Waste minimization and energy conservation in gelatin production by raw material size minimization

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Abstract— Based on current manufacturing system of gelatin production, cleaner production opportunities are discussed considering aspect such as waste minimization, energy conservation, etc. Improving the utilization of inputs and minimizing the production of unwanted or low value outputs is fundamental to improving profitability. Adopting cleaner production also helps in awareness of consequences of environmental practices that are unfriendly and that are detrimental to the industry's bottom-line. Adopting cleaner production may require onetime investment or it can be done with zero cost. A few process changes and good housekeeping in production of gelatin may increase gelatin yield and reduces wastewater quantity. Process changes such as automatic handling of machines, direct packaging etc leads to environmental as well as financial benefits. Byproduct utilization and wastewater reuse are other benefits of cleaner production. This paper discuss about current process followed in gelatinization, suggestion of cleaner production opportunities throughout the process and cost benefit analysis for suggested cleaner production opportunities. Major advantages from cleaner production in gelatinization here is byproduct reuse and waste water reutilization.

Keywords: Cleaner production, Gelatinization, Waste minimization and reuse

I. INTRODUCTION

Cleaner production is the maximum feasible reduction of all waste generated at production sites. It involves judicious use of resources through source reduction, reuse of material, water conservation; energy efficiency etc. preventing or recycling at the source eliminates the need for off-site recycling or treatment. Pollutant elimination at or near the source is typically less expensive than collecting, treating and disposal. Cleaner production facilitates energy conservation and raw material, cost reduction, , environmentally sound process, increased efficiency , etc.

Gelatin (word derived is from Latin word 'gelatus'= frozen), it contains 80-90% protein and is used extensively in the metal refining, food and photographic industry, also in such diverse industries as cosmetics, paper, plastics, pharmaceutical and toiletries. The raw material for gelatin is the collagen, naturally occurring protein, which is sourced from meat industry. From its earliest uses, when boiled up into broth, which when cooled produced a nutritious jelly, gelatin. Like its raw material, collagen, gelatin is made up of many different amino acids which are the building blocks of all proteins. Bloom value is a measure of the gel strength of a particular type of gelatin indicating the firmness of the gel. Different bloom strengths are required for different applications and must be considered together with other performance characteristics when selecting a suitable grade of gelatin.

Methodology followed for research work has been done with Literature survey in order to understand the cleaner production methods and tools. It also helps to understand research work done previously. It also helps in understanding different types of plans or the strategies for abatement or reduction of waste from the process. Primary survey is done to know about existing manufacturing process and its efficiency , generation of waste , utilities required , second is to do questionnaire survey in plant and Secondary data collection to obtain information about per day production, electricity consumption , waste generation (overall as well as in each step),material consumption, method of disposal , financial condition, present manpower , equipment, etc. To obtain result Compilation of data is done and associating it in order to compare the data before and after cleaner production.

II. INDUSTRY PROFILE

Industry studied for the research produces gelatin with specific bloom strengths suited to a variety of applications in the pharmaceutical and food industry. Gelatins are suitable for a variety of uses in the pharmaceutical industry, including hard and soft shell capsules; vitamin encapsulation, tablet binding and others. Product Ranges offered limed processed (Type B) Pharmaceutical gelatins with Bloom gel strengths ranging from 150 to 270.

A. Gelatinization

Pretreatment includes cleaning of raw material, based on type of raw materials two type of process followed to make gelatin- in acid process The raw material (pigskin) is subjected to a 24-h conditioning process. This involves treatment with acid. After this,

PHYSICAL CHARACTERISTICS	
Appearance	Colorless or pale yellow powder or granules
Bloom %	±10g
Moisture %	Max 13
Ash %	Max 2
pH	5-6.5
CHEMICAL CHARECTERISTICS	
Arsenic in ppm	Max 1
Lead	Max 1
Copper	Max 3
Zinc	Max 100
So2	Max 1000
MICROBIOLOGICAL CHARACTERISTICS	

