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Editorial

Sanjay Khatal
Executive Director
Cogeneration Association of India

The sugar industry is witnessing a record production of sugarcane as well as sugar, thus compounding the importance of handling molasses and other by-products. The year 2017-18 saw record-breaking production, while 2018-19 will see still higher peaks.

The expanding base of sugarcane and the recent breakthrough in productivity seems to be posing new challenges for the industry in terms of handling the immense generation of molasses. Discussions are actively focusing on the necessity of ‘B’ heavy molasses and ethanol production, so as to save the sugar industry from excess production of white sugar and its adverse fallout on the pricing issue, which are not only likely to cripple the industry, but may also lead to large-scale exits.

In this scenario, the overall diversification of the sugar industry into distilleries and cogeneration has been important landmarks in the sugar industry. With the growing importance of environmental issues in India and globally, the spotlight has shifted to not only proper disposal of wastes, but rather for their ‘alternative usage’.

Spent wash, the effluent of ethanol production, may turn out to be a key source of bio-energy either by transforming it into biogas (methane), which can be used as boiler fuel, or after concentrating it in Multiple Effect Evaporators and then incinerating it, along with support fuel such as bagasse/coal/other biomass, in an incineration boiler, and integrating this with a turbine to produce “bio-electricity”.

The benefits are several. Besides power generation to meet captive requirements, the resulting potash-rich ash sale generates good revenue and eliminates the disposal problem. Overall production cost per liter of alcohol reduces and steam is generated to meet the process requirement of the distillery. India is a net importer of potassic fertilizer. Therefore the aforesaid concept can help in a small way to reduce the magnitude of imports.

The Cogeneration Association of India (Cogen India), with support from National Sugar Institute, Kanpur and All India Distillers’ Association, New Delhi, and several other organizations *(details are within this issue)*, organized a Business Meet in Lucknow in March 2018, to accelerate such projects in this sector.

Interesting insights into issues concerning all stakeholders were shared and discussed. A particularly interesting case study by management of Balrampur Chini Mills on their distillery waste incineration experience was presented. They had pondered the decision three years ago to opt for incineration of distillery spentwash for their three units producing ethanol. A team visited few installations in southern India and Kenya, and found that units were operating with coal as support fuel with very highdown-time and very inefficient operations. But since Balrampur Chini had plenty of surplus bagasse, they decided to use it as support fuel. Their 60 klpd distillery with 40 tph incineration boiler has since been operating successfully.

Waste heat recovery is another technology initiative gaining rapid ground in India.

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South Asian Perspective: Bagasse-Based Cogeneration In Sugar Mills

Introduction

Cogeneration through combined heat and power (CHP) is the simultaneous production of electricity with the recovery and utilization of heat. Cogeneration is a highly efficient form of energy conversion and can achieve primary energy savings of approximately 40% as compared to the separate purchase of electricity from the national electricity grid with a gas boiler for on-site heating. CHP plants are typically embedded close to the end-user and therefore help reduce transportation and distribution losses, and improve the overall performance of the electricity transmission and distribution network. Bagasse-based cogeneration systems are integrated systems that use bagasse as a fuel for the generation of heat energy and electricity.

The sequential cogeneration system, in which heat energy is produced first followed by electric power generation, is called topping cycle; while when electricity is generated first, followed by heat energy, it is called bottoming cycle. This electricity can be used by the industry itself, where the cogeneration system is installed, while surplus can be dispatched to the national grid of that particular country/region. Through cogeneration, waste heat (which in other cases may be emitted to the environment) is converted into a useful form of energy, while the efficiency of the system can be improved. Thus, it is a sustainable way to generate electricity at an affordable cost.

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Editor

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Cogeneration Association of India
(Cogen India)
c/o MSFCSF Ltd., 1st floor, Sakhar Sankul
Shivajinagar, Pune 411 005, India
Tel: +91-20-25511404; Fax: +91-20-25511467
Email: cogenindia@gmail.com
Web: www.cogenindia.org

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World Experience

Due to fluctuating oil prices and environmental effects of hydrocarbons, the enthusiasm of the world towards alternate energy sources has increased. USA was the 1st country to come up with a policy for promotion of cogeneration under the Public Utility Regulatory Policies Act 1978. Demark has been promoting cogeneration since 1980, leading to development of a cumulative 450 MW of small-size cogeneration projects in about 300 different towns by 1986. Spain started to develop policies regarding cogeneration during 1980, which were well received by the stakeholders. Privatization and liberalization of energy markets in the UK has created opportunity for enhancing cogeneration power production. The UK Government is striving to remove unnecessary barriers for development of cogeneration. In this regard, the government has exempted small-scale cogeneration facilities from licensing. Japan has adopted cogeneration since 1990. The cogeneration capacity of Japan is about 2% of the total electric power generation potential of the country. Similarly, South Korea is committed towards cogeneration since 1980. During 1995, the cogeneration capacity of South Korea was about 6,225 MW. In Thailand, the government approved a

Deshbandhu Sugars in Bangladesh

policy during 1988 to enhance the power generation through renewable energy and cogeneration means.

Bagasse-based Cogeneration

The residual fibrous waste, which is obtained after crushing sugarcane, is termed as bagasse. Bagasse is a fuel source and generally used for generation of heat and electricity by burning in a furnace/boiler. The heat content of bagasse depends on different factors, i.e. sugarcane variety, method of harvesting and efficiency of machines, etc.

Bagasse cogeneration projects are generally based on conventional Rankine steam cycle for power generation. In this process, bagasse is directly burnt in a furnace/ boiler to produce pressurized high temperature steam from water passing through pipes of the boiler. Some of the steam produced is used in various processes of the plant, while the remaining is used for power generation. For power generation, the steam is expended through the blades of a turbine, which is coupled with a generator. The mechanical energy of turbine is transferred to the generator where change in the electromagnetic field results in electricity generation. Some of the generated power is used for internal use of the sugar mill, while the excess can be dispatched to the national grid or other load centers through proper interconnection arrangements.

Generally, steam with temperature of 520°C and pressure of 70-100 bars is produced during the cogeneration process. High pressure and temperature are effective for higher power output.

Bagasse Potential in South Asia Countries

Within South Asia, the three most prominent countries with high sugarcane output and good potential for bagasse production are Bangladesh, India and Pakistan.

The total sugarcane production of Bangladesh is about 7.3 million tons. This sugarcane is used in about 15 sugar mills, which are under the supervision of Bangladesh Sugar and Food Industries Corporation (BSFIC). The operating period of these mills is about 150 days. All these mills have capability of power generation through cogeneration with an overall capacity of more than 100 MW. The boilers of sugar mills are mostly of low pressure, which can be replaced by high-pressure boilers, due to which additional power can be generated.

India is a major producer of sugarcane, with a total production of about 280 million tons. Around 75-90% of bagasse is used in sugar mills for the production of

Sugar mills in Pakistan (www.pakistantoday.com.pk)

internal steam and electric power. The Indian potential for bagasse-based power generation is about 5,000 MW, which can be enhanced up to 15,000 MW by adopting efficient techniques. This 5,000 MW power production is anticipated from about 212 different cogeneration projects.

Pakistan is the fifth largest sugarcane-producing country of the world, as its total annual production is about 60 million tons. There are 89 sugar mills in Pakistan, which makes it one of the largest agri industries of the country. The major production of sugarcane crop is in the province of Punjab, followed by Sindh province. Majority of these sugar mills have high potential for cogeneration power production. Currently, the bagasse-based power production capacity of the country is about 1,000 MW, which can be extended to about 3,000 MW.

In light of the above information, the total sugarcane production capacity of South Asia is about 347 million tons – Bangladesh (7 million tons), India (280 million tons) and Pakistan (60 million tons). Since 37% of sugarcane remains as bagasse residue after extracting juice, out of 347 million tons of sugarcane, about 128.4 million tons of bagasse can be available for cogeneration power production.

Bagasse-based Power Generation Capacity in South Asia

The power generation capacity of South Asian countries, based on 128.4 million tons bagasse availability, is thus about 8,000 MW. Literature shows varying capacity of South Asian countries for bagasse-based cogeneration. In this article, the power generation capacity, i.e. 8,000 MW, is based on certain assumptions as given below.

