15. Fish industry waste: Treatments and environmental impacts

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Introduction

Increase in the number of food processing industries all over the world forced the issue of management of waste generated. Generation of solid and liquid waste in the food industries decreases availability of food and increases pollution potential. Seafood processing industry is also facing the same issue even though they differ in the type of raw material used, utility of water and processing method. Regular processes associated with waste generation in seafood processing units are beheading, gutting, filleting, shrimp peeling etc and the waste generated is enormous. The waste generation after filleting process is approximately 75% of total fish weight. Solid waste generation in fish processing ranges from 50 to 80% of original raw material (Mathew, 2010). Different components of solid waste include scales, skin, bones, meat portions, viscera, shells of prawns and crabs etc. The disposal of seafood waste not only has significant cost but also have major impact on environment.

Waste water from fish processing industries originates from sources such as fish unloading, dressing, melt water from melting of ice, equipment and

utensil washing, treatment with additives, cleaning and disinfection of facilities and premises. Other than cleaning of fish, water is used for flushing of offal, blood and slime from surfaces of processing equipments, utensils, floors drains and sumps. Automated processing equipments are mostly installed with water spray system which can clean equipment to remove offal. As these processes are resulting in high water consumption and also cause mixing of the rinse water with offal and blood. Seafood processing waste water contains considerable contaminants in soluble, colloidal, and particulate forms (Chowdhury et al., 2010). Characteristics of waste water generated will differ with species of fish used for processing, type of processing method, end product prepared. The severity of contamination can vary with processing operation such as small (washing or cleaning of fish) mild (fish fillet making) and heavy (preparation of surimi). Very high level of biochemical oxygen demand (BOD), fat, oil and grease (FOG), and nitrogen are important characteristics of seafood waste water (Tay et al., 2016). High content of organic material make the pollution potential of effluent very high (Bugalo et al., 2012).

Treatment of seafood processing waste water

Different treatment measures for seafood processing waste water include primary treatment, biological treatment and physico chemical treatment.

Primary treatment

Primary treatment is for reducing the contaminant load prior to other treatment measures. In this stage removal of substantial content of

insoluble floating matter can be carried out by physical and chemical measures. Major consideration should be given to the quick removal of solid contents in order to reduce the development of BOD and COD (chemical oxygen demand). This treatment includes screening, sedimentation, flow equalization, and dissolved air flotation which can reduce a maximum of 85% of total suspended solids, 65% of BOD and COD content. Larger solids (≥0.7 mm) can be removed by screening. Screening by tangential method and rotary drum are commonly used for solid removal from wastewater generated in seafood processing industries. Immediate screening of fish solids with low intense agitation is recommended to avoid break down of solids. Sedimentation helps in removing solids from water by utilizing gravitational force. Depending upon the species and process used for processing, oil and grease content can be removed by dissolved air floatation (DAF) technique using tiny air bubbles to get rid of floating material.

Biological treatment

Biological treatment utilizes microorganisms to eliminate soluble nutrients from discharge (Henry & Heinke 1996). The organic content of the waste water can be utilized by microorganisms mainly heterotrophs. The microbial population active is different complex groups which are related each other. Genera such as *Pseudomonas*, *Nocardia*, *Flavobacterium*, *Achromobacter*, and *Zooglea* are involved in single aerobic unit. Protozoas and rotifers are usually occurring in a well functioning system, and consume dispersed bacteria and non settling particles. The wastewater

processing by biological method is broadly divided into aerobic and anaerobic type. In case of aerobic system, microbes of aerobic and facultative nature play major role and in case of anaerobic system is predominated by anaerobes.

Colloidal and dissolved form of organic material will be converted in the form of useful final products in biological systems. Efficiency of the system will depend upon the continuity of process. Frequent methods of aerobic operation include activated sludge systems, lagoons, trickling filters and rotating disc contactors. It also generates a consolidated waste stream containing microbes in excess and has to be disposed appropriately. The major considerations for aerobic treatment system are area availability, suitability to operate for seasonal periods in seafood processing industries, operational skill and cost involved.

Mixed group of acclimatized micro organisms in an activated sludge system utilizes organic matter content in waste water along with dissolved oxygen and soluble nutrients. Soluble organic material will be converted into carbon dioxide and cellular materials. The effluent is allowed to settle to take apart biological matter along with sludge content. These types of systems are originated in England 1900s. Type of activated sludge system using in the seafood waste treatment is extended type which utilize elongated timing for aeration and less untreated load (Tay et al., 2006). For optimum operation primary screening and flow equalization before activated sludge practice is necessary. Compared with other food-processing waste waters, seafood waste requires higher oxygen availability

for stabilization. The frequent methods of activated sludge practice are conventional and continuous flow stiffed tanks. During the conventional system waste water is dispersed in the aeration unit, and the flow direction is set using baffles in plug flow way and it requires high oxygen and organic load. A simple activated sludge system is given in the Figure 1. Inflow streams are completely mixed systems with many points for facilitating proper homogenization and two different resident times of shorter duration are ensured in this system. In the cases of insufficient land space, aerated lagoons are used which are excavated earthen systems where there is no recycling of solid waste.

