Industrial Waste Management by Sustainable Way

Mahabub Alam

Abstract—Nowadays industrial waste management is the key concern over the world. Biogas generation and bio-compost from knitting, cutting, spinning waste is one of the right and sustainable way of waste management. Wastage is generated almost all process in spinning, knitting and cutting in the industry. Cotton contains huge amount of dust, foreign-matters, seed and other particles. Micro dust of cotton waste has no salability and pollutes the atmosphere. Mostly, it is disposed of by burning as a result increase the CO2 level in the atmosphere which is the threat for environment as pollutes the surrounding areas. The main objective of this project is sustainable use of cotton waste by producing biogas and utilization of Slurry after Biogas Generation. Biogas generation by anaerobic digestion is sustainable, cost effective and eco-friendly method in Bangladesh. Finally, our concern is to maximum utilization all collected cotton wastes in a sustainable way i.e. anaerobic digestion way. Our experiments on wastes where those wastes produced bio-gas such as spinning cotton micro dust: 1st of all for production of gas to observe; after 30-40 days of feeding 180cc biogas was generated from 100g cotton spinning dust via lab scale biogas plant & gas also confirmed via flammability test. On the other hand, smaller size of cotton cutting jhut fabric show comparatively low gas production and found that gas production depends on decomposition rate of cotton waste. Slurry treatment applied in a plant after generation of biogas and output of this application showing that many new leafs were grown and looking more refresh within 12-14 days. So, unusable spinning cotton waste can be resources for our economy and environment instead of hazards or waste. We have recommended that yarn singeing machine can be run by produced biogas.

Index Terms—Spinning, Cotton Waste, Biogas, Slurry Treatment, Singeing Machine, Plant.

I. INTRODUCTION

In Bangladesh readymade garments industry are most popular both male and female worker [1] which also same to the spinning mills. Textiles have been an extremely important part of Bangladesh’s economy for a very long time for number of reasons [2,3] where ready-made garment industries are backbone of economy and spinning section also heart of yarn and fabric manufacturing. The export oriented Ready-Made Garment (RMG) sector has made crucial contribution to the Bangladesh economy [4]. Not only the textile industry plays a vital role to augment the socio-economic development of Bangladesh but also pose major public health problem [5] also.

However, spinning sector is one of the vital backward linkages to the fabric manufacturing as well as garments/textiles manufacturing industry in the Bangladesh. According to BTMA information there are 424 spinning mills are running at present. The country consumes cotton fibers approximately 7.3 million bales per year, where huge amount of cotton waste is generated during yarn manufacture [6]. The problem of the final waste from spinning industries has now assumed serious dimensions, since it has no salability and pollutes the atmosphere [7]. The growth of global population and rising of living standards have increased apparel consumption, and the generation of textile and clothing waste. This has raised concerns about the loss of resources and the environmental damage [8].

My main aim of this study is such cotton waste proper utilization via biogas production. Biogas generation by anaerobic digestion is sustainable, cost effective and eco-friendly method in Bangladesh [4] because Bangladesh is one of the low energy consuming countries of the world. At present, the per capita energy consumption is 220 kg and the rural areas houses are scattered where piped supply is not suitable for those areas. To face this grave situation, finding alternative or renewable sources of energy is the only option. Biogas technology may be one [9].

II. EXPERIMENTAL

A. Materials & Methodology

We have collected micro cotton dust, big size cutting waste, knitting waste from Al-Haj Karim Textile Mills Limited, sister concern of Karim Group located at Kalampur, Dhamrai. Biogas generation by anaerobic digestion is sustainable, cost effective and eco-friendly method in Bangladesh.

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Md. Rasel (corresponding author) is now Master’s Student, Department of Industrial and Production Engineering, Shahjalal University of Science and Technology (SUST), Sylhet-3114, Bangladesh. (raseltex888@gmail.com @gmail.com). He completed undergraduate study from Department of Textile Engineering, Southeast University, Dhaka, Bangladesh, and published couples of research articles, book as a corresponding author to various peer reviewer’s journal.

Israt Zerin (corresponding author) is lecturer, Department of Textile Engineering, Southeast University, Dhaka, Bangladesh (isratzrin@gmail.com).

