CLEANER PRODUCTION ASSESSMENT AND TREATABILITY STUDY OF WASTEWATER FROM FISH PROCESSING INDUSTRY

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Abstract: The rapid industrialization of India in the recent past has been the striking feature of Indian economic development. But the other perspective of industrialization has been the serious damage to the surrounding environment due to the wastes and pollutants generated from the industries. Typically, there are two different types of environmental innovations that mitigate the environmental burden of production: cleaner production and end-of-pipe technologies. Cleaner production reduces resource use and/or pollution at the source by using cleaner products and production methods, whereas end-of-pipe technologies curb pollution emissions by implementing add-on measures. Thus, cleaner products and production technologies are frequently seen as being superior to end-of-pipe (EOP) technologies for both environmental and economic reasons. This research assessment aims to study the cleaner production approaches through CP tools and methodologies leading to reduces resource use and/or pollution at the source by using cleaner products and production methods and to study biodegradability of the waste and based on it, deciding the suitable method of treatment of wastewater from fishery industry and its various plants at veraval.

***IndexTerms* – Cleaner Production, Fish Processing wastewater.**

1 INTRODUCTION

In 1992, the concept of Cleaner Production (CP) was developed, at the Rio Summit, a programme of United Nations Environment Programme (UNEP) and United Nations Industrial Development Organization (UNIDO) which was focused on the reduction of impact on environment from industries.
Cleaner production is a pro-active and integrated solution to pollution problems by eliminating or reducing pollutants at the source during the course of production processes.
Cleaner production, with great strength and flexibility, begins a new era of "Pollution Prevention" Cleaner Production concepts have consequences for the whole life cycle of a product and can adopt improvements in product design, selection of raw materials, efficiency in production and/or energy usage, safety during manufacture and consumer use, reparability, and recyclables.
Cleaner Production (CP) aims to reduce the consumption of natural resources per unit of production, the amount of pollutants generated, and their environmental impact, while making alternative products and processes financially and politically more attractive.
Properly implemented CP increases profitability, lowers production costs, enhances productivity, lowers risks and liability, improves Company image, improves worker's health and safety conditions, reduces waste treatment and disposal costs, saves costs on raw material, water and energy.
The characterization of wastewater and its treatment is also done keeping in mind the concept of CP.

1.1 CP Tools

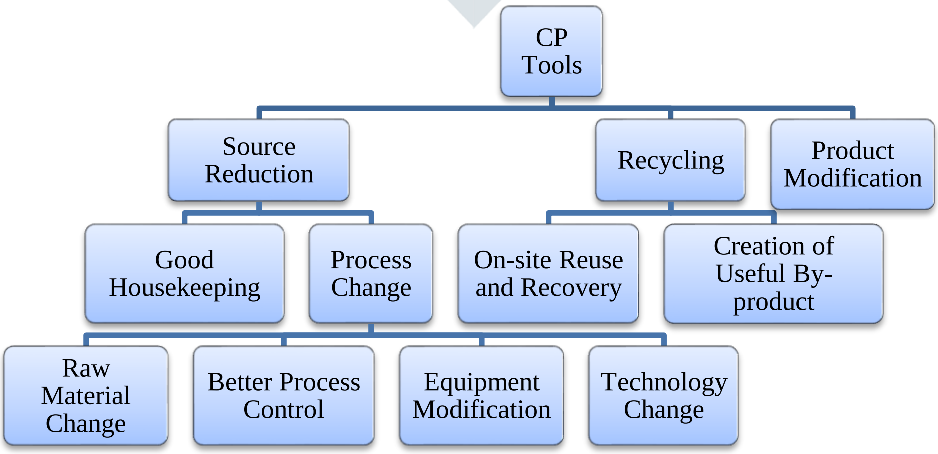

Figure 1: Classification of CP Tools

To properly implement CP, following CP tools can be effectively considered to execute the production cleaner and green.

1.2 Production Process

The major steps involved in processing of shrimps include raw material receiving, beheading/gutting/deveining, washing, grading, weighing, freezing, packing, frozen storage and dispatch. Other minor steps which are also very important includes glazing, chemical treatment, thawing, wrapping and metal detection. The entire processing area is air-conditioned. The major steps are explained below.
During the walkthrough, we observed that there are 3 types of operation & functioning of work depending upon quantity of raw material received, availability of labors and demand of product.

1. When the raw material is in excess or labors to raw material ratio is low the following operations are conducted.

   Raw Material Receiving → Plate Freezing → Storage

2. When the labors staff is full and when the raw material received is of customer demand the following operations are conducted.

