Survey on bagasse cogeneration in sugar plants of north Karnataka

Mr. Mahesh G. Emmi 1 *, Dr. Aravindrao M. Yadwad 2, Dr. Vinay V. Kuppast 3, Dr. Sampanna M 4

1 Research Scholar, N.I.E., Mysore, affiliated to VTU,Belgavi
2 Associate Professor, Dept. of Mech. Engineering, & Deputy Dean [AA], N.I.E., Mysore
3 Associate Professor, Dept. of Mech. Engineering, BEC, Bagalkot
4 General manager - Indian cane power limited, Davangere
*Corresponding author E-mail: maheshemmi@gmail.com

Abstract

Cogeneration is the idea of converting two forms of energy from one fuel. In the sugar industry from bagasse two forms converted are heat and electrical power. The sugar industries utilise bagasse to generate power and to operate the plant. Here the bagasse serves as a fuel to the Boiler and this power consumption is known as captive power generation. The so generated power will be more than the power required for the running of the industry. The remaining excess power can be fed to the power grid as a power export.

The actual site survey of different bagasse cogeneration plants has been carried out and included in this review. Also, this paper reviews the performance of the bagasse cogeneration plants all over the world. The review includes not only study on the power generation but also throws an insight to identify the scope for the study on the performances of the cogeneration plants in Karnataka based on the global pervue. The efficient and effective utilisation of the bagasse cogeneration plants could be identified for the improvement of the performance of the cogeneration plants and also the economics of running a sugar industry.

Keywords: Bagasse Cogeneration, Power Grid, Sugar Plants.

1. Introduction

Indian sugar mills, both in the private and co-operative / joint sectors, have acknowledged importance of implementing high efficiency grid connected cogeneration power plants for generating ex- portable surplus. In fact, additional revenue stream by sale of ex- portable power to State Electricity Boards (or third party consumers), has become the only way for achieving long term sustainability, given the fiercely competitive domestic and international sugar markets.

Most of the sugar producing countries such as Brazil, Reunion Island, India and Mauritius, successfully demonstrated cogeneration of power from bagasse. As per WADE (World Alliance for Decentralized Energy) information, bagasse cogeneration is able to produce nearly 25% of existing power need in the world’s prime sugar producing countries. Currently, the share in developing prime sugar producing countries. Currently, the share in developing country is about 7%.

There is wide scope of enhanced use of bagasse-based cogeneration in sugarcane producing countries. The bagasse cogeneration plant facilitates sugar industries to generate additional profit by direct sale of excess electricity to power grid and earn carbon credits. In addition, through the cogeneration plant of steam and power allows sugar plants to meet their in-house power requirement. This tends to reduce the operation cost of the plant.

1.1. Potential of cogeneration plant in India

The total availability of biomass in India is about 500 MMT/year. 7000 MW added electric power could be generated through bagasse based cogeneration in the country from around 500 plus Sugar plants. There is a need that these sugar plants, systematically adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse produced by them.
Process parameters such as temperature, pressure, time of retention plays a vital function in the quality attributes of a pre-processing. He compared the relative merits and demerits of different pre-processing methods for sugarcane bagasse for effective use of the pre-processing. Researchers listed the different pre-processing methods are:

1) Size reduction.
2) Drying.
3) Pelletising.
4) Briquetting.
5) Torrefaction

Pre-processing is introduced for efficient use of SCB in cogeneration plant and to release soil and water pollutants which may be produced due to elemental composition of bagasse. In this investigation researcher also compared different methods of gasifier and compared their merits and demerits. The types of gasifier are:

1) Updraft
2) Downdraft
3) Crossdraft
4) Fluidised bed
5) Entrained flow
6) Plasma.

Researcher here identified that the torrefaction pre-processing method was the most efficient and effective method. According to technical and economic viability as a consequence of its design characteristics makes the down draft gasifier well suited for the gasification of SCB.

4) Abdel Khoodaruth (2015) has studied the bagasse cogeneration plant in flexi factory complex at Mauritius. The Flexi factory com-plex consists of sugar plant, distillery, refinery, and bagasse cogeneration plant. Sugar plants in Mauritius are installed latest and efficient motors with variable speed drives, automatic systems and real time monitoring system. The researcher investigates the effect of reduced steam of a multiple effect evaporator by adding one effect of falling thin film evaporator type (FFTE). The researcher recommended shifting from five effect evaporator to six effect evaporator in Mauritian cane plant. The researcher also confirms saving of steam consumption i.e. 41.5 kg/h. This can increase the power generation from cogeneration plant by 18 x 109 Wh. 5. Wang Guangwei et al. (2015) This team investigated using Thermo Gravimetric Analysis (TGA) in the CO2 inert atmosphere. Further, the data is construed with three different models

i) Volume Model (VM)
ii) Random Pore Model (RPM), and
iii) Unreacted Shrinking Core

Model (URCM). The increase of both heating rate and gasification temperature could improve gasification process of coal char. The Kinetics analysis indicates that RPM shows better experimental results as compared other two models. The experimental results showed that the activation energy using RPM for isothermal gasification and non-isothermal gasification was 212.6 and 193.9 kJ/mol respectively. Researchers derived in this study that RPM predicted the satisfactory results of gasification process of coal char under different heating rates and different temperatures. This research was acknowledged to National Science Foundation of China & Baosteel for fanatical support.

