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A Review on Conversion of Wastes to Wealth in Textiles

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Abstract

Ready-made garment industries and backward linkage industries of the textile sector produce huge wastes. These wastes create environmental pollution due to lack of implementation of suitable technics. But these wastes can become wealth for human beings if appropriate and eco-friendly conversion methods are applied to manage these wastes. There are several suitable options to convert textile wastes to wealth, such as the conversion of biogas from both effluent and sludge. The fabric waste obtained from ready-made garment industries is suitable to export globally. A comprehensive literature survey has been done and discussed in this review article.

Keywords: Textile Waste, Conversion, Wealth, Biogas, Recovery, Reuse.

1. Introduction

A large quantity of readymade garments has been produced every day globally. To support readymade garment industries many backward linkage industries are essential, such as yarn manufacturing, fabric manufacturing, and wet processing industries. These industries produce yarn, fabric, and dyed fabric. Eventually, readymade garments are produced using different types of fabrics. Due to the production of textile materials, large quantity of both of solid and liquid wastes is generated. From yarn manufacturing industries huge quantity of cotton dust is produced. The wet processing industries use huge water resulting production of wastewater after production. Bangladesh is a large ready-made garment-producing country. In 2016, Bangladesh produced 1.8 million metric tons of fabrics resulting in production of 2.17 million m^3 wastewater from wet processing industries [1]. The solid wastes generated from textile industries can be classified into three categories based on yarn, fabric, and ready-made garment, (a) wastes due to production (b) pre-consumer wastes, and (c) wastes generated after use, [2]. Another type of solid waste is generated after the treatment of textile wastewater is called sludge, [3]. It was reported that, a large quantity of sludge generates every year from the textile sector of Bangladesh (2.81 million metric tons) [3]. All of these wastes generated from the textile sector could be converted to wealth by implementing appropriate methods. This paper covers a comprehensive review of suitable conversion methods of textile wastes to wealth.

2. Discussion

2.1. Conversion of wastes to wealth in yarn manufacturing technology

The cotton fiber is designated as white gold in cotton textile mills because of its features as fibre characteristics. In yarn manufacturing technology cotton is processed from blow room to ring-frame where eventually it is converted to yarn. The soft waste generates in the preparatory section which is suitable for

reusing using appropriate waste management technics [4]. Fibre forms of wastes are called soft wastes in spinning mills. These are suitable to produce further yarn of low quality. For example, coarser count yarn and open-end yarn belong to this type of yarn [5]. The spinning waste can be converted to biogas which is a significant method of conversion of this waste to wealth and this method can also be designated as a conversion of waste to energy [6].

2.2. Conversion of wastes to wealth in wet processing industries

Bangladesh is contributing to global ready-made garment production. Many wet processing units are essential to support ready-made garment industries. It was reported that 1500 billion ground water is consumed every year in wet processing units of Bangladesh [3]. After processing these wet processing units discharge 2 million m^3 wastewater every day in Bangladesh [3]. These wastewaters could be used to generate biogas. Opwis et al. reported an innovative method for conversion to biogas from desizing wastewater [7]. The authors stated that the water-insoluble starch is hydrolyzed to oligosaccharides which are water-soluble in nature during conventional desizing where amylases have been used. The enzymatic desizing also creates a high COD load because of the existence of a high concentration of carbohydrates. The wastewater generated from this process creates environmental pollution. To get rid of the pollution problem due to the discharge of wastewater created by desizing process, a creative technique could be introduced. The technique belongs to the conversion of desizing wastewater to biogas which is a suitable conversion method of waste to wealth. Microbes were generated by the fermentation of liquors which produced biogas. A biogas plant with more than 500 L capacity was used for several weeks. This biogas plant was capable to reduce more than 85% chemical oxygen demand (COD). This method was considered as an attractive method for economic and environmental benefits.

