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PERFORMANCE EVALUATION OF BAGASSE UNIT IN A SUGAR INDUSTRY A REVIEW.

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ABSTRACT

This paper gives an overall view of the performance of sugar industries, especially for bagasse cogeneration plants generating electricity. The compilation of the existing scenario is based on the survey and research study conducted in sugar, mining, paper, power, industries including cogeneration unit. The review has been carried out taking into account the shortage of raw material (crop) used, availability of machinery to produce power, power consumption, auxiliary power requirements to run the industry and co-generation system. The widely used approach to overcome the hindrance faced for higher yield, hazard free and smooth operation of the unit is very much called for at this stage. This aspect has been discussed in this paper. This is followed by few feasible recommendations or options for implementation are provided.

KEYWORDS: bagasse co-generation, maintenance, simulation, energy efficiency.

INTRODUCTION

Sugarcane is not only agri but energy corp. India is one of the largest producers of sugarcane. Sugar industry is the second large agriculture based industry. This can spread prosperity in rural area. The generated employment has multiple effects and helps in over all development of the nation. Sugar industries in India have big share in agriculture processing industry. There is very strong impact of sugar industries on our rural development and provides healthy rural economy. The sugarcane is main crop in 21 states of India. Mainly sugarcane mills are operating in areas like Maharashtra, Gujarat, Tamilnadu, Karnataka and Utterpradesh.Bagasse is the stringy substance that leftovers after sugarcane or sorghum stalks are crushed. And a byproduct generated in the method of manufacture of sugar. It can be effectively utilized for generation of steam. It is presently not only used as a biofuel and in the manufacture of pulp but also in paper goods and building materials. The bagasse produced in a sugar factory is however used for generation of steam which in turn is used as a fuel source and the surplus generation is exported to the power grids of state governments. Bagasse burned in quantity produces adequate heat energy to deliver needs of a sugar factory.

DEMAND– SUPPLY GAP OF POWER SECTOR IN INDIA

In India, the installed power plant capacity was approximately 1300 MW in 1947 and it is about 120,000 MW in 2006. Power has a significant role to play in industry and agriculture. Power demand increases continuously due to increase of the industrialization and per capita power consumption. At present, the per capita power consumption is about 600 KWHr. It is likely to increase to 1500 KWHr in 2016.

At present, the gap between the demand and supply is about 30% during the peak hours. The Central Government has notified on 12-02-05 that the availability of the power demand is to be fully met only by 2012. But to achieve, the country has to install 2,000,000 MWhr capacity. Per capita availability has to increase from the present level of 600 KWHr to 1500 KWHr in 2016. Aggressive attitude of the country to grow in the power field to meet the level of infrastructure demand is required in the competitive international market.

NEED FOR BIO MASS BASED POWER PLANT

The ever growing energy demand & the steep depletion of fossil fuels have directed us to explore the possibility of developing other sources of energy particularly from non-conventional renewable energy sources, which is also environmental friendly. Further, it is an undisputed fact that the present level of generation of power from Hydel, Thermal and nuclear sources could not meet the increasing demand due to various problems. In order to

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reduce the Green House Gas Emission, the Non-Conventional Energy is to be utilized for the generation of electricity. One of the Non-Conventional renewable Energy source is Bagasse. So the Ministry of Non – Conventional Energy, Government of India encourages Sugar Mills for Bagasse based Co- Generation by increasing the various subsidies We have to cross the hurdles such as lower growth rate i.e. around 5% against expected 12 % every year, lower PLF in the range of 75 % on an average, T&D losses varying in various states. In the above scenario the country has to necessarily to come out with innovative options to encourage the energy conservation measures, increasing the PLF, export of surplus power to the national purpose etc.