5) A. Bahurudeen et al. (2014) have done research on cement produced from the ash obtained from the cogeneration plant after burning the bagasse. Researcher here presented the durability performance tested by five different methods. The methods were rapid chloride penetration test, chloride conductivity test, water absorbative test, and Torrent air permeability test. The researcher confirmed the results from this study showed that use of SCBA (sugar cane bagasse ash) in concrete significantly enhances its durability performance. SCBA can be used as supplementary cementitious material to achieve durable concrete. Sugar cane bagasse ash (SCBA) is successfully used as the cementitious material and it help to increase profitability of the sugar plant.
6) A. Khoddaruth (2014) optimised bagases cogenerated energy system of the Flexi factory complex by energy analysis. The re-search was conducted in Flexi Factory at Mauritius. Actual para-meters of a flexi-factory are used to calculate the energy efficiency of each components parts of the system as well as social, economic and environmental benefits. Increased and value added refined special sugars, dehydrated ethanol and green electricity are major con-strained by a key factors from climate. The 5Es analysis (Energy, Engineering, Economy, Environment and Ethics) were used to check perfor-mance of cogeneration systems.

7) J.A. Ruiz et al. (2013), this team has reviewed gasification techniques in depth and analysed important factors mentioned in the design of a gasification plant. Gasification is a thermo chemical incom-plete oxidation method in which carbon substances like bagasse, charcoal, are converted into gas in the existence of a gasify-ing member for example air, steam, oxygen,CO2 or a mixture of these.

![Steps in Gasification Process.](image)

The gasification process can be used for producing syngas, H2 or other fuel. Further this fuel can used to generate electricity or thermal energy. Gasification occurs at temperatures range between 500 - 1400ºC. The researchers here conclude that gasification is a mul-tifarious technology. Parameters are involved in this are criti-cal and subject to certain risks. In addition it is complex to choose the exact gasifier for a given power generation capacity and the bagasse to be used. The gasification plant operation is complex comparative to combustion. The process is sensitive to different parameters. These parameters cannot always be controlled. Following are few of the observations from the study.

a) The gasification reaction temperature and the equivalent ratio have a major impact on the gasification process.

b) Moisture content reduces the gasification efficiency.

2.2. Actual site survey of cogeneration plant visits in north Karnataka

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Company Name</th>
<th>District</th>
<th>Installed Capacity in MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Prabhulingeshwara Sugar</td>
<td>Belgaum</td>
<td>38.45</td>
</tr>
<tr>
<td>2</td>
<td>Indian Cane Power Ltd</td>
<td>Belgaum</td>
<td>37.53</td>
</tr>
<tr>
<td>3</td>
<td>Ugar Sugars Works Ltd.</td>
<td>Belgaum</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>Shree Renuka Sugars Ltd</td>
<td>Belgaum</td>
<td>34</td>
</tr>
<tr>
<td>5</td>
<td>Venkateshwara Power</td>
<td>Belgaum</td>
<td>34</td>
</tr>
<tr>
<td>6</td>
<td>Shree Renuka Sugars Ltd</td>
<td>Belgaum</td>
<td>34</td>
</tr>
<tr>
<td>7</td>
<td>Satish Sugars Ltd</td>
<td>Belgaum</td>
<td>34</td>
</tr>
</tbody>
</table>

SSWL was established in 1995. The plant is located at MANJRI, Dist Belgium. The Sugar plant has a capacity of 5000 TCD. The plant has power co-generation capacity of 22MW.

d) Shiraguppi Sugar Works Ltd, Belgum, Karnataka.

d) Athani Sugars Limited, Belgaum, Karnataka.

Athani Sugars Limited is an integrated sugar manufacturing company. Its associated production consists of producing and marketing of Ethanol, power generation and manufacturing and marketing of organic compost. The management owns 2 sugar mills located in Belgaum Karnataka and Kolhapur Maharashtra with 13,000 TCD capacities. The sugar mill located at Athani has cogeneration plant commissioned in 2012. The capacity of the plant is 24 MW.

c) Bilagi Sugar Mill Limited, Bagalkot, Karnataka.

This plant is located at Bilagi Taluku, Bagalkote district of Karnataka. The plant started operating from the year 2005. In their first phase, the capacity of sugar cane crushing was 2500 TCD with cogeneration plant of [8] MW. In second phase they increased sugar cane crushing capacity to 5000 TCD, with cogeneration of power to 30MW.

d) Shiraguppi Sugar Works Ltd, Belgum, Karnataka.

Fig. 5: Bilagi Sugar Mill Limited.

Fig. 6: Shiraguppi Sugar Works Ltd.

3. Summary

Review of performance evaluation of sugar industry along with power consumption indicates that adequate opportunities exist for power saving and improving efficiencies in cogeneration plants. Most of the researchers focused on the thermal parameters as performance measures which act as process indicators. The perfor-mance of the sub systems of the cogeneration plant need to be analyzed as far as the design of the components contributes to the overall performance of the system. Hence in addition to the thermal parameters, the design parameters also have to be considered in arriving to the performance analysis of the system. From the act-ual site survey it is learnt that there are a lot of challenges in the bagasse cogeneration plants in different sugar industries. The chal-lenges are not only in the area of generation technology but also in

![Indian Sugar Cane.](image)
the supply to grid. The technology adopted is not contemporary and advanced in India and hence the efficiency of cogeneration plants is very limited. This provides an enormous scope for improvements in optimisation of the plant efficiencies by a more detailed study of input parameters and failure analysis by utilising simulation techniques to suggest means of tailoring the parameters to acquire optimum exploitation of available bagasse to produce greater power output.

References


[6] A. Bahurudeen et al. (2014), “Performance Evaluation of Sugarcane Bagasse Ash-Based Cement for Durable Concrete”, 4th International Conference on the Durability of Concrete Structures, Purdue University, West Lafayette, IN, USA.