   Raw Material Receiving → Preprocessing → Processing → Freezing
   Packing → Dispatch →

3. When there is a demand of particular product (Which was stored earlier)

   Preprocessing of Stored Material → Processing → Freezing →
   Packing → Dispatch

2 Assessment/Experiments

2.1 Waste Identification:

During the walkthrough at the plant, following waste streams were identified and calculated the total quantity of the waste generated during the whole day and its cost was calculated accordingly.

Table 1: Waste Identification from various processes

Process	Types of waste generated and its amount
Raw Material Receiving	**Waste type: Solid** • Some unwanted marine species came along with the desired raw material. • Defective pieces. **Amount of waste generated = 0.5% of total raw material received.** **Waste type: Liquid** • Spillage of black ink on floors and weighing balance due to damage of ink-sacks. • Wastewater discharge due to first washing and removal of ice in received containers. **Amount of waste generated = 2kLD**
Beheading/ Peeling/ Deveining	**Waste type: Solids** • Removed heads and/or skins/scales of shrimps. • Defective pieces. **Amount of waste generated = 30–32% of total raw material**
Grading	**Waste type: Solids** • Removal of shrimps with black spots, broken pieces, irregular texture, deterioration, foreign objects, loose legs/ veins. **Amount of waste generated = 5–7% of total raw material** **Waste type: Liquid** • Wastewater discharge due to second washing which may also contain flushing of some removed skin, veins of shrimps and squids. **Amount of waste generated = 2kLD**
Freezing	**Waste type: Liquid** • Water used to de frost the plate freezer. **Amount of waste generated = 12–15 kLD**
Thawing	**Waste type: Liquid** • To attain normal temperature of frozen slabs, twice or thrice the water is to be changed.

	Amount of waste generated = 8–10 kLD

2.2 Wastewater Characterization:
All the analysis and testing of wastewater parameters were carried out by following the APHA 20th edition.

Table 2: The general wastewater characteristics:

Parameter	Unit	Value
pH	N.A.	7.24
TDS	mg/l	13,980 – 15,527
TSS	mg/l	835 – 1,080
BOD	mg/l	900 – 1,100
COD	mg/l	2,000 – 2,200
Chlorides	mg/l	8,747 – 9,565

As the BOD/COD ratio is approximately 0.5 which indicates the wastewater is highly biodegradable, hence it was decided to provide aerobic treatment to the wastewater.

3 RESULT AND DISCUSSION

3.1 Cleaner Production Options:

Based on observations during the walkthrough, following cleaner production options were considered for implementation.

Table 3: CP Options and its benefits

Sr. No.	CP Options	Economic & Financial Benefits	Environmental Benefits
1.	Use of wipers for floor cleaning instead of running water	• Water drawing and transportation cost reduction.	• Conservation of water.
2.	Reuse of water from Thawing process or use of Automatic Thawing Machine	• Water drawing and transportation cost reduction.	• Conservation of water.
3.	Industrial symbiosis of waste generated during peeling & degutting	• Saving disposal cost.	• Reuse, recycle.
4.	Collection and use of black ink from raw materials in separate chamber	• Revenue generation. • Reduction in treatment cost.	• Less load on ETP & CETP.
5.	Boiler water recycle and heat recovery in cooking unit	• Saving in fuel	• Reduction in carbon emission.
6.	Collection and segregation of plastic pin from squids	• Revenue generation. • Medical Purposes.	• Reduction in solid waste generation.
7.	Use of Water saver adaptor	• Saving in water and electricity bill.	• Conservation of water and electricity
8.	Reuse of water used for de-frosting of plate freezer.	• Saving of water and electricity bill.	• Conservation of water and electricity.
9.	Treatment of Wastewater through anaerobic digestion	• Use of biogas as fuel.	• Reduction in use of non-renewable energy resource.
10.	Refrigeration piping network modifications	• Saving in electricity bill	• Conservation of electricity.
11.	Refrigeration system controls	• Saving in electricity bill	• Conservation of electricity.
12.	Installation of VFD	• Saving in Electricity bill.	• Conservation of electricity.
13.	Install desuperheater on ammonia chiller	• Energy Saving and Waste Heat Recovery	• Reduction in emission of ammonia
14.	Use of high efficiency/low heat illumination system	• Saving in electricity bill	• Energy conservation
15.	Use of cogged v-belts	• Transmission efficiency increases by 3-5%	–

16.	Use of alternative energy source.	• Saving in electricity bill	• Energy conservation and reduction in carbon emission.