BAGASSE BASED COGENERATION IN SUGAR INDUSTRY

Indian Sugar Industry has to improve the revenue by value addition to the by product. So by Cogeneration Indian sugar Industry can be benefited & the revenue per ton of sugarcane can be enhanced. Sugar mills have the capacity to export about 100 KWHr power per ton cane. This will increase the revenue by Rs. 300 per ton cane. Cogeneration reduces the Green House Gas emission. This will reduce the global warming. So by cogeneration, future generation will also be benefited. All the Cane sugar plants have been using the cogeneration concept – dual use of energy in Steam, for their own captive use. But the term "cogeneration" under the present context is used to denote the export of the surplus power to the grid or for selling to any other third party. The cogeneration potential in the country in various industries, like petrochemical, paper, sugar, textile, cement etc., is around 12000 MW. Out of this, it is estimated that the potential in the cane sugar factories is around 4000 MW. Fig.1 shows a co-generation system that runs with bagasse from sugar process. All vapor from the system is consumed for sugar process.

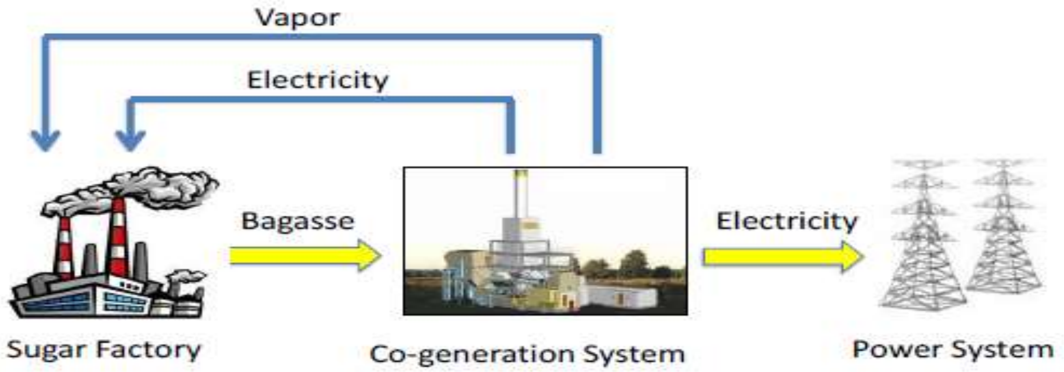

Fig.1. Co-generation system that runs with bagasse from sugar process.

LITRETURE REVIEW

SIMULATION MODELING:

Palacios-Bereche R., and Nebra S. A discussed thermodynamic modeling of a cogeneration system for a sugarcane mill. The combined production of steam and power has become the norm in the sugar cane industry worldwide. Thus the utilization of cane bagasse as fuel for the cogeneration system allows sugarcane plants to be self sufficient of thermal and electrical energy despite using low efficiency systems. The simulation / analysis of these systems would contribute to its improvement. The aim of this work is to accomplish a thermodynamic modeling of a cogeneration system using ASPEN -PLUS and compare the results of this simulation with results accomplish with THERMOFLEX which is a specialized software for analysis of cogeneration systems. The interest in an accurate modeling of the cogeneration system with ASPEN PLUS become from the fact that this software is rather adequate to modeling the entire plant. As case study , a cogeneration system with a boiler of 67 bar and condensing-extraction steam turbines is presented. This case corresponds to a real Brazilian sugarcane mill. In the last part, a comparison of results is accomplished in order to evaluate possible differences between these software. The accuracy of the ASPEN PLUS results, in comparison with the specialized software THERMOFLEX, indicates that ASPEN PLUS is suitable in a good level to perform this type of calculations. In order to obtain reliable results it is important to be careful to define the fluid property method in ASPEN PLUS; a wrong choose of the fluid property method could result in large deviations from the right values. There are also some limitations of the modeling in ASPEN PLUS. For example at the boiler modeling it was used a stoichiometric reactor to simulate the boiler furnace, in terms of energy balance there is not so much difference in relation to other models, as equilibrium model, but this consideration does not work if the focus is an emission evaluation . An equilibrium model was not utilized in the present work due to the combustion of solids materials is a complex process and due to there are not available data of the free Gibbs energy of solid formation

