ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

BAGASSE POWER, AN UNTAPPED POTENTIAL IN INDIA -A REVIEW

Kalpana Bisht*, Renu

* Department of Entomology and Agricultural Zoology , Institute of Agriculture Sciences, Banaras Hindu University, Varanasi,221005 (Uttar Pradesh), India

Department of Chemical Engineering,Malaviya National Institute of Technology, JLN Marg Jaipur-302017(Rajasthan), India

DOI: 10.5281/zenodo.205772

ABSTRACT

Conventional fuels such as coal, petroleum etc are limited in the nature therefore, alternate sources are needed to fulfill the demand of energy in future. India, which accounts for around 85 per cent of South Asian electricity generation, still facing serious power problems with current generation being about 30 per cent below the demand. Overall, Indian power demand is projected to increase to 1,192 billion-kilo-watt-hours (BkWh) by 2020, which is more than three times, 378 BkWh consumed in 1996 (Report; Ministry of Agriculture and Natural Resources). One of the major commercially grown agricultural crop in India is Sugarcane. The plant have the highest bioconversion efficiency through photosynthesis and is able to fix around 55 tonnes of dry matter per hectare of land under this crop on annual renewable basis. India produces nearly 40 million metric tonnes (MMT) of bagasse and it is being minorly used as raw material in the paper industry. Through this source cheaper electricity can be produced and the greenhouse gases can be minimized in terms of the usage of biomass as fuel. Therefore, Bagasse, can play a major role in substituting fossil fuels for the future power generation.

KEYWORDS: Bagasse, conventional fuels, power generation, renewable, emission.

INTRODUCTION

The economy of India has the second-fastest rate of increase in GDP in the world – 7.1 per cent in 2008. The country ranks sixth in the world in terms of total energy consumption and needs to accelerate development of the energy sector to meet its growth aspirations. Though rich in coal and abundantly endowed with renewable energy in the form of solar, wind, hydro and bio-energy, India has very small hydrocarbon reserves (0.4% of the world's total). Being a net importer of energy, more than 35% of the country's primary energy needs are ensured through import.

Meeting electricity demand in sustainable manner is one of the major challenges that India is facing. As per Integrated Energy Policy of GOI, electricity generation capacity must be increased to nearly 800000 MW from current generation capacity of 2, 25,793 MW by 2032[1]. Depletion of fossil fuel and increased import of energy resources is a matter of concern in India. In view of this, country has launched a programme to enhance proportion of renewable energy in the electricity mix. Ministry for New and Renewable Sources of Energy (MNRE) has adopted strategic plan for new and renewable energy sector for the period 2011-17[2]. Further, 15600 MW of renewable energy capacity was added during 11th plan i.e. (2007-12) against a target of 12280 MW [3]. Sugar production is an energy intensive industry and requires both steam as well as electricity. Bagasse is the leftover of the sugarcane after crushing and it can be utilized as a fuel after burning in the boiler of sugar mill or electricity can be generated by using Organic Renkine cycle. Bagasse-based cogeneration potential in sugar mills is estimated to be 5000MW [4]. Further, as per KPMG analysis this potential will be approximately 9700 MW by 2017[5]. As per MNRE database total installed capacity of bagasse cogeneration is 2393 MW as on 31st October 2013 [6]. It is estimated that four million units of electricity per megawatt of capacity of the cogeneration plant is generated per year [7]. Higher rate of deployment of bagasse cogeneration in India during last five years is noteworthy. In the 12th five year plan (2012-2017) 1369.7 MW of electricity against target of 1200 MW was added[3].

The four main by-products of the sugarcane industry are cane tops, bagasse, filter muds and molasses (table 1). If

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

we accept that the present world production of sugarcane has reached the 60 million tonnes level, then the quantities of these byproducts produced yearly are approximately the following:

Cane tops	**200 million tonnes**	**(fresh weight)**
Bagasse	60 million tonnes	(bone dry weight)
Filter muds	5 million tonnes	(air dried weight)
Molasses	16 million tonnes	(at 80 percent DM)

MATERIALS AND METHODS

Overview of India's sugar sector

Currently about 4 million hectares of land in India is under sugarcane with an average yield of 70 tons per hectare. Sugar industry in India is concentrated in states of Uttar Pradesh, Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Gujarat, Haryana and Punjab. During sugar production season electricity generated from the plant is used for the production process and surplus is fed into grid while during off season all electricity generated is fed into grid. However grid connected surplus power generation from sugar industries gained momentum in India in 1993 consequent to a report submitted by a committee constituted by MNSE (Now known as MNRE). Bagasse cogeneration is a now a well understood and matured technology in the country. State wise status of bagasse cogeneration in India as on 31.03.2013 is given below in table [2].