General Assumptions

- Total sugarcane production of South Asian countries is about 347 million tons
- 37% of sugarcane residue is basically bagasse
- 80% of total bagasse is considered for cogeneration by excluding 20% losses
- Number of BTUs per kg of bagasse is 6,900
- Number of BTUs per kWh of electricity is 3,412
- The efficiency of system for electricity generation is about 28%

- The annual operating hours (for bagasse cogeneration season) are 7,200 hours

Data Analysis

Total bagasse = 347 x .37 = 128.4 million tons

Total bagasse available for cogeneration = 103 million tons (considering 80% availability factor)

Total BTUs = 7.11 x 1,014 BTUs (considering 6,900 BTUs per kg bagasse)

Total electricity generation = (Total BTUs/BTUs per kWh) x Efficiency

Total electricity generation = (7.11 x 1,014/3,412) x 28% = 5.8 x 1,010 kWh

Power capacity = Total electricity generation/Number of operating hours

Power capacity = 8,000 MW (considering 7,200 annual operating hours)

Benefits of Cogeneration

Availability of electricity: Due to utilization of bagasse for cogeneration in sugar mills of South Asia, additional electricity of about 58 GWh per annum can be generated; some of which can be consumed in sugar mills and the remaining dispatched to national grids.

Economic benefits: Electricity tariffs (fuel component) of bagasse cogeneration power are about 4 cents/ kWh lower than power generated using furnace oil. Thus, by adopting bagasse-based cogeneration power production in South Asian countries, cheaper electricity can be generated with total net savings of about USD 2.32 billion per year. Thus, it may be an effective way to decrease the financial burden of South Asian countries while saving their foreign reserves.

Environmental benefits: Cogeneration is an environment-friendly approach of power generation. In cogeneration the efficiency of the system increases and leads to less carbon dioxide emissions. For each kWh of electricity generated through cogeneration, about 0.37 kg CO_2 emissions are avoided. Thus, total 21.46 million tons CO_2 emissions can be reduced in South Asia if bagasse-based cogeneration capacity is fully utilized.

Challenges

Seasonal availability: The availability of bagasse in South Asian countries is mainly during winters, especially November-February; while the peak electricity demand period in the region is May-August. Thus, the key challenge is matching bagasse availability to peak electricity demand in summer. This is difficult as storage of bagasse throughout the year is not an economical option.

Technical barriers: Most of the sugar mills are using conventional technology for sugar production while lacking cogeneration technology. The equipment for cogeneration needs to be imported from other developed countries, as it is available only in India (in the South Asian region). Cogeneration technology requires installation of advanced control systems for supervision of the plant. Similarly, to dispatch the produced power on the national grid, there is a need to check the capacity of transmission lines in terms of load flow studies, short circuit analysis and dynamic stability. One of the technical challenges in the region is the lack of technically skilled workforce that can operate cogeneration-based plants.

Agricultural barriers: Mostly, the farming methods in South Asian countries are traditional and lack use of modern technology. Thus, it leads to low yield per acre of sugarcane. Furthermore, the crop losses during handling and transportation are also high. The issues between farmers and mill owners regarding sugarcane prices are also common in these countries.

Financial barriers: As most of the machinery for cogeneration plants is imported from India and other countries, thus initial capital investment is high. Therefore, sugar mill owners and other investors might be reluctant to promote cogeneration in the initial stages. Due to various risks, banks may also not be enthusiastic initially.

Policy barriers: The policy and regulations regarding cogeneration in these countries are mostly new as compared to other developed countries, and thus, still need time to attract key stakeholders. In addition, various regulatory barriers exist in the form of licensing for commercial operations, power purchasing agreements and approval from environmental agencies. A key issue is rational pricing mechanism, as regulatory bodies approve tariff or issue upfront tariff on the lower side for cogeneration facilities due to low capital and operating costs. Generally, low tariff tendency may discourage project developers.

Lack of awareness: Power generation through

Indu Shankar Sugar Mill in Nepal

cogeneration is a new experience for South Asian countries and thus, there is little information/data available for different stakeholders, including sugar mill owners, investors, farmers, government departments and the general public. Due to limited information, decision-making process by various stakeholders regarding cogeneration technology adoption seems quite difficult.

Recommendations

- In South Asia the availability of bagasse is mainly in winters, when hydropower electricity generation reduces due to decrease in water level of rivers; thus, bagasse power is helpful in meeting the deficiency of hydropower, and cogeneration should be promoted.
- Increased communication and collaboration with international manufacturers is needed to fully understand the technicalities of this technology.
- Manufacturers should be provided with information about local operating conditions for more efficient design of cogeneration plants.
- The quality of the local manufacturing of spare parts should be increased to match international standards.
- Instead of dispatching generated power to long distances, it will be more appropriate to dispatch the power (where possible) to utility grids of nearby distribution companies.
- To enhance local technical skills, the EPC and O&M contractors, and workers of the plants should be provided with advanced training.
- To increase the production of sugarcane, farmers should be encouraged to adopt advanced agricultural technology and farming methods. The national agricultural departments and research institutions should focus on any possible reduction in losses of crops during cultivation, harvesting and transportation. Thus, a well-managed supply chain system needs to be put in place to reduce the crop losses.
- The pricing issue between farmers and sugar mills owners should be resolved on priority basis and a long-term solution should be presented jointly by the Government, sugar mill owners and farmers' associations.
- Mill owners should be educated about potential savings resulting from adoption of bagasse-based cogeneration.
- Different banks and financial institutions should also be convinced for investment in these projects.
- There is a need to establish a single-window service in each of these countries for the facilitation of various stakeholders, including facilitation in financial aspects.

Gal-Oya Plantations (P) Limited in Sri Lanka

- A benchmark payback period along with Net Present Value for these projects should be calculated and shared with investors.
- A mutual fund may be established for financing cogeneration projects, with the stakes from regional as well as international financial institutions.
- To promote bagasse cogeneration, review committees should be established under the relevant ministries.
- The regulatory bodies should make the licensing process simple and thus save time.
- The PPAs should ensure secure purchasing of electric power on long-term basis.
- Regulatory bodies should establish an effective pricing mechanism. Prices that are cost reflective for producers and affordable for consumers should be adopted for bagasse cogeneration.
- Environmental NOCs may be issued to bagasse cogeneration projects on priority basis due to less carbon emissions from these projects.
- Various awareness programs regarding bagasse cogeneration should be arranged for various stakeholders including sugar mill owners, investors, policy makers, etc. These programs should include trainings, workshops, focused group discussions and case studies, etc. on a regular basis to provide constructive information and data for effective decision-making.

Author: Anwar Zeb
Energy Analyst
Elan Partners
4th Floor, Rizwan Plaza, 9th West, Blue Area
Islamabad, Pakistan
Email: anwarzeb05@gmail.com
Tel: 0092-3159090640

For detailed references, please contact the author.

Cogen India is hoping to work together with SAARC Energy Centre and SAARC sugar mills to modernize and expand their complexes to incorporate cogeneration and possibly, ethanol and other facilities.

Energy Efficiency in Indian Sugar Industries

The energy audits conducted by The Energy and Resources Institute (TERI) in various sugar industries in India indicates that many sugar plants are still using out-dated technology and inefficient equipment, and are following inefficient operating practices. But some of the progressive sugar plants have already initiated various energy efficiency measures and are reaping the benefits of reduced energy consumption.

This article depicts a comparison of specific energy consumption of inefficient sugar plants and energy-efficient sugar plants with reference to the major energy consuming equipment/sections. The case studies of many energy efficiency measures adopted by energy efficient sugar industries are also discussed in detail.

Introduction

Year on year there is an increasing trend in setting up of new sugar plants and capacity enhancement of existing sugar plants in India, due to increase in demand for sugar. There were 654 installed sugar factories in the country as on 31 Dec 2010. The sector-wise breakup is is below.

These sugar industries consume a considerable amount of energy for production of sugar and power. But the awareness on energy efficiency in sugar industries in India is still lower compared to that in developed countries. Less importance is given to energy efficiency in sugar industries because they are self-sufficient in fuel and power.

	Sector	Number of Factories
1	Co-operative	321
2	Private	272
3	Public	62
	Total	655

Note: The data includes closed sugar factories
Source: Department of Public Food and Distribution

By knowing the process and cogeneration equipment power consumption and by evaluating their operating efficiencies, energy efficiency of these equipment can be improved, which results in reduced energy consumption for the same amount of production. The incorporation of energy efficiency measures can be done for new plants starting from the design stage and also as a retrofit for existing plants.