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for the elements: cellulose, hemicelluloses and lignin of the bagasse. Moreover, the gas exhaust temperatures at the inlet and outlet of each heat exchanger of the boiler are not real and correspond only to energy balance, due to all heat losses for convection and radiation of the boiler were considered previously, at the burner. In fact, this last aspect can be improved in future works, simulating the heat loss for each one of the components.[2]

Nikhil Dev, Rajesh Attri and Samsher in their paper entitled, 'System Modeling And Analysis Of A Cogeneration Cycle Power Plant Using Graph Theoretic Approach', studied the performance of electric cogeneration. Unit electricity generation cost from an energy resource such as coal with the help of energy conversion systems such as cogeneration cycle power plant (CGCPP) is dependent upon many of the factors such as (a) system structure which is comprised of layout and design (b) system availability which is further dependent upon maintenance (c) power plant thermal efficiency and other regulatory aspects. These are the parameters which are affecting power plant performance. The quantification accuracy is further dependent upon the expert advice available with the decision maker. Decision maker is required to collect a large quantity of data for better accuracy of the results. Therefore, the methodology based upon GTA is practical and capable of analyzing real time power plant.[3]

Peter Lasch, Christof B¨uskens, and Matthias Knauer worked on modeling and optimization of cogeneration plants. Cogeneration plants have a long tradition in Germany and are used to transfrom a given energy into various destination energies, e.g. natural gas into mechanical, electrical and heat energy. In this paper a cogeneration plant composed of several components like gas turbines, waste heat boilers, steam turbines, etc, is modeled in steady state. The thermo-dynamic behaviour of the plant is determined by a set of measured data, which is used to adopt the mathematical model to the real plant. By defining a suitable objective function incorporating e.g. emission trading, an appropriate NLP-solver can be used to solve the generated model which includes several nonlinear constraints. Solutions for different environmental and business conditions are presented, to demonstrate the enormous potential of the proposed method for energy suppliers.[4]

G. Cimdina et.al. have studied the efficiency of biomass cogeneration by modeling the process. The paper presents the analysis of operation conditions of biomass cogeneration plant (CHP). The data set for analysis comprises the data measured on an hourly basis at the cogeneration plant in Jelgava. According to the performed analysis the change in the plant's specific fuel consumption is determined by the following four statistically important parameters:

· Boiler capacity against plant fuel consumption
· Plant electrical capacity against plant fuel consumption
· Plant thermal capacity against plant fuel consumption
· Outdoor temperature.

When comparing cogeneration plant's energy-generation processes, it can be observed that the highest rate of efficiency is in the boiler, followed by heat generation for consumer needs, while the lowest is in generating electrical power. It can be explained by losses in the energy generation network, which are higher in the case of power generating than in heat generating for consumer needs. The reduction of the specific fuel consumption rate is determined by possibilities of loss reduction within plant's energy generating processes.[5]

B.T. Aklilu and S.I. Gilani, in their research paper, 'Mathematical modeling and simulation of a cogeneration plant', emphasized to develop mathematical models to simulate a single shaft gas turbine based cogeneration plant with variable geometry compressor. At off-design the variable vanes are re-staggered to improve the cogeneration performance. Two modes of operation are identified with the first mode being for part load of less than 50% running to meet the part load demand. This is achieved by controlling the fuel flow and air bleeding at the downstream of the compressor to avoid surge formation. The second mode of operation is for part load greater than 50%. It is running to meet both the part load demand and the exhaust gas temperature set value by simultaneously regulating the fuel flow and the variable vanes opening. To accommodate change of compressor parameters during variable vanes re-stagger correction coefficients are introduced. A behavior of a 4.2 MW power generating cogeneration plant is simulated. The effect of variation of power and ambient temperature on cogeneration parameters like fuel consumption, temperature, pressure, variable vanes opening, efficiency and steam generated is studied. Comparison between the field data and the simulation results is in good agreement. To support the calculations required for off-design analysis, a computer program is developed in MatLAB environment.[6]

