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Research paper

Survey on bagasse cogeneration in sugar plants of north Karnataka

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Abstract

Cogeneration is the idea of converting two forms of energy from one fuel. In the sugar industry from bagasse two forms con- verted 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 genera- tion plants 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 perview. The effective and efficient utilisation of the bagasse cogeneration plants could be identified for the im- provement 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 cogen 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 custom- ers), has become the only way for achieving long term sustainabil- ity, given the fiercely competitive domestic and internationalsug-ar 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 develop- prime sugar producing countries. Currently, the share in developing country is about 7%.
There is wide scope of enhanced use of bagasse-based cogeneratetion 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 require- ments. This tends to reduce the operation cost of the plant.

Table 1: RE Progress Report

Sr. No	State	Potential for Exportable Sur-plus,MW	
		Conventional Energy-efficient Sugar Mills	Sugar Mills
1	Maharashtra	1000	1250
2	Uttarpradesh	1000	1250
3	Tamilnadu	350	500
4	Karnataka	300	400
5	Andhrapradesh	200	300
6	Bihar	200	250
7	Gujarat	200	400
8	Punjab	150	250
9	Haryan & Other	100	400
	total	3500	5000

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

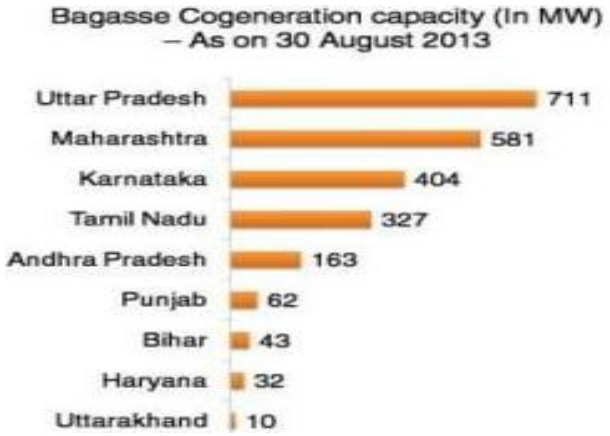

Fig. 1: The Minister of New and Renewable Energy Dr Farooq Abdullah in the Lok Sabha gave this Information on 30 Aug 2013.

2. Literature survey

The literature survey of this paper is classified in to two separate segments to identify the research scope for the further study.

1) Literature survey carried out from the already published papers.
2) Actual site survey of cogeneration plants visit in North Karnataka state.

2.1. Literature survey carried out from the already published papers

1) Sonaje N. P. (2017) had reviewed on performance evaluation of sugar industry along with power consumption. Here the researcher reviewed the performance of not only Indian sugar indus- try but the same from developed industry. He suggested that ener- gy audit is one of the powerful tools check the energy perfor- mance of the sugar industry. In the review, he strongly agrees to promote recycling and regenerate the energy in sugar industry from the bagasse (sugarcane fiber). Here, the researcher concluded that there are adequate opportunities of power saving and cogen- eration in the plants.
2) José Ramón Copa Rey et al. (2016) has presented the thermodynamic study of the integration of biomass integrated gasifier-gas turbine combined cycle (BIG-GTCC) technology in the sugar industry. In this experiment, researcher referred the real data of sugar industry. There were two cases defined for an experiment, Case I: Fuel gas with calorific value (4 to 6 x 106 J/kg) is pro- duced with air as a gasifier.

Case II: Fuel gas with calorific value (10 x 106 J/kg) with steam / air mix 50% each.

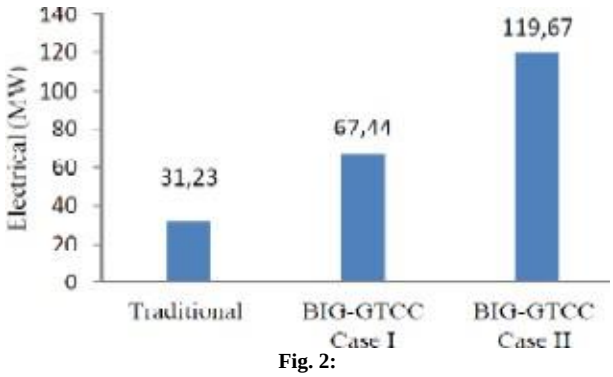

Fig. 2:

The research concluded that in both cases the power generation is i increased as compared to traditional sugar plants. The increase in power generation is 27.4 % & 60 % in Case I & II respectively.

3) AnthonyAnukam et al. (2016) has stated that pre-processing SCB (Sugarcane bagasse).

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) Torre faction

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 investiga- tion 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 cogen- eration 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 Grav- imetric 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.Reserch here presented the durability perfor- mance tested by five different methods. The methods were rapid chloride penetration test, chloride conductivity test, water absorptive test, and Torrent air permeability test. The researcher confirmed the results from this study showed that use of SCBA (sugar cane ba- gasse 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.Khoodaruth (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 parame- ters 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 performance of cogeneration systems.
7) J.A. Ruiz el at. (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 incomplete oxidation method in which carbon substances like bagasse, charcoal, are converted into gas in the existence of a gasifying member for example air, steam, oxygen,CO2 or a mixture of these.

Fig. 3: Steps in Gasification Process.

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 - 14000C. The researchers here conclude that gasification is a multifarious 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

a) India Cane Ltd, Bagalkot, Karnataka.

Fig. 4: Indian Sugar Cane.

This sugar plant is located at Utter Village, Tal.Mudhol, Dist: Bagalkot, Pin: 587313, Karnataka state. The location of the factory falls under the sugarcane belt which indentified as high recovery area. This plant is well known as an integrated sugar complex with fully automated sugar production process. Presently this plant has bagasse cogeneration capacity of 5000 TCD and 28MW of power. Out of total generated power 110KV is added to nation grid. During seasonal operation ICPL Co-Gen plant generates 23.65MW & exports 16WM surplus power to the national grid.

b) 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

Fig. 5: Bilagi Sugar Mill Limited.

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. 6: Shiraguppi Sugar Works Ltd.

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

Sr. No	Company Name	District	Installed Capcity in MW.
1	Prabhulingeshwara Sugar	Bagalkot	38.45
2	Indian Cane Power Ltd	Bagalkot	55
3	Ugar Sugars Works Ltd.	Belgaum	44
4	Shree Renuka Sugars Ltd	Belgaum	37.53
5	Venkateshwara Power	Belgaum	30
6	Shree Renuka Sugars Ltd	Belgaum	68
7	Satish Sugars Ltd	Belgaum	34

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 performance 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 actual site survey it is learnt that there are a lot of challenges in the bagasse cogeneration plants in different sugar industries. The challenges are not only in the area of generation technology but also in

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 im- provements 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.

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