Energy Consumption in Sugar Industries

The main sources of energy for sugar industries are steam and electricity. Bagasse is being used as fuel in the boilers to generate high pressure steam, which in turn drives the turbine to generate both electricity and low pressure steam. The low pressure steam is used for the sugar production process requirements. Hence in a sugar industry with a cogeneration plant, the energy consumed can be sub-classified as follows:

- Raw material : Sugarcane
- Products : White Sugar, Molasses
- Types of fuels used : Electricity, Bagasse, Coal

Specific Energy Consumption

Steam to Cane ratio : 26 - 45% range
Electricity : 22 - 37 kWh/MT

- Energy Consumption in Sugar Industry
  - Energy Consumption by Process Equipment
  - Energy Consumption by Cogeneration Auxiliaries

Factors influencing energy consumption in sugar industries are as follows:

- Crushing capacity
- Steam generation parameters
- Vintage
- Equipment used, etc.

Steam Consumption in Sugar Mills

Steam to cane ratio

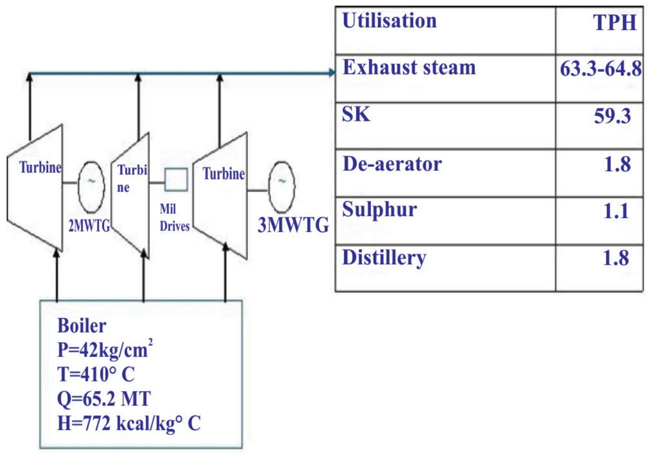
- The sugar mills with steam to cane ratio in the range of 45% are still using steam drives
- Many private sugar mills in South India had switched over to electrical drives and they are able to achieve steam to cane ratio in the range of 30~35%

- By further optimization of steam usage by improving process efficiency, a few sugar mills are able to achieve steam to cane ratio in the range of 26~30%

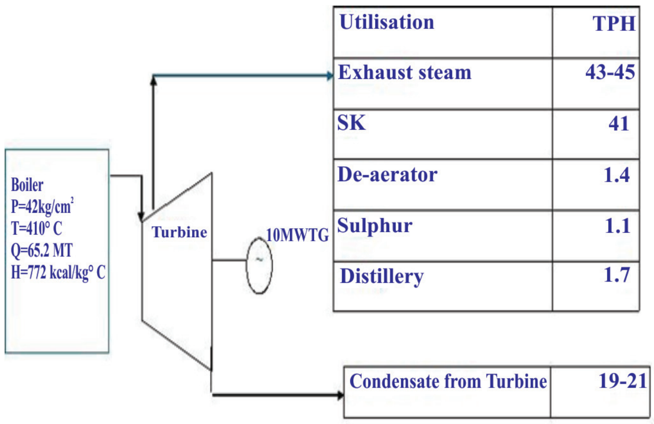
Comparison of sugar mills with high and low steam to cane ratio

Description	Plant A – 3,300 TCD (137.5 TCH) (Steam Drives)	Plant B – 3,300 TCD (137.5 TCH) (Electric Drives)
Steam consumption	63.3 TPH	43.5 TPH
Steam to cane ratio	46.03%	31.63%

Steam utilization in 3,500 TCD standard sugar mill



Steam utilization in 3,500 TCD energy-efficient sugar mill



Case Studies

(to improve energy efficiency in thermal systems)

1. Adoption of high-pressure cogeneration system

Plant A leading sugar mill in Tamil Nadu
Capacity 5,000 TCD

Before Implementation

The cogeneration set-up had three low-pressure boilers providing steam to the process and turbine generators. Historically, the factory has not exported any power to the grid.

After Implementation

A high-pressure boiler cogeneration system was installed as below:

Boiler	Turbine
1 x 120 TPH, 87 kg/cm²	1 x 22 MW

Surplus power exported to grid per hour	15	MWh
Power exported to TNEB* grid per year	401	Lakh* kWh
Revenue from power export per year	1,253	Lakh Rs
Actual investment	800	Lakh Rs
Payback period	<1 year	

** Tamil Nadu Electricity Board*

2. Heat recovery from boiler blow-down

Plant A leading sugar mill in Tamil Nadu
Capacity 5,000 TCD

The high-pressure blow-down water from the boiler was being flashed in a vessel and the vapour generated taken to the de-aerator for heating purposes. The hot blow-down water at 97 Deg C was let into the effluent treatment plant (ETP) after natural cooling. The quantity of blow-down water was 2.5 TPH.

This heat energy can be utilized to raise the temperature of turbine condensate that will reduce the extraction steam consumption in the de-aerator.

Before Implementation

Blow-down water temperature : 97 Deg C
Turbine condensate temperature : 58 Deg C

After Implementation

Blow-down water temperature : 68 Deg C
Turbine condensate temperature : 66 Deg C
Rise in turbine condensate temperature : 8 Deg C
Turbine condensate quantity : 30 TPH

2.5 ATA steam requirement to raise the condensate temperature to 105 Deg C

Without preheating : 30 * (105 – 58)/650 : 2.17 TPH
After preheating : 30 * (105 – 66)/650 : 1.80 TPH

Saving in 2.5 ATA steam : 0.37 TPH

Revenue while considering electrical energy

Increase in power generation : 0.37 (1/4.5 – 1/5.75) * 1,000 : 17.85 kW
For 270 days operation : 17.85 * 24 * 270 : 115,668 kWh
Annual increase in revenue : Rs 3.6 lakhs

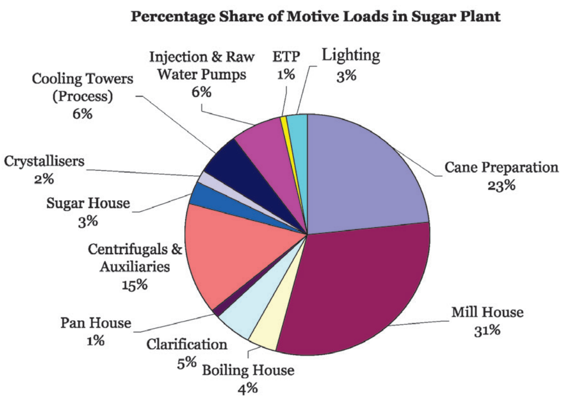
* 1 lakh = 100,000

3. Installation of bagasse drying unit

A bagasse drier is a unique device wherein the hot flue gases are mixed with the wet bagasse from mills. This wet bagasse dries up and accumulates all the ash and unburnt carbon with it. This dried bagasse with all the unburnt ash is fed into the boiler. Thus it acts in two ways. First, it dries the wet bagasse, thereby increasing the system efficiency and saving bagasse. Second, it acts as a pollution control device and reduces the suspended particulate matter (SPM) of the flue gas.

Plant : A leading sugar mill in Uttar Pradesh
Capacity : 6,500 TCD
Bagasse savings after implementation of drying unit : 3,061 MT/year
Cost savings : Rs 19.26 lakhs

Electrical Energy Consumption in Sugar Mills



Electricity to Cane Crushing Ratio

- The sugar mills with electricity to cane crushing ratio in the range of 30~35 kWh/MT are still using inefficient process equipment resulting in high fluctuation in crushing rate, such as 'A' Batch centrifuges, higher sized motors, inefficient gears, inefficient capacity controls, etc.

Comparison of sugar mills with high and low electricity to cane crushing ratio

Description	Plant A – 3,300 TCD (Standard)	Plant B – 3,300 TCD (Efficient)
Electricity	31 kWh/MT	23 kWh/MT

- The sugar mills which have adopted efficient capacity controls, continuous A centrifuges and proper sizing of equipment, are able to achieve electricity to cane crushing ratio in the range of 22-26 kWh/MT.

Case Studies

(to improve energy efficiency in electrical equipment)

1. Installation & automation of high capacity 'A' batch centrifuges

Instead of operating many small capacity (eg. 750 kg) 'A' batch centrifuges, it is advantageous to install single large capacity (1,750 kg) 'A' batch centrifuges. In case of operation of many small-capacity 'A' batch centrifuges, the average energy consumption per ton of Massecuite production is about 3.8 kWh/T, but in case of single large-capacity 'A' batch centrifuges, it is 1.3 kWh/T only. In the batch pans, by auto feed systems, the boiling mass consistency can be maintained. By automation, time taken for Massecuite dropping and restarting after dropping and washing can be reduced, and this reduces the steam % on cane indirectly.