Frank Nsaful worked on the process modeling of sugar mill biomass. The sugar industry over the years has been producing sugarcane bagasse as part of the sugar milling process. The main objective of this work was to develop process models for the processing of sugar mill biomass into energy and energy products. Based on this, biomass to energy conversion process (BMECP) models have been developed for various process configurations of two thermo chemical processes; Combustion and Fast Pyrolysis using the Aspen Plus® simulation software. The aim of process modeling was to utilizing sugar cane bagasse as an input energy source to supply the energy requirements of two sugar mill configurations (efficient and less efficient mills), while generating extra electricity and high valued energy products for sale. Four BMECP configurations; 30bar BPST, 40bar CEST, 63bar CEST and 82bar CEST systems were modelled for the combustion thermo chemical process:.[7]

PERFORMANCE ANALYSIS AND VALIDATION:

Venkata Seshendra Kumar Karri in his work he discussed the need to operate a boiler efficiently in today's environment is at the top of many plant owners and operators lists. Unfortunately, operating a boiler efficiently and meeting local emission regulations do not always go hand in hand. However, advances in boiler system design and technology have made this a much more achievable task. The potential for energy improvements and cost savings is substantial when considered that most boilers operating today are per-forming at efficiencies that are less than 70 percent. The performance calculation and rectification measures are essential for performance evaluation and efficiency enhancement. This present deals with the aim of estimating the heat losses occurring in thermal power plant boilers and hence finding suitable ways for reducing it, hence allowing plants to achieve more performance, sustainability and cost-effective maintenance operation of a steam system.[8]

Flore A. Marion In parallel, a systems performance model of the engine generator, its heat recovery exchangers, a steam driven absorption chiller, a ventilation unit, fan coil cooling/heating units has been programmed making use of TRNSYS transient simulation software. This model has now been used to estimate the energy recoverable by the system operating in the IW for different characteristic periods, throughout a typical year in Pittsburgh, PA. In the initial stages of this modeling, the engine parameters have been set at its design load, 27 kW, delivering up to 17 kW of steam and 22 kW of hot water according to calculation. The steam is used in the absorption chiller during the summer and in hot water production during the winter. Hot water is used in desiccant regeneration for air dehumidification during the summer, in IW heating during the winter, and in domestic hot water product year around. [9]

I. Emovon, B. Kareem, and M.K. Adeyeri, The main objective of this Paper was to evaluate the outage cost due to system downtime (Turbine failure) of Egbin Thermal power station from the year 1999 to 2008. The result of the analysis carried out revealed that for the whole ten years under review that there was a power generation loss of 46 percent of the Installed capacity putting the performance of the power station at 54 percent. Further investigation which is the aim of the paper revealed that the 46 percent of production loss resulted to revenue loss to the tune of $24,186,569,250. However a simple performance indicator was developed to evaluate the outage cost for the station which can also be applicable to other power station in Nigeria and beyond.[10]

A. Khoodaruth investigated the conditions in Mauritius. Mauritius has a long tradition of using cogeneration systems for electricity generation. Bagasse, a by-product of sugar cane is burnt in high temperature and pressure boilers to produce uperheated steam to be used for combined heat and power generation. Steam is fed in condensing extraction steam turbine coupled with an alternator to produce electricity and the exit low pressure steam of the turbine is used for the processing of sugar with flexibility to be employed also in distillery and refinery activities. Multi-criteria analysis of such bio-refinery inputs and outputs is conducted considering Energy, Engineering, Economic, Environmental and Ethical dimensions like sustainability, equity and democratization of the energy sector. Due to the reduction of price obtained for the sale of sugar to the European Union, the sugar industry has to re-engineer itself to move towards the flexi-factory concept for its survival. Actual parameters 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. Policy implications crucial to the future viability of such complex energy systems; these are fully discussed in relation to national and international objectives.[11]