Sakib Hossain Bhuiyan is Masters Student, Department of Applied Chemistry and Chemical Engineering, Noakhali Science and Technology University, Noakhali, Bangladesh. (sakibbh@gmail.com)

Kazi Md Hasanul Hoque is master’s student, School of Materials and Textile Silk Institute, Zhejiang Sci. Tech. University, Hangghou, China. (kazhasanulhoq@gmail.com)

Mazadul Hasan is master’s student, Department of Textile Engineering, Bangladesh University of Textiles, Dhaka, Bangladesh. (mazadulhasan@yahoo.com)

Md Mahabub Alam, student, Department of Textile Engineering, Southeast University, Dhaka, Bangladesh. (mahubub.seu25@gmail.com)

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Fig. 1. micro cotton dust, big size cutting waste, knitting waste Picture [8]

B. Purity test of garments cutting jhut fabrics

To confirm composition of cotton jhut fabric, we did test by dissolved fabric on sulphuric acid solution and finally proved that collected garments jhut is 100% cotton as completely destroyed composition in the acid solution. Then collected all wastes are made smaller parts which are bigger size.

C. Purity test of knitting & spinning wastes

We balanced 100gm knitting waste sample 2times then 2times 100gm dissolved into acid solution & proofed that 100% cotton knitting wastes. Similarly spinning cotton micro dust also fully dissolved and destroyed 100% in the acid solution.

D. Experiments

Sample-1: Hundred gm. cotton spinning waste with different seeding material were taken. Then this micro dust was mixed with water in the conical flask. Then we added 5 g of cow dung &3 g of NaHCO3 to maintain pH 8-8.5. The ratio between material & water is determined by the nature of the biomass in respect of its moisture content, density, ambient temperature, pH, etc. Excess water may reduce the concentration of biomass in digester and also reduce the volume available for gas collection. Finally, Biogas Production done from spinning waste via Lab-Scale Biogas Plant. Gas confirmation test done by burning or Flame test, slurry is fertile confirmed by directly application in the money plant.

Sample-2: All smaller size jhut fabric produced following sample-1 to confirm gas generation.

Sample: 3: All knitting wastes produced following sample-1 to confirm gas generation.

Sample: 4: Finally, all collected waste samples; blend together as raw materials for production biogas as well as bio-compost. 1st of all, all big size sample waste blended by machine to make micro cotton dust.

III. RESULTS AND DISCUSSION

A. Biogas Generation

A lab scale bio plant was constructed in the chemistry lab of southeast university of Bangladesh. A lab scale biogas plant was constructed in the Chemistry lab of Southeast University of Bangladesh with technical support from BCSIR, Dhaka. The plant was constructed by connecting a conical flask with two glass bottles. The conical flask is called digester (2.5 L). The middle glass bottle is designated as gas collector. The third bottle is (10L) is called water collector. The digester was connected to gas collector by a plastic pipe by means of three ways gas valve and some volume of water was displaced to the water collector because of pressure of produced gas. The gas collector was connected to the water collector so that displaced water was easily transferred to the water collector. There was another connection between gas collector and gas outlet pipe. During the production bio gas the connection was closed but it was opened when the collected biogas was separated out to the gas balloon for flammability and other tests [10].

The amount of generated bio gas depends on the quantity of spinning waste. In this work we got 175cc biogas from 100 gm. of cotton spinning waste at room temperature (25°C) which was confirmed by flammability test which shown in the below images.

TABLE I: THE ARRANGEMENT OF CHANNELS

<table>
<thead>
<tr>
<th>SN</th>
<th>Sample</th>
<th>Days</th>
<th>Observation</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spinning waste</td>
<td>30</td>
<td>Gradually increase biogas</td>
<td>Biogas</td>
</tr>
<tr>
<td>2</td>
<td>Knitting waste</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Jhut/Cutting waste</td>
<td>42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 2. Purity Test Picture [8]

Fig. 3. Lab-Scale Biogas Plant Construction

Fig. 4. Daily observation of gas production
After 7 days of feeding Burning test was performed. In 3rd week gas starts to ignite in the burner for a while. A noticeable increase in the amount and the rate of gas production was observed in the 33rd days and it lasts for almost 3 minutes. It seems that the flow of gas will increase with the increase in the decomposition rate of micro dust.