Parameter	Before implementation	After implementation
Capacity per charge/ cycle	700 kg	1,750 kg
No. of machines	4	1
No. of cycles per hour	14	20
No. of working hours per day	20	20
Output in a day	= 700 x 4 x 14 x 20 = 784 T	= 1,750 x 1 x 20 x 20 = 700 T
Specific power consumption	3.8 kWh/T	1.3 kWh/T
Reduction in power consumption per day	= (3.8 – 1.3) x 784 = 1,960 kWh	
Additional output required to meet the daily requirement	= 784 – 700 = 84 T	
Additional machine to be run	One existing machine required to run for 8.5 hours along with new machine	
Extra power required	= 3.8 x 84 = 320 kWh	
Net energy reduction per day	= 1,960 – 320 = 1,640 kWh	
Annual energy savings (for 180 days of crushing)	= 1,640 x 180 = 2.95 lakh kWh	
Annual cost savings	= 2.95 x 3.30 = Rs 9.74 lakhs	
Total investment required	Rs 30 lakhs	
Simple payback period	3.0 years	

Plant : A leading sugar mill in Andhra Pradesh
Capacity : 3,125 TCD

2. Installing continuous high capacity centrifuge for B & C pans

In the batch pans, Pan Station vapour demand fluctuation is about 500%. In the Continuous Pans, there is consistency in the boiling mass and boiling height. So there is no fluctuation in pan vapour demand and continuous pans are useful energy efficient equipment in cogeneration plants of sugar mills.

Parameter	Before implementation	After implementation
Capacity per machine	8 T/h	18 – 22 T/h
No. of machines	3	1
No. of working hours per day	24	24
Approximate actual output from each machine	8 T/h	20 T/h
Output in a day	= 8 x 3 x 24 = 576 T	= 20 x 1 x 24 = 480 T
Approx. kW consumption per machine	48 kW	80 kW
Energy consumption per day	= 145 kW x 24 h =3,480 kWh	= 80 kW x 24 h = 1,920 kWh
Reduction in power consumption per day	= 3,480 – 1,920 = 1,560 kWh	
Additional output required to meet the daily requirement	= 576 – 480 = 96 T	
Additional machine to be run	One existing machine required to run for 12 hours along with new machine	
Extra power required	= 48 kW x 12 h = 576 kWh	
Net energy reduction per day	= 1,560 – 576 = 984 kWh	
Annual energy savings (for 180 days of crushing)	= 984 x 180 = 1.8 lakh kWh	
Annual cost savings	= 1.80 x 3.30 = Rs 5.94 lakhs	
Total investment required	Rs 17 lakhs	
Simple payback period	2.9 years	

3. Increasing energy efficiency by installing VFDs

Due to frequent variation in the crushing of sugarcane, the loading of most of the equipment varies, resulting in inefficient operation. In such a situation, installation of VFDs will result in efficient capacity utilization of equipment, leading to reduction in specific energy consumption.

- Application of VFDs in sugar process equipment:
- Cane carriers
- Rake elevators
- Injection water pumps
- Imbibition water pumps
- Magma pumps
- Raw juice pumps
- Clear juice pumps
- Syrup pumps
- Sugar drier ID fans & supply air fans (hot & cold)
- Application of VFDs for cogeneration auxiliaries:
- FD fan
- ID fan
- SA/PA fan
- Boiler feed water pump
- Cooling water pumps
- Condensate extraction pumps
- Cooling tower fans

4. Installation of VFDs for sugar process equipment and cogeneration auxiliaries

Plant 1 : A leading sugar mill in Tamil Nadu
Capacity : 4,000 TCD

Description	Power Saving in kW	Investment (Lakh Rs)	Cost Savings/ year (Lakh Rs)
Cane carrier VFD	15	5	1.8
Strained juice pump VFD	9	2.5	1.08
Weighed juice pump VFD	40	6	4.8
Sulphited juice pump VFD	15	2.5	1.8
VFDs for air compressors, vacuum pumps, bagacillow blower	25	10	3

Plant 2 : A leading sugar mill in Karnataka
Capacity : 5,000 TCD

Application	Before implementation: Operating load, kW	After implementation: Operating load, kW	Annual energy savings, kWh	Annual cost savings, Lakh Rs	Implementation cost, Lakh Rs	Payback period, Years
ID fan-1	138	110	165,600	6.12	6	0.98
ID fan-2	105	84	126,000	4.66	6	1.29
FD fan-1	71.7	57.4	86,040	3.18	4.5	1.42
FD fan-2	73.8	59	88,560	3.27	4.5	1.38

Plant 3 : A leading sugar mill in Andhra Pradesh
Capacity : 3,600 TCD

Application	Before implementation: Operating load, kW	After implementation: Operating load, kW	Annual energy savings, kWh	Annual cost savings, Lakh Rs	Implementation cost, Lakh Rs	Payback period, Years
Boiler feed water pump 1 & 2	116	66	180,000	4.5	6.0	1.33
Sugar dryer ID fan 1 & 2	46.5	39.5	21,000	0.74	3.0	4.0
Sugar dryer (hot/cold) air fan	26.8	20.8	18,000	0.63	2.2	3.5

5. Replacing eddy current drives with VFDs for cane carrier & rake carrier

Plant : A leading sugar mill in Andhra Pradesh
Capacity : 3,600 TCD

The speed control of the cane carrier and the rake carrier were accomplished by eddy current drives. The eddy current drives were replaced with energy efficient VFDs.

Energy consumption/day with Eddy current drive	2,160	kWh
Energy consumption/day with VFDs	1,680	kWh
Energy savings/day	480	kWh
Annual energy savings	86,400	kWh
Annual cost savings	2.6	Lakh Rs

6. Installing electrical heater for sulphur melting instead of using steam for sulphur melting

Plant : A leading sugar mill in Karnataka
Capacity : 3,600 TCD

Before implementation

Sulphur melting : Medium pressure steam from 2nd extraction
Steam consumption rate : 1.1 TPH

After implementation

Sulphur melting : 75 kW electrical heater

Addition power generation

by using 1.1 TPH steam : 150 kW

Net additional generation after

utilizing 75 kW for sulphur melting : 75 kW

Annual operating hours of turbine : 3,500

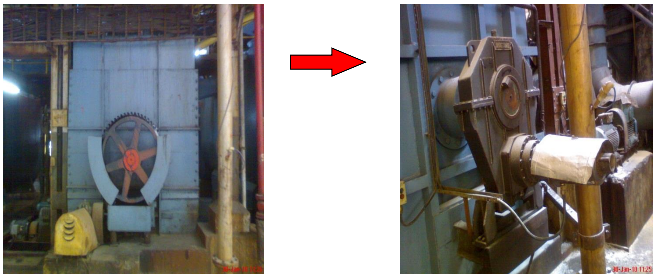
Additional units of generation : 2.62 lakh kWh

Value of additional power generation : Rs 7.74 lakhs

Investment Cost

Electrical sulphur melting : Rs 15.0 lakhs
Simple payback : 1.94 years

7. Replacing worm gears with planetary gears for crystallizers



Plant : A leading sugar mill in Tamil Nadu
Capacity : 5,000 TCD

Worm gear system

Installed capacity : 5 nos. x 9.3 kW, 13 nos. x 7.5 kW
Units consumed per day : 3,456 kWh
Total cost per annum : Rs 29.39 lakhs

After installation of planetary gear

Installed capacity : 5 nos. x 2.2 kW, 13 nos. x 1.5 kW
Units consumed per day : 732 kWh
Total cost per annum : Rs 6.23 lakhs
Savings per annum : Rs 23.17 lakhs
Investment cost : Rs 22.05 lakhs
Payback period : <1 year

8. Installing auto delta-star controller for bagasse conveyers

The operating load of the bagasse conveyers will be most of the time less than 40%, but the starting torque requirements of these drives will be higher. The power factor and efficiency of the motor depends on percentage loading of the motor. The motors operating at less than 40% loading for more than 60% of their operating time can be operated with auto star delta controllers

to achieve energy savings. When the loading of these motors goes less than 40%, the controller will operate the motor in star mode, which results in improved percentage loading and reduced losses.