S. No.	**State**	**Potential(in MW)**	**No. of Projects**	**% Utilization**
1.	Maharashtra	1250	65	46.47
2.	Uttar Pradesh	1250	53	56.8
3.	Tamil Nadu	450	26	72.67
4.	Karnataka	450	32	89.75
5.	Andhra Pradesh	300	22	54.35
6.	Bihar	300	04	14.43
7.	Gujarat	350	-	00.00
8.	Punjab	300	06	20.67
9.	Haryana & others	350	4	9.09
	Total	**5000**	**212**	**46.64**

Above table indicates that more than 50% of bagasse cogeneration potential is still untapped.

Calorific value calculation Bagasses consists of fibres, water and relatively small quantities of soluble solids - mostly sugar. The average composition of bagasse is the following:

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Fibre (including ash)	48.0 percent
Moisture	50.0 percent
Soluble solids	2.0 percent

The fibre consists mainly of cellulose (27 percent), pentosans (30 percent), lignin (20 percent) and ash (3 percent). The calorific value (CV) of bagasse is given by the formula:
Net CV = 18 309 - 31.1 S - 207.3 W - 196.1 A (expressed in kJ/kg)
Where: S=Soluble-solids
W=Moisture%
A = ash %
If W = 0, S = 2 and A = 3, then the net CV of bone dry bagasse = 17 659 kJ/kg
If W = 50, S = 2 and A =1 1/2 then the net CV of mill run bagasse = 7 588 kJ/kg
Potential and Achievement in Bagasse Cogeneration Cogeneration is defined as simultaneous generation of electricity and thermal power. Cogeneration in sugar mills have been explained by schematic diagram below:

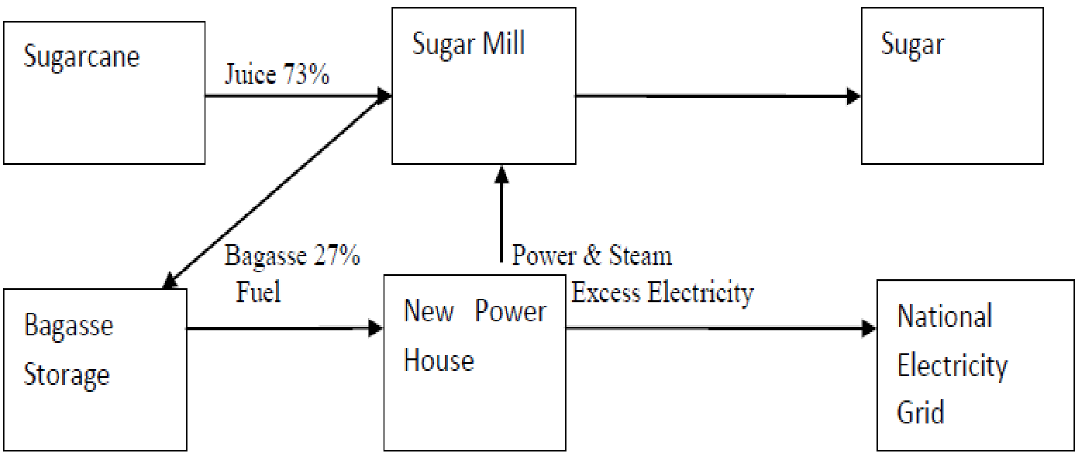

Figure 1: Schematic diagram of power cogeneration in sugar mills

RESULTS AND DISCUSSION

The more straight forward solution is to produce electricity from the bagasse saved via a high pressure boiler and condensing turbo-alternator. Power output from bagasse cogeneration mainly depends on two factors moisture content and technology used. Cogeneration plant works on organic Rankine Cycle (Figure 2). Sugar production requires large quantity of processing steam at about 2.5 bar which is lower than that required for power generation. Therefore, steam at higher pressure and temperature must be generated to increase the efficiency of Rankine cycle. Hence in cogeneration projects high-pressure boiler configurations of 67 bar or 87 bar or 105 bar are used against the conventional 32 bar or 42 bar pressure boilers used in the sugar mill. Higher pressure and temperature are critical for increasing the cycle efficiency and power output. Cogeneration plant based on 105 bar and 520°C adopted in the state of Tamil Nadu and Andhra Pradesh generate about 6% more power than 87 bar and 515°C [9].

