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Electricity Generation in Kisan Sahkari Chini Mills Ltd Sultanpur (U.P)–A Case Study

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Abstract—*Sugar Industry is one of the major agro based industry of India and sugar cane is one of the important cash crop. In sugar industry besides sugar crystal, methanol and electricity are also produced. The sugar cane industry has enormous potential to produce energy by using its byproducts as bagasse (the fibrous residue of cane milling) and trashes (the cane tops and leaves). The Kisan Sahkari Chini Mills Ltd Sultanpur (U.P) has been selected for investigation in this study. This study tries to propose the alternative processes / technique for increasing the electricity generation. The technology presently used for electricity generation in this sugar industry is Condensing Extraction Steam Turbine (CEST). From the past experience it is observed that CEST technology is not commercial viable. It has been reported that to increase the power output of sugar industry, two modifications should be performed. First modification is the use of biomass integrated gasifier and the second one is the use of DC motor in place of mill turbine. Biomass integrated gasifier increases the electricity generation and use of DC motor reduces the steam consumption which finally increases the power output. By using above two modifications in the CEST technique, the emission of CO_2, greenhouse gases and particulates would also be significantly reduced. The significant level of biomass available as byproducts of sugar cane processing, offers a potentially attractive application of gasifier in sugar industry. With the use of above two modification in the CEST technique in sugar factroies, selling additional power to the grid will be possible. This also offers an excellent opportunity for the sugar mills to generate additional revenue.*

1. INTRODUCTION

The cane sugar industry has long recognized the enormous potential in the use of bagasse for the production of energy. Many sugar factories are presently producing considerable amounts of electricity for export to the utility grid while at the same time meeting on-site energy needs.For the production of electricity; there are methods which are not fulfilling the present demand of electricity and also not viable environmentally [1]. One of the methods which have been widely used is Condensing Extraction Steam Turbine (CEST).To meet the present demand, first of all analyzed the drawbacks of CEST technique and find a new technology; Biomass integrated gasifier technique. BIG technology is an advance technology with the potential to be cost-competitive with conventional CEST; using biomass by-products of sugarcane processing as fuel; while dramatically increasing the electricity generated per unit of sugarcane processed [1].Biomass gasification technology applied to bagasse gasification in conjunction with gas fired turbines, offers higher thermodynamic efficiency. In the biomass integrated gasifier technique there is not only increments in efficiency but also improvements in acceptability. Integrated Biomass Gasification Combined Cycle systems replace the traditional combustor with a gasifier and gas turbine. Exhaust heat from the gas turbine is used to produce steam for a conventional steam turbine. The gas and steam turbines operate together as a combined cycle [2].

2. LITERATURE REVIEW

During the past decade, there have been substantial efforts undertaken worldwide to develop CEST technology [3]. A comprehensive research work has been published by Southern Bahia, Brazil and Selby, North Yorkshire, UK. By the different research work, there is gradual advancement in technology as BIG open cycle and BIG combined cycle. In Mauritian sugar industry, while adoptingthe conventional steam cycle, supplied on an average 15 kWh/t cane (Anon, 1992-95) electrical energy to the national grid (based on total cane production), totaling 70-85 GWh annually. In 1997; 125 GWh of electricity was exported to the national grid [1].

With biomass gasification technology, efficiencies in the range of 40-45% based on net plant output and lower heating value of the fuel are reported (Elliot and Booth, 1995) to be feasible evenwith first generation plants. Further, it appears that plant size will have little effect on the economic and technical viability of BIG [1]. Efforts have been made over the past 15 years to develop the capability for recovering and using trash as a fuel for electricity generation in a number of countries, Including Australia [4].

1 Condensing Extraction Steam Turbine (CEST) Technique

1. In sugar Industry CEST technique is used for electricity production at present.
2. In the condensing extraction steam turbine system figure 1; components of the system are Bagasse and trash vessel,

boiler, steam turbine, generator, back pressure turbine drive.

3. In this method bagasse and trash which are obtained from sugarcane burns into boiler which produces steam figure 1.
4. This steam supplies to steam turbine at high pressure.

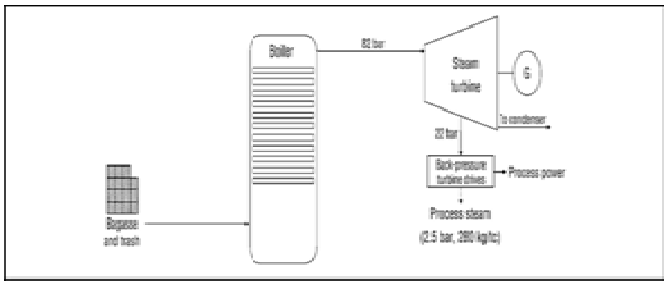

Fig. 1: Schematic diagram for a condensing-extraction steam turbine (CEST) cogeneration system.

5. Turbine produces mechanical energy which is finally converted into electrical energy with the help of alternator.
6. In the next step; low pressure steam from the steam turbine goes to back pressure turbine where again it provides electrical energy and finally process steam is supplied to the sugar manufacturing unit.
7. In this conventional system, electricity is generated from steam power plant and a small amount from back pressure turbine [2].
8. In the CEST technique Mill turbine is also used which is used to run the roller of mill.

3. BAGASSE HANDLING

First of all sugarcane from the unloading department goes to cutter after that it goes to leveler to cut the cane into smaller length. After the leveler cane goes to crushing department where cane juice and bagasse is separated. From here bagasse is supplied to boiler unit where it produces steam. And excess bagasse is kept for any unplanned events.

