Renewable Energy Integrated Waste Water Treatment For Handloom Dying Units: An Experimental Study

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Abstract
Environmental pollution because of urbanization and fast development of industries detrimentally affects human wellbeing and environment. The world is on the edge of environmental safety issues and heading towards the sustainable energy. On account of that waste water management is important factor to enrich our environment. Now in India the government is spending huge amount of money for cleaning and conserving the water bodies. Textile Industries contributes highly on the economic part, on the other hand it tends to pollute the environment heavily.

Generally, wastewater requires a certain level of treatment before it come into contact with the surface. Many technologies is readily available to treat the waste water at large quantum. However, a tiny industries like Hand Loom Textile & Dying unit, the quantum of waste water generated is less and the existing technology is not cost effective for treatment. The paper attempts to convert the wastewater coming out from the handloom dying units into the recyclable water using renewable energy technologies. "Chinnalapatti" is famous for Handloom weaving. The present paper attempts to address the problem faced by the Handloom weavers.

The study attempts an integrated waste water treatment plant incorporating Solar Energy with biomass combustor for vaporization of waste water. Also, a Wind Energy assisted vibrator for creating turbulence of water for better evaporation.

Keywords: Waste water, solar still, evaporation, condensation.

Introduction

The Fresh, clean water is a limited resource. The need for harmless, clean drinking water is increasing rapidly. It is estimated that out of 1,62,000 of 5,75,000 Indian villages face the problem of brackish/contaminated water[1].The textile Industry is in no way diverse than other chemical industries, which causes pollution of one or the other type. The textile industry consumes large quantity of water in its varied processing operations. Textile dyeing is the popular environmental unfriendly industrial process, because they create colored wastewaters that are greatly contaminated (polluted) with dyes, textile. Auxiliaries and chemicals. Effluents produced by textile industries are frequently strongly colored and their dumping into water causes environmental spoil, together with important impact on the photosynthetic action of aquatic plants due to reduced light penetration. These wastewaters can be toxic to aquatic organisms due to the existence of metals, or chlorides, and breakdown products of dyes. Textile industries symbolize a central environmental trouble due to their high water consumption. The removal of color is associated with the breakup of the conjugated unsaturated bonds in molecules. For this reason, many chemical treatment processes have been used extensively to treat textile waste waters. But these treatment processes are applicable only for large scale industries. In case of small scale handloom weaving industries these treatment processes are not affordable[2].

In textile wet processing (Table I), water is used mainly for two purposes. Firstly, as a solvent for processing chemicals and secondly, as a washing and rinsing medium. Besides this, some quantity of water is consumed in ion exchange, boiler, cooling water, steam drying and cleaning. Textile Industry is being forced to consider water conservation for many reasons. The primary reasons being the increased competition for clean water due to declining water tables, reduced sources of clean waters, and increased demands from both industry and residential growth, all resulting in higher costs for this natural resource. Water and effluent costs may in the more common cases, account for as much as 5% of the production costs[3].

Hazards of water pollution: Mills discharge millions of gallons of this effluent as hazardous toxic waste, full of color and organic chemicals from dyeing and finishing salts. Presence of sulphur, naphthol, vat dyes, nitrates, acetic acid, soaps, chromium com- pounds and heavy metals like copper, arsenic, lead, cadmium, mercury, nickel, and cobalt and certain auxiliary chemicals all collectively make the effluent highly toxic. Other harmful chemicals present in the water may be hydro carbon based softeners, formaldehyde based dye fixing agents, and non bio degradable dyeing chemicals.The colloidal matter present along with colors and oily scum increases the turbidity and gives the water a bad appearance and foul smell. It prevents the penetration of sunlight necessary for the process of photosynthesis.