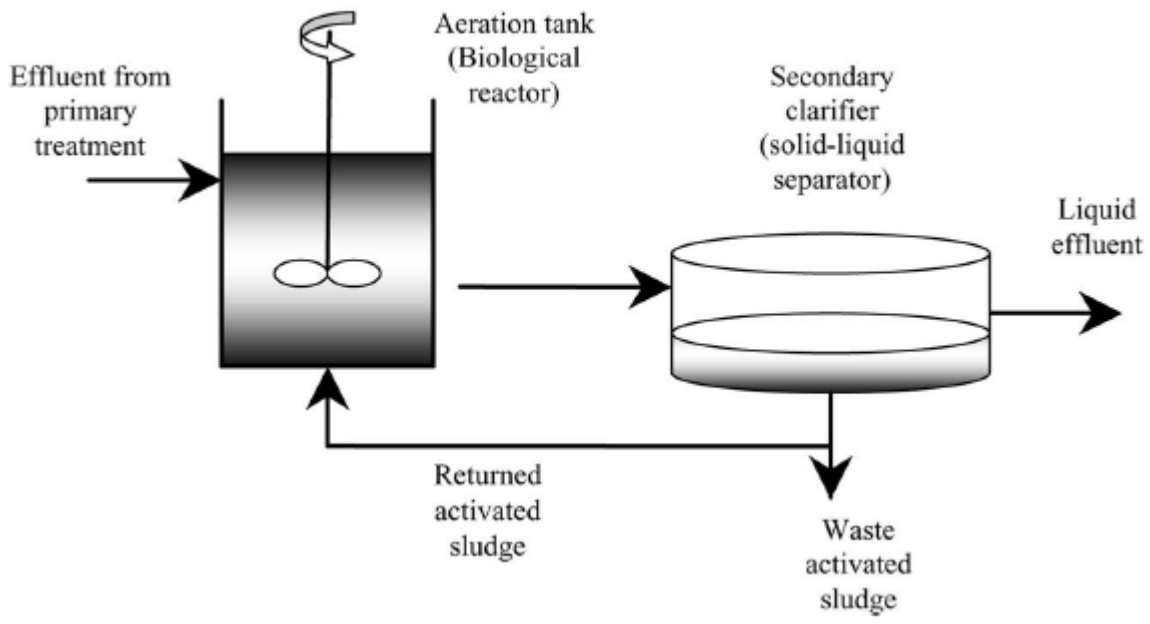

Figure 1. Simple activated sludge system

Anaerobic form of biological treatment is can be used in cases of high BOD

such as blood water or stick water. In case of anaerobic treatment the organic load in the waste water will be initially changed to dissolved form of organic matter, and then utilized using acid-producing bacteria resulting volatile fatty acids, carbon dioxide and hydrogen. The end products will be utilized by methane generating bacteria and convert it to methane and carbon dioxide. Main microbes associated are *Metanobacterium, Methanobacillus, Metanococcus, and Methanosarcina*. Efficient closing of digestion tanks is essential for the success of the anaerobic system.

Physico chemical treatments

The different physico chemical treatment measures are coagulation/ flocculation, electro coagulation, disinfection by means of chlorination, ozonation, UV radiation etc. In case of coagulation, colloidal organic material in the seafood waste water will be destabilized in presence of a chemical coagulant under rapid mixing, followed by settling of particles and collection of clarified effluent. Coagulation of protein rich waste water can be carried out by adjusting the pH by means of acid or alkali addition. Other commonly used coagulants are polyelectrolytes of anionic and cationic nature. It should be ensured to use a non toxic coagulant to make utilize the recovered sludge for animal feed preparation. Electro coagulation systems are reported which utilizes electric charge for coagulation, but the BOD reduction level was comparatively lesser in these systems. Another physico chemical treatment measure is disinfection using bactericidal agents like chlorine, ozone (O_3), and ultraviolet (UV) radiation.

Energy efficient low cost effluent treatment plant by ICAR-CIFT

ICAR-CIFT has developed the technology to trim down or improve and recycle water and organic matter from seafood processing unit. A theoretical plan was prepared for the management and clearance of waste produced from all activities of seafood processing unit. Thrust points are

- The effluent produced out of treatment process obey the terms specified by CPCB / state PCB's
- Recycled water can be appropriately used again for activities of seafood processing unit
- The space required for setting up of the facility is less
- Atmospheric pollution free & environmental technique
- Power required is less
- Simple to operate
- Less initial investment cost

ICAR-CIFT, Cochin gives this technology on consultation basis.