B. Decomposition Rate

| TABLE II: DECOMPOSITION OR DEGRADATION OF GAS |
|-----------------|-----------------|----------|----------------|
| SN | Materials | Size | Duration | Results |
| 1 | spinning waste | Micro dust | 7-15 days | Good |
| 2 | knitting waste | Micro and small | 15-30 days | Excellent |
| 3 | Jhut/Cutting waste | Small and big | 15-30 days | Very good |
| 4 | All blended collected wastes | Micro | 30 days | Outstanding |

Study may prove that Decomposition depend on bacterial growth, duration (bacterial growth also depend on how long materials you are keeping together in the bath/solution) and particle size or structure as we got cotton micro dust and knitting dust generated gas comparatively good than Cutting Jhut wastes.

We found during our experiments 3 types of wastes degradation or decomposition rate compare to gas generation periods.

Cotton (cellulose) is hydrophobic so liquid can easily penetrate into the cellulose. Liquid contain micro-bacteria as cow dung is used (bacteria may attack to decompose the cellulose substance), so liquid molecules stay on the cellulose surface and may slowly penetrate into the cellulose substance then start to decompose.

So, it’s also matter of burning question that how cellulose materials can be decomposed and decomposition rate relation with bio-gas generation as biogas production depend on quantity of cotton waste?

C. Biogas Composition

The biogenic material generates biogas and consists of Carbon di-oxide (CO2), Methane (CH4), Nitrogen(N2), Hydrogen (H2), Oxygen (O2), Hydrogen sulphite (H2 S). Biogas is a type of bio-fuel, which primarily consists of methane and carbon dioxide [8].

After tested our samples we obtained 59% Methane, 37% Carbon di-oxide and rest of them all together.

1. Methane (CH4): 59%  
2. Carbon di-oxide (CO2): 37%

D. Application of Biogas

Among various blend ratio of poly cotton, 65/35 cotton/polyester is the most largely consumed combination particularly for reasonable price, durability [12] and the surface of knitted fabric is not smooth as compare to woven fabric. It is due to its construction technology. Knitted fabric is made by sewing loops, and there is quite uneven surface. Moreover, protruding fibers (fiber ends) are also present on the surface of knitted fabric [13]. Abrasion of the surface tends to texture the protruding fiber ends, causing them to
form into tiny balls, are also known as pilling [14]. Pilling is a serious defect for textile fabrics. The process of eliminating the surface fibers by treatment cellulose enzyme is well established [15] but some industry follows both physiochemical treatment i.e. singeing & enzyme treatment to improve materials quality. So, a (yarn) singeing machine can be run by produced biogas from cotton wastes because yarn passes the machine very faster over the gas burner as a result yarn surface become smooth and improve yarn quality.

**E. Application of Slurry after Biogas Generation**

Biogas plant (BGP) with anaerobic digestion providing a facility to generate organic manure (Biogas spent slurry). The digested biogas slurry (DBGS) is rich in macro and micro nutrients that provide essential plant nutrients for longer period. Biogas slurry may be considered as a good quality organic fertilizer for sustainable agriculture. A combination of biogas slurry (Dry-DBGS & Wet-DBGS) and synthetic fertilizer enhanced carbon nitrogen transformation with substantive effect on crop yield [11]. After generation of biogas we applied this slurry around the base of a “money plant” (Epipremnum aureum) and kept it for 12-14 days under sunlight.

After slurry treatment as organic manure we investigated that the many new leafs were grown and looked more fresh after 12-14 days which is the blessing of organic fertilizer (Image-2).

**IV. CONCLUSION**

In this research project, we generated biogas and biocompost from micro dust of cotton waste where slurry/biocompost shown as a fertilizer in the money plant. So, considering the organic nature of cotton dust this could be used for organic farming which would also help in reducing dependence on the costly and hazardous chemicals and pesticides. Finally, our project has great impact on cotton waste management and encouraging to implementation biogas plant for household or industrial purposes which will be a great utilization of such waste. Our next part of this project is design and fabrication of machine then run by biogas.

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**REFERENCES**