Manufacturing capability exists in the country for the equipment/machinery required for setting up cogeneration projects. Capability exists in the country for manufacturing spreader stoker fired, travelling grate/dumping grate boilers; atmospheric pressure fluidized bed boilers and circulating fluidized bed boilers. Manufacturers are further upgrading capabilities for high efficiency boilers. Manufacturing capability exists in the country for condensing, single extraction/double extraction condensing; back pressure turbines with the efficiencies comparable to the best in the world [8].

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

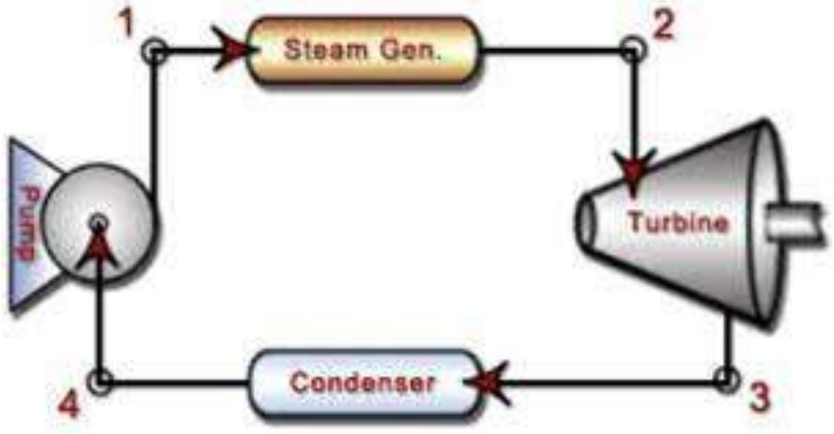

Figure 2: Cogeneration plant works on Rankine Cycle

Recent Advancement

Focusing on the demand projected to increase to 1,192 billion-kilo-watt-hours (BkWh) by 2020, lots of agricultural and technological advancement are needed which can tap the energy to its maximum. Few advancement can be feasibily applied; Raising the cane varieties which are rich in fibre content viz. Co-0238, CoH-119, CoH-05262, CoH-05265, CoH 05266, CoJ 88, CoLk 05201, CoPb05211, CoPk 05191 and UP 05233. Use of self-detrashing cultivars, breeding programmes should be done for more biomass. Replacement with high pressure boiler and condensing turbo-alternator.

CONCLUSION

India has vast untapped potential of bagasse cogeneration. GOI has also taken several initiatives to enhance bagasse cogeneration which received positive response from sugar sector. More collaborative efforts are needed to wean our dependency on petroleum-based energy inputs.

REFERENCES

[1] Integrated Energy Policy of GOI, 2006, retrieved from, planningcommission.gov.in/reports/genrep rep intengy.pdf on 25.11.2013.
[2] Strategic plan for new and renewable Energy sector for the period 2011-17 of MNRE, retrieved from mnre.gov.in/file-manager User iles strategic plan mnre 2011 17.pdf on 2.12.2013
[3] Eleventh plan (2007-12) power capacity addition through grid interactive renewable accessed from http://data.gov.in/dataset/eleventh-plan-power-capacity-addition-through-grid-interactive-renewable-power on 1.12.2013.
[4] Energy Statistics 2013, Ministry of Statistics and Programme Implementation Government of India, New Delhi.
[5] KPMG Report, the Indian Sugar Industry Sector Roadmap 2017, 2007
[6] MNRE website data on installed capacity retrieved from http://www.mnre.gov.in/mission-and-vision-2/achievements/ on 18.12.13.
[7] MNRE Press Release dated 30.08.2013 accessed from http://pib.nic.in/newsite/erelease.aspx?relid=98949 on 03.12.2013
[8] MNRE website www.mnre.gov.in/schemes/grid-connected/biomass-powercogen/ accessed on 03.12.2013.
[9] MNRE Annual Report 2012–2013, New Delhi, India retrieved from http://mnre.gov.in/file-manager/annual-report/2012-2013/EN/chapter3.html.