Textile industries require huge water. As a result, a large quantity of wastewater is generated. For safe discharge of wastewater different types of effluent treatment plant is used. Among those physiochemical, biological, and biochemical effluent treatment plants (ETPs) are widely used for textile wastewater treatment. After treatment of Textile wastewater, an inevitable semisolid is generated which is called sludge. A large quantity of sludge creates further threats to the environment. But by utilizing the appropriate method this solid waste can be converted to energy which is a very suitable and sustainable technic in textile waste management. This sludge can be converted to biogas by anaerobic digestion. Guha et al. reported a sustainable eco-friendly technic for biogas generation from textile sludge [8]. They explained that, typical biogas consists of methane (CH_4, 50-75%), carbon dioxide (CO_2, 25-50%), nitrogen (N_2, 0-10%), hydrogen (H_2, 0-1%) and H_2S (0-3%). Authors described that the textile sludge is very harmful to create environmental pollution if it is disposed here and there. The textile sludge possesses high biodegradability. The sludge was treated for anaerobic digestion at 35.0 °C and pH 8.5. Sodium bicarbonate ($NaHCO_3$) was used to maintain an alkaline condition, initially, authors performed lab-scale experiments to the possibility of generation of biogas. After successful lab experiments, they implemented a pilot project to convert sludge to energy. The authors used 25 kg sludge with 20 L liquid sludge (sludge in water), 3 kg cow dung, and 450 g sodium bicarbonate for anaerobic, at 35 °C for 10 days. After anerobic digestion 11 cft biogas was generated which was used for cooking food of a family for 4 days (12h). Due to the hazardous nature of textile sludge generation of biogas is also feasible by mixing it with municipal wastes. After the generation of, a large quantity of residual sludge remains. This residual sludge could be utilized for the construction of

roadways [9]. Authors performed lab-scale experiments to check the possibility of use of both raw and residual sludges in roadway construction. They succeed in lab-scale experiments. The authors also proposed that the textile sludge can be co-processed with cement which will be suitable for the construction of septic tanks and rings for the sanitary latrines in rural areas.

Textile sludge is also suitable for composting on non-crop plants. Guha et al. reported in another report that it could be used for composting on tagar, joba, gandhoraj, mehogony, and rain tree [10]. According to the report, composting was favorable for mehogony and rain trees but it was disfavorable for other plants.

Recycling of textile wastewater obtained from dyeing industries could be a good solution to implement the concept. Advanced technologies are very much useful in this area. Sharma et al. reported some advanced technics for recycling dyeing wastewater [11]. The authors clearly explained some advanced methods. The permeate obtained after two types of filtrations (sand and nano) was processed for the preparation of the dye bath. The wastewater rejected from this step was sent to two types of evaporators, one is multi-effect and another one is solar pond. Treated waste water obtained from both physicochemical and biological ETPs can be further treated by reverse osmosis (RO) and the permeate is sent for reuse. The rejected wastewater was sent for nanofiltration to recover salt, it can be sent for evaporations also. Eventually, the rejects obtained from nanofiltration were sent to a multi-effect evaporator for recovery of condensed water.

Recovery and reuse of chemicals from Textile wastewater are cost-effective methods that are designated as conversion of waste to wealth. Caustic soda (NaOH) is a common chemical used in textiles. Guha et al. reported recovery of caustic soda from mercerization wastewater of woven dyeing [12].

2.3 Conversion of wastes to wealth in ready-made garment industries

Jhoot export

A large quantity of waste is generated from the ready-made garment sector of Bangladesh. This waste is locally known as “Jhoot”. This waste can be converted to wealth. As per the report of the Export Promotion Bureau (EPB), Bangladesh exported Jhoot and earned US$ 64.95 million in 2018-19 [13]. This “jhoot” is also recycled locally to manufacture yarn which is being used to produce export quality curtains and towels. This jhoot can also be used to produce biogas by anaerobic digestion. Guha et al. reported a sustainable and eco-friendly method to produce sufficient biogas from jhoot [14].

3. Gap Analysis and Recommendations

From the literature survey, some gaps are identified in this field of research. Most of the reported methods are related to yarn manufacturing, wastewater recycling, and jhoot recycling. There are other production sections where huge quantities of wastes are generated such as knitting, dyeing, and geotextiles. A complete database of total quantity of generated both liquid and solid wastes from the textile sector is not available. A combined research works involving textile experts and economists of textile producing countries are not done properly. Based on the above gaps following recommendations are proposed for further development.

(a) A survey should be done for quantitative estimation of generated wastes in knitting, weaving, non-woven, and geotextiles.
(b) More emphasis should be given to wastes generated from the ready-made garment sector.

(c) A complete database should be generated for further research.
(d) A combined effort involving textile experts and economists should be given to discover better economically viable conversion methods.

4. Conclusion

All wastes generated can be converted to wealth by implementing appropriate methods. There are several options available to do this sustainable and eco-friendly work. The yarn wastes could be reused to produce further yarn and biogas. The wastewater generated from dye houses can be converted to energy. Other solid wastes can be utilized to convert to energy which is a very useful and eco-friendly technique.

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