This interferes with the Oxygen transfer mechanism at air water interface. Depletion of dissolved Oxygen in water is the most serious effect of textile waste as dissolved oxygen is very essential for marine life. This also hinders with self purification process of water. In addition when this effluent is allowed to flow in the fields it clogs the pores of the soil resulting in loss of soil productivity. The texture of soil gets toughened and penetration of roots is prevented. The waste water that flows in the drains corrodes and incrustates the sewerage pipes. If allowed to flow in drains and rivers it effects the quality of drinking water in hand pumps making it unfit for human consumption. It also leads to leakage in drains increasing their maintenance cost. Such polluted water can be a breeding ground for bacteria and viruses.

Textile effluent is a cause of significant amount of environmental degradation and human illnesses. About 40 % of globally used colorants contain organically bound chlorine a known carcinogen. All the organic materials present in the wastewater from a textile industry are of great concern in water treatment because they react with many disinfectants especially chlorine. Generally, wastewater requires a certain level of treatment before it can come into contact with the surface or with groundwater. Depending on the source, wastewater requires some kind of treatment. Renewable energy sources have been used and will continue to be used, either directly or indirectly,wastewater treatment[4].

Zero Liquid Discharge: Zero Liquid Discharge (ZLD) is a treatment process designed to remove all the liquid waste from a system. The focus of ZLD is reduce wastewater economically and produce clean water that is suitable for reuse (e.g. irrigation), thereby saving money and being beneficial to the environment. ZLD systems employ advance desalination treatment technologies to purify and recycle virtually all of the wastewater produced.

Also ZLD technologies help plants meet discharge and water reuse requirements, enabling businesses to:

- Meet stringent government discharge regulations
- Reach higher water recovery (%)
- Treat and recover valuable materials from the wastewater streams, such as potassium sulfate, caustic soda, sodium sulfate, lithium and gypsum

The conventional way to reach ZLD is with thermal technologies such as evaporators (multi stage flash (MSF), multi effect distillation (MED) and mechanical vapor compression (MCV)) and crystallizers and recover their condensate[5].

Experimentation

Solar still: Solar still works based on the principle of greenhouse effect, when sun emits radiation in the form of short wavelength and it strikes the solar still glazing and the radiation reaches the bottom of the solar still and the bottom will be coated by dull black paint for the effective absorption of solar radiation (Fig. 1). Due to this short wavelength of radiation converted into heat and this heat will be trapped by solar still glazing and surrounding should be insulation required to avoid the convective, conductive and radiation losses. Initially filled the waste water form handloom dying units in solar still and it absorbs radiations from sunlight, the waste water gets evaporated. During condensation the vapor converted into the water and it should be deposited on the glazing, to collect the fresh water. Remaining dye will be deposited on the bottom surface of the solar still and it can be further used in the handloom dye. Main purpose of the solar still is used for obtaining the fresh water from waste water from handloom dying units and also obtained the dye for further usage in the handloom units only by the solar radiation without using any external energy to obtain the fresh water. The efficiency of solar still is mainly depends on the solar radiation, design of still, insulation and it consumes more time for completing the process.