9. Installing Induction lamps as a replacement for HPMV/ HPSV/MH lamps

The HPMV/HPSV/MH* lamps are used for street lighting in the sugar mills and these are operated throughout the year during night-time. These lamps can be replaced with induction lamps with the following advantages:

- Long life of over 20 years
- Energy savings up to 60%
- 95% light output maintenance beyond 40,000 hours operation
- Very high power factor of 0.99 lag
- Instantaneous starting
- Reduced maintenance

Comparison of Induction Lamps with FTL/MV/SV/LED* Lamps

Lighting Source	Lumens/W	Correction factor	Pupil Lumen/W
FTL 6500K	55	1.72	95
FTL 2900K	65	0.98	64
HPSV	65	0.76	49
LPSV	163	0.35	57
LED	60	1.45	87
Induction Lamp	80	1.64	130

**FTL: Fluorescent tube light; LED: Light-emitting diode*

10. Operating the lighting circuit with reduced voltage using lighting voltage control transformer

It is a good practice to install a lighting voltage control transformer, which will facilitate operating the lighting system with reduced optimum voltage levels. The 1-phase voltage level can be maintained between 205 ~ 210 V exclusively for the lighting circuit. Optimum voltage levels result in reduced energy consumption up to the extent of 10% on total lighting energy consumption. Apart from energy savings, it also results in long life of the lighting fixtures.

11. Replacing 40W T8 FTLs with 28W T5 FTLs

In sugar mills large numbers of 40W T8 FTLs are used in the process area as well as offices. Even though the sugar mills operate between 6~8 months, it is worth replacing 40W T8 FTLs with 28W T5 FTLs. Major benefits of T5 fixtures over conventional T8 FTLs are:

- Uniform lighting output for wide band of supply voltage
- Instant start and flicker-free operation
- Further it improves the PF close to unity
- Less heat generation, reduced loading on air-conditioning
- Increased lamp life of around 15,000 hours
- Higher lumens per watt (around 105 Lm/W)
- Energy saving up to 15 W/lamp (including saving from choke losses)

Major Concerns

The major concerns in implementing energy efficiency measures are as follows:

- Lack of awareness on energy efficiency, new products and latest technologies.
- Low technical and managerial expertise
- Low energy productivity
- High investment
- Less confidence
- Difficulties in outsourcing arrangements

Conclusion

Analysis of the energy consumption pattern in many of the Indian sugar mills reveals that there exists tremendous scope for improving energy efficiency. Specific energy consumption can be reduced to the tune of 22-26 kWh/ ton by incorporating various energy efficient equipment like VFDs, energy efficient transmission gears, pumps and motors, etc. Improving energy efficiency in sugar mills will result in an energy saving of up to 20%, and gives the opportunity to generate and export more power from their cogeneration plant. Specific power export is an indication of energy efficiency. This offers an estimated potential of about 650 MW of electrical energy in India. In future, sugar mills without energy efficient equipment will become non-viable.

Author:
Dr GR Narsimha Rao
Director, Industrial Energy Group
The Energy and Resources Institute (TERI), Southern Regional Centre
Post Box No. 7117, 4th Main, Domlur II Stage
2nd Cross, Bangalore - 560071, Karnataka, India
Phone: +91-80-25356590 (5 lines)
Fax: +91-80-25356589
Email: grnrao@teri.res.in

* HPMV: High pressure mercury vapor; HPSV: High pressure sodium vapor; MH: Metal halide

Energy-Efficient Milling Solutions by Ulka

Introduction

Electrical power is a necessity for any nation, for social, agricultural and industrial development, particularly in developing nations. In such circumstances, the cane sugar industry could be one of the best resources to help produce power by way of ‘cogeneration’ and, in the process, make the sugar industry a profit-making industry once again. This will help in not only its survival, but also its development and expansion in India.

For any cogeneration plant, besides efficient power generation, it is important that the factory is also run efficiently/economically in order to save power. Savings in power can deliver higher coincidental cogeneration and effect additional profits in the process.

Technology Background

Globally, “three-roller mills” are in vogue. These will be referred to as “conventional mills” hereafter. These conventional mills are based on technologies and designs that date back to more than two centuries ago. Of course, with the availability of modern technology, different kinds of efficient drives are now available to drive the mills. It is a painful contradiction that the mill itself has not seen any significant developments in technology. The only development that has been made in the past, is in the feeding arrangement of these mills, making the conventional mills more bulky and more power-consuming.

Cogeneration, however, has presented new opportunities coupled with new demands for the sugar industry. Some of these are:

- Economy in power consumption so that the saved power can be exported
- Reduction in bagasse moisture contributing to additional saving of bagasse, resulting in improved boiler efficiency and higher cogeneration.

All these, obviously, lead to enhanced profitability.

There is, however, a dilemma. Any attempt to enhance efficiency of the mills or reduce bagasse moisture, adds to additional power demand from the mills themselves, defeating the whole purpose of economy and increased profitability.

The Solution

What then is the solution? It lies in re-designing the mill, which will fulfill the desired targets of reduction in power consumption and delivery of reduced bagasse moisture.

The scope of redesign is limited to the removal of the trash plate of the conventional mill and of the closed pressure chute of the pressure feeders, thus enabling the mill to offer substantial and smooth escape of juice (juice drainage).

Several such attempts of redesign have been made, where two-roller mills have been used with or without an under-feed roller and with the mounting of conventional pressure feeders with the closed pressure chute. In some of the designs, the hydraulic loading was also removed. Also, different configurations like horizontal placement of mill rollers with vertical feed of bagasse, etc., have been introduced. It is for the industry to study the actual working of such attempts; but it could be said, without prejudice, that these attempts have not been able to deliver proven satisfaction.

The Ulka Solution – The CMR Mill

Ulka Industries, after a lot of research, was successful in developing and offering to the industry, the Ulka CMR Mill. This mill is a unique combination of the company’s two-roller mill (patented) and its three-roller pressure feeder system (patented), and does not have the conventional trash plate and closed pressure chute – both of which consume the major share of mill drive power while hardly contributing to the desired goals of ideal milling.

Moreover, this incorporates many thoughtfully designed and incorporated features like higher diameter bottom roller with deep Messchaert grooves, Lotus-type top roller even for the Last Mill, three-roller pressure feeder system without a closed pressure chute, bottom roller of the pressure feeder with a Lotus-type arrangement, hydraulic loading of the top mill roller with a swing arm and, among others, a design which allows fluent juice drainage through five ports as against three ports, as offered by conventional six-roller mills, and deliverance of four compressions with only five rollers, as against four compressions as delivered by the conventional six-roller mill. All these factors contribute to extraordinary

efficiency and performance of the Ulka CMR mills. This is complemented by the fact that, at the same time, power consumption is reduced by about 1.0 kWh per TCH per mill, as compared to the conventional six-roller mill.

These elements and efficiency parameters make it highly attractive for not only a cogeneration unit, but for any factory, having cogeneration or not.

Advantages & Benefits

The following are the advantages/benefits of installations of the Ulka CMR mills as proved and experienced at actual field installations at various factories:

1 Power saving of about 1 kWh/TCH per mill, as compared to conventional six-roller mills.

2 Enhanced efficiency: Primary Extraction (PE) of 75 to 80% at Zero/First Mill position, as compared to a maximum of 72% by the conventional mill with GRPF (Grooved Roller Pressure Feeder).

3 Reduction in bagasse moisture to below 48% in the last mill installations, which directly lead to:

   a Improvement in boiler efficiency with consequent improvement in steam parameters like steam temperature and pressure.

   b Increase in quantity of bagasse savings by about 1,200 tons per lakh[1] tons of cane crushed.

   c Since the percentage of sweet water going to boilers is reduced, it would reflect in additional bagging of sugar and hence additional profit.

   d Increase in imbibition even upwards of 250%, and at higher temperatures, which would result in increased milling efficiency.

4 With the above achievements, enhanced RME (reduced mill extraction) by about 1% for the mill tandem.

5 Re-absorption factor is successfully controlled.

6 Installation of one-size larger mill possible, using the existing mill foundation.

7 Existing mill drives can generally be used with modifications to suit new CMR mill installation, as the power requirement of the Ulka mill is lower as compared to the conventional six-roller mill.

8 Modernization/efficiency improvement/capacity expansion, possible to be executed in stages, each stage adding to the profitability and desired goals.

Many cogeneration factories have installed the Ulka CMR mill as the last mill in replacement of the existing conventional mill and have derived outstanding benefits from such installations, adding to the profitability of the factory. Most of these factories have been able to recover the cost of the new mill within 1-2 seasons only.