4. MODIFICATIONS IN CEST TECHNIQUE TO INCREASE THE POWER OUTPUT

By improvements of the CEST plant in sugar factroies, selling additional power to the grid will be possible. This also offers an excellent opportunity for the sugar mills to generate additional revenue. This also contributes to serve the national cause in a small way, by bridging the demand supply gap.To increase the power in the sugar factory there are two methods, first one is to replace high power consuming equipment with that type of equipment which consumes less power and second method is to increase the power output of the sugarmill. To increase the power output in sugar mill One of the methods is to replace mill turbine with DC motors and second method is use of Biomass Intregrated Gasifier.

(a) Replacement of Mill Turbine with DC Motors

In CEST technique Steam turbines are used to drive the mill. One of the methods of increasing the power output, is to replace the lower efficiency mill turbine with better efficiency drives as DC motors.Mill turbine has efficiency of 25-30%. And power turbine has efficiency of 65-70%.Hence ,The steam saved by the installation of DC motors can be passed through the power turbine to generate additional power.

(b) Biomass integrated gasifier (BIG) technique

1. BIG plant is shown in figure 2.The main components of the BIG plant is Bagasse trash vessel, dryer, gasifier, gas cleaning System, gas turbine, generator, heat recovery steam generator.

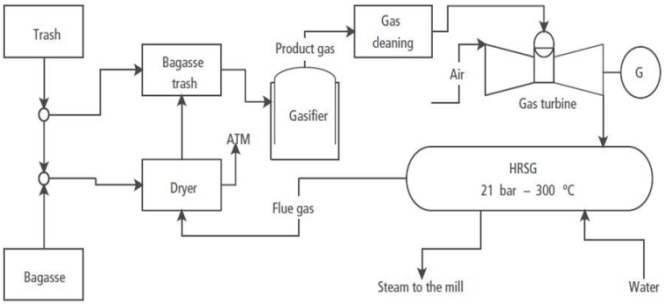

Fig. 2: Simplified diagram of BIG plant integrated with the mill

2. Figure 2 describes the working of BIG plant integrated with the mill.
3. Biomass integrated Gasifier Technique uses the combined cycle format with a gas turbine driven by gases from the gasifier.
4. Firstly bagasse and trash into the gasifier produces product gas.
5. This product gas after passing through gas cleaning system goes to gas turbine. Where it produces electricity with the help of generator.
6. After expansion through gas turbine exhaust gases exchange heat with the heat recovery steam turbine. The exhaust gas exchanged heat with water to generate superheated steam.
7. Where steam turbine expands steam and with the help of generator produces electricity.
8. After expansion through steam turbine, exhaust steam may be circulated through condenser or used as process steam.
9. And exhaust gases after heat recovery steam turbine flows to dryer.

5. COMPARATIVE STUDY OF CEST TECHNIQUE AND BIG TECHNIQUE (AFTER THE MODIFICATION OF CEST TECHNIQUE)

1.1 Electricity Production

1. In BIG technique electricity is produced from gas and steams both – first from the gas turbine and second from

the steam turbine while in the CEST technique electricity is produced only by steam turbine.
2. Thus electricity produced from BIG is more with respect to CEST technique [3, 5].
3. Biomass integrated gasifier increases the electricity generation and use of DC motor reduces the steam consumption which finally increases the power output.

6.2 A Clean Environment

1. BIG can meet all future environmental permitting constraints for thegeneration of electricity.
2. In BIG system, emission of NO_x and CO_2 is greatly reduced due to use of gasifier.
3. In the CEST system direct burning of bagasse and trash produces more $NO_x$and CO2.
4. This environmental performance creates a wide space for the acceptability of BIG technique [6].

6.3 Fuel Flexibility

1. The combined cycle method of BIG technique can be fuled by natural gas, oil or coal and other agro based product in case of any unplanned events or in off season
2. While In CEST technique fuel flexibility is much less than BIG [6].

6.4 Low Water Use

The water required to operate the BIG plant is only 50 to 70% of the quantity required in CEST plant [6].

6.5 Useable By- Products

1. Waste disposal is minimal at a BIG plant.
2. The by- products which is obtained from gasifier can be used for agriculture.
3. But in CEST, burning produces ash which is lesser affective fertilizer than BIG by-products.

6.6 Public Acceptability

BIG sites offer an acceptable electric power generation option to a public concerned about environmental hazards and waste. Negligible plant emissions, little or no waste, safe jobs for workers, safe environments for their families, low-cost electricity for their homes are factors that result in acceptance by the general public [6].

6. ELECTRICITY GENERATION IN KISAN SAHKARI CHINI MILLS LTD. SULTANPUR

In Kisan Sahkari Chini Mills Ltd. Sultanpur, CEST technology is being used for electricity generation. The electricity generated in the plant is totally consumed inside the plant. If CEST technology is replaced by BIG technique, the can be considerably increased and the plant can be able to supply the electricity to the grid resulting in increased profit / revenue of the above plant. On the basis of the data available in the literature and in the plant such as electricity production, clean environment, fuel flexibility, water use and public acceptability, it can be proposed that the CEST technology being used in this plant can be replaced by BIG technique.

7. SUMMARY AND CONCLUSION

1. BIG system replaces the traditional combustor with a gasifier and a gas turbine. Exhaust heat from the gas turbine is used to produce steam for a conventional steam turbine.
2. The gas and steam turbine operate together as a combined cycle.
3. In our study it is analyzed; CEST technique used in Kisan sahkari Chini Mills Ltd Sultanpur, can be replaced by Biomass Integrated Plant and replacement of mill turbine with DC motor, which can increase in electricity output of sugar plant and add revenue to sugar Industry.

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