blood and tissue particles; protein and fat residues; suspended solids; salts; oils and grease; nutrients such as nitrogen and phosphorus; cleaning chemicals and disinfectants. If discharged untreated, such wastewater can cause severe environmental impacts including oxygen depletion in water bodies, foul odours, eutrophication, and damage to aquatic ecosystems.

Objectives of wastewater treatment

The primary objectives of wastewater treatment in the seafood industry are:

- Protecting rivers, lakes, oceans, and other receiving water bodies
- Preventing environmental pollution
- Protecting public health
- Ensuring compliance with pollution control regulations
- Providing water suitable for irrigation or reuse
- Recovering valuable resources such as energy and nutrients
- Reducing operational and environmental risks

Effective treatment not only safeguards the environment but also enhances the sustainability and reputation of seafood processing facilities.

Designing a wastewater treatment plant

Every wastewater treatment plant is unique and must be designed based on the specific requirements of the processing facility. Several important factors considered during the design stage are characteristics and strength of the effluent; quantity of wastewater generated; type of seafood processing operation; nature of waste produced; disposal method (discharge or recycling); nature of the receiving water body; applicable environmental regulations; odour control requirements; and space availability and operational costs. A well-designed treatment plant ensures efficient removal of pollutants while maintaining operational reliability and regulatory compliance.

Wastewater characterization

Before designing or operating a treatment system, wastewater must be properly characterized. Regulatory authorities specify limits for wastewater discharge into public sewer systems or natural water bodies based on parameters such as pH; BOD (Biochemical Oxygen Demand); COD (Chemical Oxygen Demand); TSS (Total Suspended Solids); TDS (Total Dissolved Solids); organic compounds; inorganic compounds; oil and grease; and nutrient content. Monitoring these parameters is essential for evaluating treatment efficiency and ensuring compliance with environmental standards.

Wastewater treatment technologies

Several biological and advanced treatment technologies are used in seafood processing industries depending on wastewater characteristics and treatment objectives.

Sequential Batch Reactor (SBR)

SBR systems treat wastewater in batches through filling, aeration, settling, and decanting stages within a single reactor. They are suitable for facilities with variable wastewater loads.

Moving Bed Biofilm Reactor (MBBR)

MBBR systems use floating media carriers that support the growth of beneficial microorganisms. These microorganisms degrade organic pollutants efficiently while requiring relatively less space.

Membrane Bioreactor (MBR)

MBR combines biological treatment with membrane filtration, producing high-quality treated water suitable for reuse.

Fluidized Bed Biofilm Reactor (FBBR)

FBBR systems maintain biofilm-coated particles in suspension, providing efficient organic matter degradation and high treatment capacity.

Anaerobic Digestion

Anaerobic treatment processes degrade organic matter in the absence of oxygen, producing biogas that can be utilized as an energy source.

Typical wastewater treatment process in seafood industries

Wastewater treatment generally involves multiple stages to progressively remove solids, organic matter, nutrients, and pathogens. Main stages are collection of waste water; screening; equalization; biological treatment; coagulation and flocculation; primary settling; secondary biological treatment (Nitrification); secondary settling; filtration; disinfection; final treated water; and sludge management.

Wastewater generated from different sections of the processing facility is collected and transferred to the treatment plant using lift stations and pumps. Large solids

such as fish scales, shells, skin, bones, and tissue particles from the wastewater are removed by screening using drum screens. Equalization tanks balance fluctuations in flow rate and pollutant concentration, ensuring stable downstream treatment performance. Biological reactors such as MBBR systems degrade dissolved organic matter using microbial activity. Chemical coagulants and flocculants are added to aggregate fine suspended particles into larger flocs for easier removal. Settling tanks allow suspended solids and flocs to settle under gravity. Secondary bioreactors help remove ammonia and nitrogen compounds through nitrification processes. Tube settlers or clarifiers separate treated water from biological sludge. Filtration systems remove fine suspended particles and improve water clarity. Disinfection processes such as chlorination, ultraviolet treatment, or ozonation eliminate pathogenic microorganisms. The treated water may be safely discharged into the environment or reused for non-potable industrial purposes. Sludge generated during treatment is further processed, dewatered, and disposed of or reused in an environmentally responsible manner.

Optional advanced treatment processes

Depending on the required water quality and reuse objectives, additional advanced treatment systems may be incorporated. The technologies to improve treatment efficiency and support sustainable water reuse practices include Grease traps for removal of fats and oils; DAF (Dissolved Air Flotation) for suspended solids and grease removal; UF (Ultrafiltration) for fine particle removal; Ozonation for advanced disinfection; and RO (Reverse Osmosis) for high-quality water recovery and reuse.

Conclusion

Effective wastewater management provides several environmental, social, and economic benefits such as protection of aquatic ecosystems; conservation of water resources; reduction in pollution load; improved compliance with environmental regulations; enhanced corporate sustainability image; opportunities for water recycling and reuse; recovery of energy and nutrients; and improved operational efficiency. With increasing pressure on freshwater resources and stricter environmental regulations, wastewater treatment is no longer merely a compliance requirement but an essential component of sustainable seafood processing.

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Ms. Chithra M.B is a seafood industry professional with over 30 years of experience in seafood processing, food safety management, quality assurance, operations, auditing, and training across India and the UAE. She currently serves as Quality Control and Operations Manager at Gulf Seafood LLC, Dubai. She holds an M.Sc. in Industrial Fisheries from Cochin University of Science and Technology and has extensive expertise in HACCP, FSSC 22000, BRCGS, HALAL, food safety training, laboratory management, and supplier auditing. She has participated in several international food

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