Mohammed A et.al. in their work, cogeneration power and MSF water desalination plant has been modelled using the IPSEpro software package based on plant operational scenarios and validated against measured recorded data from the plant. The relative differences between the model results and measured plant data vary rom 1.1% to 3.7% for the power plant and 1.0 % to 1.8 % for MSF desalination. The model uncertainties could be attributed to either modeling assumptions or to input data uncertainties, with measured plant performance uncertainties due to measurement device precision and effects of external factors. The results suggest that the real tolerance on data supplied to the model (all themselves measured) plus the real performance measurement uncertainties restrict the achievement of the model predications to within about 1% of measured plant performance. In this study, though, the difference may be as high as 3.7%, suggesting that further improvement remains possible. However, even at this level, it is reasonable to suggest that this model may be used for further investigation of this cogeneration plant. The results show the differences between the model results and measured data varying from 1.1% to 3.7% for the power plant and 1.0% to 1.8% for MSF desalination. [12]

Boddu N. Venkatesh and Vim Chankong in their work focused on the development of modeling tools for optimal energy management in an industrial/commercial setting having cogeneration plants. Both cases of gas and steam turbine-based cogeneration plants are taken into consideration. A scheduling tool is also built into this model to help in scheduling of multi interval shiftable loads with variable amplitude load profiles. In this paper, authors demonstrated a method for solving the problem of energy management in an industrial/ commercial complex having cogeneration plants. Authors have attempted to model the problem as a mixed integer program. The model developed can be used for single plant or multiplant cogeneration systems operating in either topping or bottoming cycles. This model automatically adjusts the operating costs due to varying levels of steam/flue gas regeneration. This allows a more accurate picture of the actual savings made because of cogeneration. It is known that the efficiency of various components in a cogeneration plant varies with the operating load. As the load increases, the efficiency of the system also increases.

P C Tewari, Rajiv Khanduja, Mahesh Gupta, [3] (2012) these researchers enhanced the performance of crystallization unit of a sugar plant. For the work they used genetic algorithm. There were three main subsystems in the crystallization unit which arranged in series. The mathematical formulation of the dilemma is done using exponential distribution failures and repairs. Differential equations are developed on the basis of Markov birth-death process. These equations can solved using normalizing conditions and steady-state availability of the crystallization unit determined. The performance of each subsystem of crystallization unit is optimized using genetic algorithm. The effect of GA parameters such as population size and number of generations on unit performance, i.e., availability, has also been discussed. The findings of the presented paper will be highly useful to the plant management for the timely execution of proper maintenance decisions and, hence, to enhance the system performance.

S.M. Seyed-Hosseini, N.Safaei, M.J.Asgharpour [4] (2006) here the researchers developed an effective methodology to decision making field for reprioritization of failure modes in a system Failure Mode and Effects Analysis (FMEA) for corrective measures. The proposed methodology can cover some shortcomings of conventional Risk Priority Number (RPN) method and like. Here researchers proposed method called Decision Making Trial and Evaluation Laboratory (DEMATEL) is an effective approach for analyzing relation between components of a system in respect to its type (direct/indirect) and severity. The main advantages of DEMATEL are involving indirect relations in analyze, allocating as possible as unique ranks to alternatives and clustering alternatives in large systems. Proposed method that called DEMATEL prioritizes alternative up on severity of result or weight and direct/indirect associations of between them.

SUMMARY OF LITERATURE REVIEW:

It is observed from the literature review that a simulation model can be developed to understand the process behavior and efficiency of the power generation system. The Indian biomass power generation scenario suggests that there exists a scope for bagasse power cogeneration in sugar plants would be the answer for the future energy demands of the country. 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.

CONCLUSIONS

1. The salient points that come out from this review study are given below.1. The performance of sugar industry in the present day context has been brought out wherein the per capita consumption of sugar has an edge ever the growth of the population.
2. The gap between demand and supply of power from generating units are required to be bridged to improve the per capita availability of power.
3. The raw materials such as sugarcane and other ingredients required for sugar production as well as the solid waste management have be effectively done and they should not hamper the production of sugar. These have to be implemented with meaningful exercise and logical thinking.
4. The machineries required for the sugar industry have to be made available as well as in good coordinating condition and not causing hindrances to the production of sugar.
5. The overview of power situation study indicate the necessity for co-generation projects so that the shortage of the power may be overcome.\The auxiliary power required to run the sugar industry has to be met from the electricity generation through co-generation units.

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