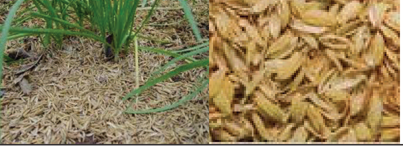
It is estimated that the installation/replacement in the zero or first mill position enables the factory to avail additional profitability of about Rs 18 lakhs per lakh ton of cane crushed. If installed/replaced as the last mill in the existing tandem, these benefits rise to a phenomenal figure of about Rs 50 lakhs per ton of cane crushed.

Impact on National Cogeneration

The detailed analysis below, of about 50 installations of the Ulka CMR mill, show that it has been immensely beneficial not only to the Industry, but to the Nation, in terms of the huge additional amounts of power that have been generated as a direct consequence of the substantial reduction in bagasse moisture.

As of date, more than 100 Ulka CMR mills have been installed all over India, ranging from a size of 30” x 60” to 50” x 100”. While these also consist of five complete mill tandems, most of the installations are as the last mill, since the profitability of the unit is highly enhanced by the reduction in bagasse moisture.

[1] 1 lakh = 100,000



INSTALLATIONS as LAST MILL

CANE CRUSHED in LAKH MT

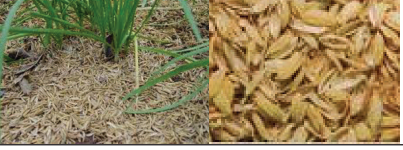
Sr.	Factory Name	Year of Installation			Crushing Season						Total
			2016-17	2015-16	2014-15	2013-14	2012-13	2011-12	2010-11	2009-10	
1	Shree Doodhganga-Krishna S.S.K. Niyamit, Karnataka	2005	07.02	10.10	10.08	08.37	-	-	-	-	**35.57**
2	Sakthi Sugar Ltd., Unit-I, Apkudai, Tamilnadu	2006	03.47	09.46	04.00	04.59	11.43	15.45	15.12	10.00	**73.52**
3	Chamundeswari Sugars Ltd., Karnataka	2006	-	-	08.00	05.47	07.91	07.12	08.91	05.08	**42.49**
4	Godavari Sugar Mills Ltd., Karnataka (Tandem A)	2007	05.92	09.48	08.84	07.83	06.35	09.63	07.85	11.96	**83.27**
5	Wahid Sandhar Sugar Ltd., Punjab	2008	04.50	04.48	04.00	03.26	03.76	02.66	02.72	02.33	**27.71**
6	Shree Renuka Sugars Ltd., Athani, Karnataka	2008	04.75	10.23	12.70	10.46	-	-	-	-	**38.14**
7	DSM Sugar Rajpura, Uttar Pradesh (UP)	2009	09.64	06.50	06.50	07.40	07.57	07.73	05.60	05.03	**55.97**
8	DSM Sugar Mansurpur, UP	2010	11.75	09.76	10.90	08.52	08.91	07.20	07.42	-	**64.46**
9	Dhampur Sugar Mills Ltd., Bijnor, UP	2010	18.74	15.90	16.70	13.08	15.13	13.68	12.74	-	**105.97**
10	Vitthalrao Shinde S.S.K. Ltd., Maharashtra	2010	07.06	16.07	17.50	10.79	11.87	14.21	13.98	-	**91.48**
11	Karmayogi Shankarravji Patil S.S.K. Ltd., Maharashtra	2010	03.43	07.80	12.20	09.21	09.29	11.90	14.36	-	**68.19**
12	Shri Gurudatt Sugars Ltd., Maharashtra	2012	05.27	08.01	07.29	06.76	05.71	-	-	-	**33.04**
13	Sakthi Sugar Ltd. Sivganga Unit No. II, Tamilnadu	2012	01.33	03.03	02.30	03.52	04.38	-	-	-	**14.56**
14	E.I.D. Parry, Pettaivaithalai, Tamilnadu	2012	02.35	0.86	00.32	-	6.62	-	-	-	**10.15**
15	Dharani Sugars & Chemicals Ltd., Tamilnadu	2013	03.03	04.45	04.10	04.10	-	-	-	-	**15.68**
16	Godavari Sugar Mills Ltd., Karnataka (Tandem B)	2014	05.92	09.48	12.00	-	-	-	-	-	**42.81**
17	The Sanjivani (Takli) S.S.K. Ltd. Kopargaon	2014	02.46	05.50	06.61	-	-	-	-	-	**14.57**
18	Shree Doodhganga-Krishna S.S.K. Niyamit, Karnataka	2015	07.02	10.10	-	-	-	-	-	-	**17.12**
19	Nirani Sugar, Karnataka	2015	08.02	19.01	22.54	-	-	-	-	-	**49.57**
20	Ryatar S.S.K. Niyamit, Karnataka	2016	01.88	-	-	-	-	-	-	-	**01.88**
21	Shri Dnyaneshwar S.S.K. Ltd., Maharashtra	2016	02.08	-	-	-	-	-	-	-	**02.88**
22	Tirupati Sugars, Bihar	2016	08.26	-	-	-	-	-	-	-	**08.26**
	TOTAL										**897.29**

INSTALLATIONS as FIRST/ZERO MILL											
CANE CRUSHED in LAKH MT											
Sr.	Factory Name	Year of Installation	Crushing Season								Total
			2016-17	2015-16	2014-15	2013-14	2012-13	2011-12	2010-11	2009-10	
1	Sadashivrao Mandlik Kagal Taluka S.S.K. Ltd., Maharashtra	2011	03.55	05.55	05.50	04.85	-	-	-	-	**19.45**
2	Vasantdada Shetkari S.S.K. Ltd., Maharashtra	2011	00.82	06.29	03.50	04.60	04.76	05.30	-	-	**20.51**
3	Nira Bhima S.S.K. Ltd., Maharashtra	2012	01.69	04.74	06.50	03.50	05.98	-	-	-	**22.41**
4	Majalgaon S.S.K. Ltd., Maharashtra	2012	00.89	03.74	06.00	04.69	04.61	-	-	-	**19.93**
5	Vijayanagar Sugar Pvt. Ltd., Karnataka	2012	03.91	08.40	07.40	06.15	05.37	-	-	-	**31.23**
6	Yashwantrao Mohite Krishna S.S.K. Ltd., Maharashtra	2013	08.31	11.66	11.70	11.27	-	-	-	-	**42.94**
TOTAL											**156.47**

AS ZERO/FIRST MILLS	
Installations	06
Cane Crushed	156.47 Lakh MT
Power Saved	156 Lakh kWh
Extra Sugar Produced	93,882 Quintals

AS LAST MILLS	
Installations	22
Cane Crushed	897.29 Lakh MT
Power Saved	897 Lakh kWh
Bagasse Saved	10.76 Lakh MT
Extra Power Produced	473,440,000 kWh or 473,440 MWh

INSTALLATIONS as ZERO/FIRST AND LAST MILL											
CANE CRUSHED in LAKH MT											
Sr.	Factory Name	Year of Installation	Crushing Season								Total
			2016-17	2015-16	2014-15	2013-14	2012-13	2011-12	2010-11	2009-10	
1	The Sanjivani (Takli) S.S.K. Ltd., Maharashtra	2006	02.46	05.50	06.61	06.59	05.84	06.09	06.32	05.93	**45.34**
2	Sakthi Sugar Ltd., Tamilnadu	2006 & 2008	03.47	09.46	04.00	04.59	11.43	15.45	15.12	10.00	**73.52**
3	The Nandi S.S.K. Ltd., Karnataka	2007	05.69	07.26	09.50	08.45	07.70	08.78	09.27	07.30	**63.95**
4	The Shahabad Co-op. Sugar Mills Ltd., Haryana State	2008	06.67	05.51	06.91	06.98	05.96	05.32	04.70	-	**42.05**
5	Shree Renuka Sugars Ltd., Munoli, Karnataka	2007 & 2008	06.38	11.44	12.47	12.29	-	-	-	-	**42.58**
6	Shree Ganesh K.U.S.M. Ltd., Gujarat	2009	05.18	06.14	13.4	12.42	12.86	11.79	-	-	**61.79**
7	Sahyadri S.S.K. Ltd., Maharashtra	20011 & 2012	09.42	12.19	13.40	12.42	12.86	11.79	-	-	**72.08**
8	Kisanveer Satara S.S.K. Ltd., Maharashtra	2010 & 2012	04.02	07.06	08.06	08.18	08.18	07.12	-	-	**42.62**
9	Vishwasrao Naik S.S.K. Ltd., Maharashtra	2011 & 2013	03.79	05.48	04.82	04.41	04.23	03.87	-	-	**26.60**
10	Shri Hiranyakeshi S.S.K. Niyamit, Karnataka	2014	02.75	06.71	08.30	-	-	-	-	-	**17.76**
11	Vishwaraj Sugar Ltd., Karnataka	2014	03.10	07.59	08.35	-	-	-	-	-	**19.04**
12	Shree Khedut S.K.U.S.M. Ltd., Pandvai, Gujarat	2012	05.30	07.10	06.46	06.32	-	-	-	-	**25.18**
13	Shri Dudhganga Wedganga S.S.K. Ltd., Bidri, Maharashtra	2011 & 2015	04.51	07.23	06.52	05.88	-	-	-	-	**24.12**
15	Sonhira S.S.K. Ltd., Maharashtra	2016	06.16	-	-	-	-	-	-	-	**06.16**
16	Dalmia Bharat Sugar & Industries Ltd., Maharashtra	2016	05.85	-	-	-	-	-	-	-	**05.85**
TOTAL											**568.64**