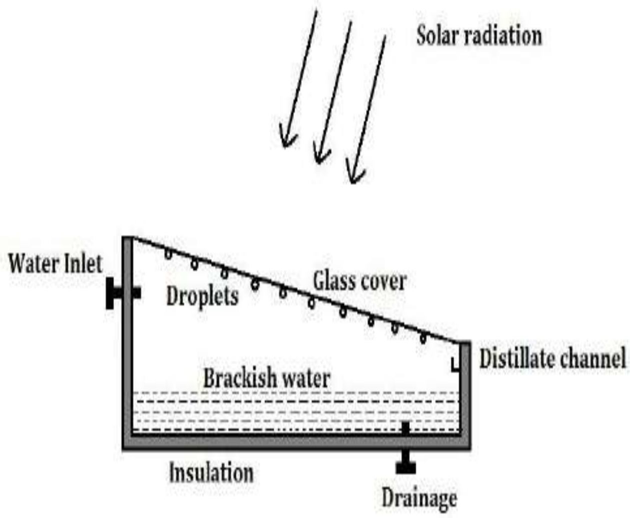

Fig. 1: Working of Solar still

Solar dryer: Solar dryer (Fig. 2) also works based on the principle of greenhouse effect, when the sun emits radiation in the form of short wavelength radiation enters into the solar dryer glazing and it converted into heat. This heat is used to evaporate the waste water from handloom dying units and the remaining dye will be alone deposited on the bottom surface. This dye will be further used for handloom units and the main drawback in solar dryer is not to obtain the freshwater because the water should be evaporated and during condensation the water can be collected in the dryer it requires special arrangements to collect the water.

Initially we filled the one litre waste water from handloom dying units in a vessel and we put in the solar dryer for the four days (Fig. 3). After the four days in a one litre of waste water, water content gets evaporated and then remaining will be deposited as dye in the bottom of the vessel. Further these dyes can be reused in the handloom dying units without polluting the environment.

Thermogravimetric Analysis: Thermogravimetric analysis (TGA)(Fig 4) is an analytical technique used to determine a material's thermal stability and its fraction of volatile components by monitoring the weight change that occurs as a sample is heated at a constant rate. Thermogravimetric analysis or thermal gravimetric analysis is a method of thermal analysis in which the mass of a sample is measured over time as the temperature changes[6].

By using the hot air oven, the TGA procedure is as follows:

- Prepare a vessel with the sample.
- Measure the weights of the vessel and with the sample of the vessel.
- Put the vessel in the hot air oven.
- When the temperature of the hot air oven reaches set to 50°C, cool it and measure the weight.
- Again keep the vessel in the hot air oven. When the temperature reaches 60°C, cool it and measure the weight
- Repeat the above process for every 10°C up to 90°C and formulate a table.
- Note the temperature and its corresponding weight.
- Draw the graph of temperature versus weight reduction.

The thermal behavior of the samples has been studied by TGA. The loss in weight of the material was analyzed. Normally the shape of the TG curve depends upon the nature of the situation of degradation reaction of the sample. The analysis of these data is often carried out with a view to estimate kinetic parameters like energy of activation of the degradation reaction. Figure4 shows that there is a gradual decrease in sample weight with increase in temperature.

Fig. 2: Solar Dryer

Table 1
Total water consumed during wet processing

Process	Water consumed
Bleaching	38%
Dyeing	16%
Printing	8%
Boiler	14%
Other uses	24%

Fig. 3: Waste water inside the solar dryer

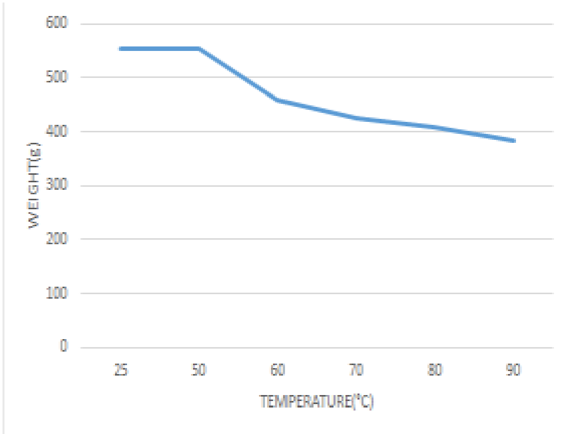

Fig. 4: Thermogravimetric analysis

Conclusion

Thus the experimental study of waste water from the handloom dying units has a great opportunity to be recycled the waste water with the application of solar energy which has a great scope for reducing the usage of fossil fuels to convert the waste water into useful water and dye by using the solar dryer and solar still. The main drawback of this research is difficult to collect the water during condensation in the solar dryer only to evaporate the water content in the waste water and the remaining should be deposited as dye it should be used for further processes.

Acknowledgement

Authors express sincere thanks to the Ministry of New and Renewable Energy, Government of India for providing support under One Time Grant for Laboratory upgradation.

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