3.2 Cost Estimation/Savings:

1. Use of wipers for floor cleaning will save 35 – 45 KLD water which will save about INR 1200 daily and yearly savings of about INR 4,38,000 with immediate payback.
2. Reuse of water from Thawing process will save 4.68% of daily water consumption with yearly saving of about INR 2,19,000 with immediate payback.
3. Reuse of water used for de-frosting of plate freezer will save around 3.75% of daily water consumption with yearly saving of about INR 1,46,000 with immediate payback.
4. The estimated pipe length of typical installation in a processing facility in the plant is about 70–200 meters. Replacement of pipe and the insulation, together with valves may reduce the electricity consumption up to 5–8% and the yearly savings of about INR 6,00,000 with payback period 5 months.
5. VFD can be installed in condenser fans to maintain required condition with minimum energy consumption. About 20% reduction in fan speed will reduce power consumption by about 50%. The simple payback period for VFD system on condenser fans is less than a year. The installation cost accounts for 10 to 12 lakhs which reduces energy consumption by 6% with payback period of 2 years.
6. LED lights are claimed to produce minimum 80% of original light output with a life of about 50,000 hours. Use of LED lighting will help in reducing electricity bills required for illumination system up to 55% with a simple payback period of 1.5 years.

3.3 Wastewater treatment:

For the treatment of wastewater Aerobic Sequential Batch Reactor of 5 litres volume and 3 litres working volume. Air was supplied through diffusors and mixing was provide using magnetic stirrer at the rate of 100 rpm. To run anoxically, aeration and mixing were turned off. Different sets mentioned above were tested and the following results were found. BOD removal was found to be in the range of 68% to 93% and COD removal was found upto 81.42%.

4 CONCLUSIONS

After implementation of the aforesaid CP options the selected fish processing industry will conserve around 85 – 98 kiloliters of fresh water consumption daily and around 16% – 23% energy conservation along with these saving of more than INR 17,00,000 – 22,00,000 per year per processing plant of the industry. Apart from this, the wastewater generated from these plants can be effectively treated by Aerobic Sequential Batch Reactor. After all sets of lab-scale experiment it is concluded that the maximum BOD removal was found out to be 93% and maximum COD removal was 81.5% at the end of day 3.

5 REFERENCES

[1] AmbA, E. F. (1993). Fish meal industry improvements in water and air quality using cleaner technology. J. Cleaner Prod, 1(1), 29.

[2] Barros, M. C., Bello, P. M., Bao, M., & Torrado, J. J. (2009). From waste to commodity: transforming shells into high purity calcium carbonate. Journal of Cleaner Production, 17(3), 400-407.

[3] Bezama, A., Valeria, H., Correa, M., & Szarka, N. (2012). Evaluation of the environmental impacts of a Cleaner Production Agreement by frozen fish facilities in the Biobío Region, Chile. Journal of Cleaner Production, 26, 95-100.

[4] C. Fabiani, F. Ruscio, M. Spadoni and M. Pizzichini, Desalination, 108 (1996) 183–191.

[5] Ching, Y. C., & Redzwan, G. (2017). Biological Treatment of Fish Processing Saline Wastewater for Reuse as Liquid Fertilizer. Sustainability, 9(7), 1062.

[6] Cristóvão, R. O., Botelho, C. M., Martins, R. J., Loureiro, J. M., & Boaventura, R. A. (2015). Fish canning industry wastewater treatment for water reuse–a case study. Journal of Cleaner Production, 87, 603-612.

[7] Dan, N. P., Visvanathan, C., & Kumar, S. (2003). Cleaner production potentials in seafood processing industry: a case study from Ho Chi Minh city, Vietnam. Cleaner production in the plastic and seafood industry in Ho Chi Minh city, Vietnam. Department of Environmental Science and technology of Ho Chi Minh city, Ho Chi Minh city.

[8] Daneshvar, E., Sohrabi, M. S., Kousha, M., Bhatnagar, A., Aliakbarian, B., Converti, A., & Norrström, A. C. (2014). Shrimp shell as an efficient bioadsorbent for Acid Blue 25 dye removal from aqueous solution. Journal of the Taiwan Institute of Chemical Engineers, 45(6), 2926-2934.

[9] Fabbricino, M., & Gallo, R. (2010). Chromium removal from tannery wastewater using ground shrimp shells. Desalination and Water Treatment, 23(1-3), 194-198.

[10] Fabbricino, M., & Pontoni, L. (2016). Use of non-treated shrimp-shells for textile dye removal from wastewater. Journal of Environmental Chemical Engineering, 4(4), 4100-4106.

[11] Ferraciolli, L. M. D. V., de Bem Luiz, D., dos Santos, V. R. V., & Naval, L. P. (2018). Reduction in water consumption and liquid effluent generation at a fish processing plant. Journal of Cleaner Production.

[12] Tay, J. H., Show, K. Y., & Hung, Y. T. (2006). Seafood processing wastewater treatment. Waste Treatment in the Food Processing Industry, 29-66.