ZERO/FIRST AND LAST MILLS	
Installations	16 factories
Cane Crushed	568.64 Lakh MT
Power Saved	568 Lakh kWh
Bagasse Saved (For Last Mill)	06.83 Lakh MT
Extra Power Produced (For Last Mill)	300,520,000 kWh or 300,520 MWh
Extra Sugar Produced (For First Mill)	341,184 Quintals

MILLING TANDEM	
Installations	04
Cane Crushed	90.39 Lakh MT
Extra Sugar Prduced	54,234 Quintals
Power Saved	90 Lakh kWh
Extra Bagasse Saved	1.08 Lakh MT
Extra Power Produced	47,725,920 kWh or 47,725 MWh

INSTALLATIONS as MILLING TANDEM

CANE CRUSHED in LAKH MT

Sr.	Factory Name	Year of Installation	Crushing Season								Total
			2016-17	2015-16	2014-15	2013-14	2012-13	2011-12	2010-11	2009-10	
1.	Gangakhed Sugar & Energy Ltd., Maharashtra	2008	01.16	07.00	9.65	5.34	7.31	8.2	-	-	**38.66**
2.	Shiraguppi Sugar Works Ltd., Karnataka	2011	03.23	05.01	5.56	4.55	3.87	0.09	-	-	**22.31**
3.	Narmada Sugars Pvt. Ltd., M.P.	2014	03.72	06.65	04.91	03.83	-	-	-	-	**19.11**
4.	Mukteshwar Sugar Mills Ltd., Maharashtra	2010	00.77	01.86	2.75	1.06	1.8	2.07	-	-	**10.31**
	TOTAL										**90.39**

Author:
Dr. Sachin Nikam
Ulka Industries Pvt. Ltd.
K.G. Mansion, 1233 Apte Road
Opp. Hotel Kohinoor Executive, Pune 411004
Tel: +91-20-25510118, 65008118
Fax: +91-20-25510119
Email: info@ulkaind.com; Web: www.ulkaind.com

contd from pg 1 (Editorial)

Thus we see the concept of "Waste to Wealth" occupying the attention of the industry. India, being bound by the Paris Agreement, is committed to bring down the country's energy Intensity. The challenge now lies in balancing our ever-growing requirements of energy against the equally important issues of protecting our environment.

Therefore, the industry will have to rise to the occasion well in time, so as to cater to the growing need of distilleries and cogeneration plants. I am sure that this recently-held Business Meet will take us home richer on how we are able to address the issues with advanced technologies in the field.

Other articles this time cover the perspectives on bagasse cogeneration in South Asian countries, the importance of energy efficiency and milling solutions in sugar industries, generator operation modes and coping with grid faults, and financing initiatives by National Cooperative Development Corporation (NCDC).

We wish to sincerely thank Ministry of New and Renewable Energy (MNRE) for their support since this newsletter's inception.

We hope our readers find this issue beneficial, and we continue to look forward to your articles, feedback and suggestions for making this an even more informative and useful newsletter next time.

FORTHCOMING EVENT

EUBCE 2018

COPENHAGEN - DENMARK
BELLA CENTER

26TH EUROPEAN BIOMASS CONFERENCE & EXHIBITION

14 - 17 MAY CONFERENCE & EXHIBITION | 18 MAY TECHNICAL TOURS

With 900+ high-level selected presentations, involving 3,500+ authors and co-authors from 81 countries, the EUBCE 2018 Conference Programme provides once again prompt answers to the evolving international scientific and policy debate, and gives a glance into the most innovative industrial projects in the fields of biomass and bioenergy.

Responding to suggestions from the scientific community, the EUBCE Conference Program will address all different subjects of the biomass sector with an updated and refined programme structure and topics addressing the latest challenges, developments and trends for bioenergy. The EUBCE program aims at providing insights into cutting-edge research on biomass technologies as well as on the appropriate approaches to deliver sustainable bioenergy.

In addition to the Conference and Exhibition, Danish members of the EUBCE organizing committee will coordinate special technical tours to plants and sites in Denmark where biomass is the key renewable feedstock into processes producing renewable energy, biofuels, biochemicals and biomaterials, as well as integrating bioproducts into traditional established fossil-based systems.

More information on www.eubce.com

Generator Operation Modes & Coping with Grid Faults

Viewpoint Article by S Chaudhary, Triveni Engineering & Industries, Deoband

In the sugar industry, cogeneration supplies Electricity and Steam to the sugar process and the excess power is exported to the state electricity board (SEB)/grid. Today, in fact, it is almost impossible for the sugar industry to survive without cogeneration, and the profitability of the plant is centered around the revenue from export of surplus electricity to the DISCOM (electricity distribution company of India)/SEB. Apart from the revenue, the most intangible benefit of the cogeneration plant is that it enhances the reliability and, in turn, the productivity of the sugar plant. Hence, the stable operation of the cogeneration plant is vital to sustaining continuous operation of the sugar mill.

The Importance of Control & Protection Systems

When looking into the statistics, the stable operation of the cogeneration plant mainly depends on the stability of the grid to which it is connected. There are always fears in the minds of plant operating people, regarding the ability of the control and protection system to cope up with the grid faults for safe and smooth islanding without affecting the plant operations. It is a great challenge for plant engineers to keep the system healthy, sensitive and yet robust to cope up with grid disturbances. However, many cogeneration plants are still facing the problems of frequent tripping of equipment and blackouts of the plant. The grid disturbances are more severe during the periods of fog and inclement weather, and since sugar mills are generally operated during winters and foggy days, they are prone to tripping caused by grid disturbances. As I have been working in the sugar industry and cogeneration plants since the beginning of my career and had come across many such incidents, I feel that it is one of the most important tasks for consultants and operation engineers to make the plant immune from such grid faults/fluctuations and avoid blackouts. This is possible only by proper selection and maintenance of the plant control and protection system, which has been explained below as a sharing of experiences.

Modes of Operation

In any cogeneration plant, there can be three modes of operation of generators according to the requirements:

I. Stand-alone mode
II. Island mode
III. Parallel with the grid mode

Each operation mode requires specific controls in the turbine governing system and generator excitation system.

The features of each mode of operation are given below:

I. Stand-alone operation

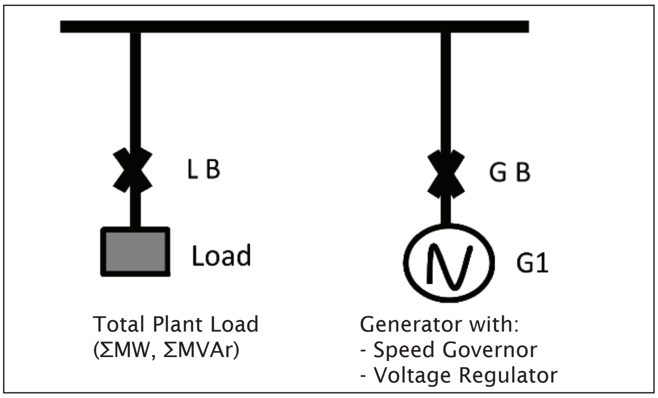


Fig. 1: Stand-alone mode of generator

In stand-alone operation a generator is not connected with other generators or the utility/grid. In this mode, we cannot control the load (kW/MW) and power factor of the generator as it totally depends upon the connected load demand. But we can control the frequency and voltage of the generator.