Total count	Max 1000
Salmonellae in 10g	Absent
Coliforms in 0.1g	Absent

Table 1: Typical specifications

the gelatin can be extracted. Where as in Alkaline process the raw material (bovine hide) is subjected to several weeks of treatment with alkali. This enables the collagen structure to be gently transformed. The collagen it contains, now softened by the pretreatment, can now be extracted using warm water. The raw materials are then treated with warm water, the gelatin being removed in a number of process steps in contaminated form. The first gelatin extracts, obtained at relatively low temperatures, are firm and have a light color compared to final product. The extraction solutions contain approximately 6 % gelatin. After these first extracts, the remaining material is treated with fresh water, at a higher temperature compared to previous step. This sequence is continued until all the gelatin has been extracted into solution. A variation of this classical extraction process is the so-called continuous process. The desired properties of the gelatin can be adjusted by means of temperature and Ph. The gelatin solution obtained from the extraction process is placed in high-performance separators where it is freed from residual traces of fat from the raw material and from any insoluble particles. Precoat filters are then employed to remove fine-particle contamination with the help of ultrafilteration process, followed by ion exchange process. Purification of the gelatin is completed by removing any salts present using an ion exchange process. Plate and frame filter with manual operation is also used to get the concentrate. In the concentration step, multi-stage vacuum evaporators are used to remove part of the water from the dilute gelatin extraction solution in a gentle process. In this way, the gelatin becomes viscous, highly viscous solution is then passed through polishing filters made of cellulose plates; these remove the very finest of particles that may remain. Noodles of liquid gelatin is now formed. Subsequent to the concentration step, the gelatin solution is heat-sterilized for safety purposes; it is then cooled and set. The gelatin is now in the form of gelatin noodles; these are then run onto a enclosed conveyor belt of a dryer. Here, the gelatin is dried. At the end of the drier, the now hard and brittle gelatin is broken up and stored in the warehouse until required for further use. Individual batches are only released for further use on the successful completion of physical, chemical and biological testing in the lab. Gelatin is packed in multiply paper sacks, all containing a polythene liner. Gelatins should be stored in the sealed containers in cold dry conditions away from odoriferous materials. Under such conditions, gelatins are generally considered to be stable almost indefinitely.

III. CLEANER PRODUCTION OPTIONS

After studying entire process of gelatin production cleaner production options are generated at several stages for environmental and economic benefits. At primary stage of process, bone washing is done which requires large quantity of water. Waste water produced at other steps can be used again for bone washing as it does not required standard quality of water. Raw material minced smaller than usual can speed up process at every stage. After extraction phase in the process, by product produced has property like dichlorophosphate, hence it can be used as animal feed. Industry uses 4 manual filter press, for which flow rate of filtrate is less instead use of 2 filter press at a time can increase the flow rate and pressure required for filtration can also be increased. Waste water in huge quantity is generated in settling stage, filtration process, and evaporation. At first stage of evaporation only 6% of gelatin is retrieved and then it is followed by second stage of evaporation. Instead if waste water generated at each stage of process is sent back to settling again, more amount of gelatin can be regained. Effluent discharge practice at each stage can be done by practicing controlling spills at filtration stage, draining of pipe before cleaning and use of automatic shutoff systems which can result in BOD reduction in waste water and Reduced trade waste discharge volume and loading. Storage of gelatin noodles and gelatin granules require cold and dry condition. After formation of gelatin, it is stored in ware house where cold and dry condition for quality of gelatin is maintained, instead of open storage of gelatin it can be directly packed in to desired quantity.

Per day production	7-8 tons
Wash water requirement	8.5 m^3/ton
Total waste water produced per ton gelatin	2000-3000 tons
Byproduct produced	Dichlorophosphate
Process type	continuous
Electricity consumption per day	45Kwh

Table 2: production details

IV. RESULT

Result obtained from process study and cleaner Production suggestions showed that there can be huge conservation of energy and water by adopting simple cleaner production methods. In many stages such as filtering there can be reduction in cost too. For example if instead of 4 filter press only 2 is used according to need, it saves amount of 2 filter press as well as energy required for it is conserved. In preliminary stage of mincing of raw material when it is minced to very small size than usual, time require for washing and mincing reduced to 1-4 hours instead of 10-60 hours hence energy required in case of the process for such long duration has been reduced to more than 10%. Waste water is used again for washing, BOD reduction; proper handling of effluent discharge time and energy in waste water treatment is conserved. Gelatin is stored in cold, dry condition so when it is directly packed cost of storage and maintenance of specific condition is saved.

Condition before CP	**CP Options**	**Environmental benefit**
Mincing of raw material	Mincing in very small size	Conservation of water up to 5 m^3/ton, residue after extraction is negligible
Fresh water used for bone washing	Use of waste water for bone washing	Conservation of fresh water and reduced quantity of waste waster
Total 4 filter press used with low flow	Use of 2 filter press for filtering	Conservation of energy and increased efficiency.

rate and pressure.		
Waste water at each stage is discharged as effluent.	Waste water at each stage is fed back to settling tank for retrieving gelatin out of it.	BOD reduction in waste water.
Effluent discharge	Spill control, drainage of pipe adopted.	Clean process
Storage of gelatin at cold, dry condition in ware house	Direct packaging of gelatin.	Conservation of energy and reduced wastage of product in in-house transportation.

V. CONCLUSION

The adoption of simple techniques without many changes in process and without cost involvement can also lead to environmental and economical benefits. From study conducted above it is concluded that small process change where waste minimization and energy conservation can lead to major benefits such as reduction in BOD in waste water, controlled use of water, limited use of electricity, increased efficiency, reduced process time, etc. hence in gelatin industry adoption of feasible cleaner production opportunities helps in improvisation.

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