In stand-alone mode the governor determines the frequency and the voltage regulator determines the voltage of the generator.

- More/less inlet steam will raise/lower the frequency (Hz) of the System.
- More/less excitation current will raise/lower the voltage (kV) of the system.
- Total connected load demand determines the generator output power (MW, MVAr).

II. Island operation

In island operation mode a generator is connected with other generators, but not with the utility grid. In island operation mode/isolated system the generators supply all power to the connected load. All the generators of the

system together determine the frequency and voltage of the system. Total load (MW, MVAr) should be shared by the generators as per their rated capacity.

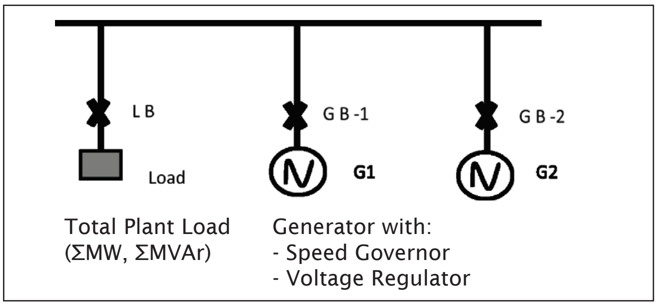


Fig. 2: Island mode of operation

- More/less inlet steam will raise/lower generator's active power and the bus frequency (MW, Hz).
- More/less excitation current will raise/lower the generator's reactive power and the bus voltage (MVAr, kV).
- Total plant load determines the sum of the power of all generators (MW, MVAr).
- Governor control options: Droop speed control.
- AVR control options: Droop voltage control.

III. Paralleled with grid/utility operation

If a generator is paralleled with the utility grid and is considered as an infinite bus, then the governor and voltage regulator of the generator cannot control the frequency/speed and voltage of the generator because the utility grid will determine the generator frequency/speed and voltage. But the load (kW or MW) and the power factor can be controlled by the governor and voltage regulator of the generator. An example is a generator used for cogeneration in sugar industry.

- More/less inlet steam will raise/lower the generator's active power (MW).

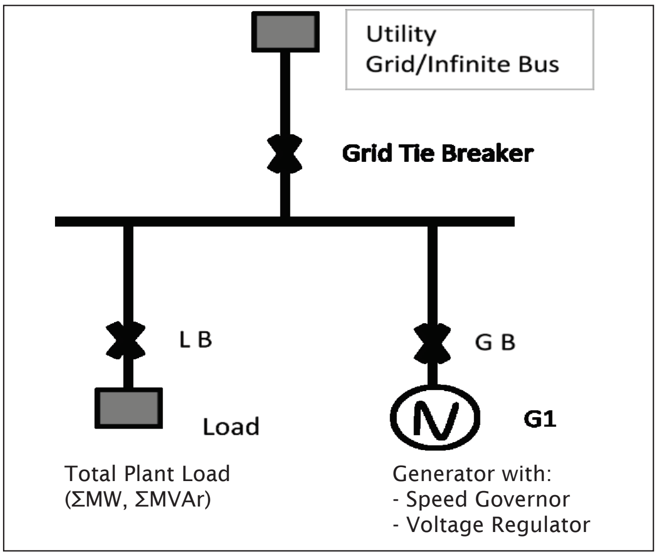


Fig. 3: Generator paralleled with utility grid

- More/less excitation current will raise/lower the generator's reactive power (MVAr).
- Utility grid/Infinite bus determines the frequency (Hz), speed (rpm) and voltage (kV) of the system.
- Difference between the total plant load and the generator output power will be imported or exported (MW, MVAr).
- Governor control options: Droop speed control, base load (MW) control.
- AVR (Automatic Voltage Regulator) control options: Droop voltage control, PF/VAr control.

Selection/Change of Operation Mode

When a generator runs parallel with the grid, then its turbine governor and AVR should be configured to select their mode of operation automatically after tripping and closing of the generator breaker or grid breaker.

Grid Disturbances

Usually, grid disturbances are caused due to the following reasons:

- Under or over voltage (UV/OV)
- Under or over frequency (UF/OF)
- Rapid fall or rise in frequency (+df/dt or -df/dt)
- Power failure in the grid
- Fault in the grid

It should be noted that an overloaded grid will give rise to fall in frequency and a fault in the grid will give rise to fall in the voltage.

Grid Interconnection Relays

Consider a cogeneration plant as shown in Fig. 4 having captive load and also synchronized with the grid. During the grid disturbance, if the plant generator is not successfully isolated from the grid then it will also sink with the grid, which results in significant loss of production. Therefore, the aim of any protection system

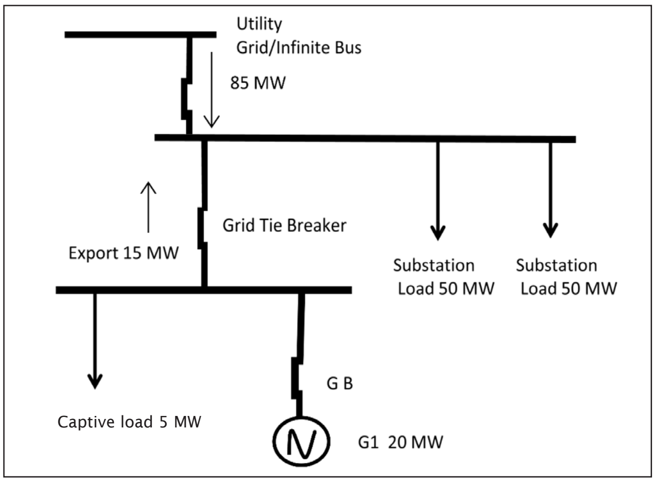


Fig. 4: Generator that exports power and meets local demand

employed for the grid interconnection is to sense the disturbance and isolate the plant generators from the grid as fast as possible.

There is a set of protection relays for the grid disturbance and islanding scheme connected at the incomer bus. These relays sense the grid disturbance and give a trip command to the grid tie breaker to make the plant isolated from the grid, whenever the grid disturbance exceeds a set limit.

The following relays are used to detect the grid disturbances and their severity:

- Under frequency and over frequency relays (81U/81O)
- Rate of change of frequency relays (81R)
- Under voltage/over voltage relays (27/59)
- Vector shift relays (78)

In the case of grid failure as in Fig. 5, captive generators tend to supply power to the other consumers connected to the substation. The load and generation imbalance leads to fall in frequency and this can be detected by the under frequency relay. But due to the inertia of the machine, frequency drops gradually. Hence to speed up the islanding decision [ROCOF (df/dt) or rate of change of frequency], vector shift relays are used.

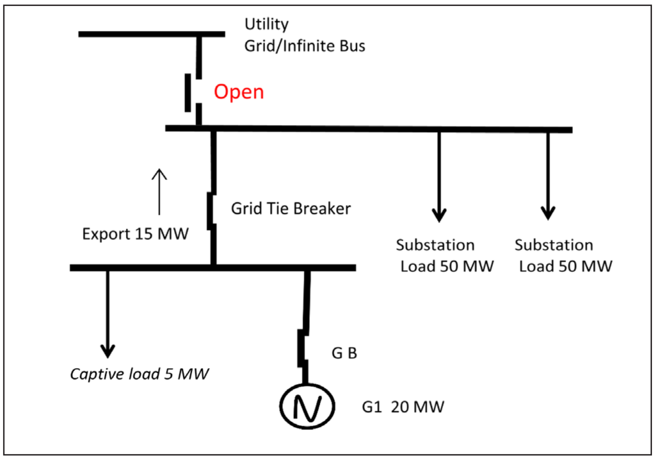


Fig. 5: Loss of grid/utility

Whenever there is a fault on the grid close to the plant, the captive plant generators tend to feed the fault, and then voltage at the supply side drops. This can be used to isolate the grid with the help of under voltage relays.

ROCOF or df/dt Relay

The most common and widely used methods to detect the islanding operation are ROCOF and vector shift relay. When the connection with the grid is lost, as shown in Fig. 5, the islanded generator is free to slow down or speed up as determined by the new load conditions, machine rating and speed governor response. The ROCOF, following a power disturbance, can be approximated by:

$df/dt = \Delta P.f/2GH$

Where P = Change in power output between synchronized and islanded operation

f = Rated frequency

G = Machine rating in MVA

H = Machine inertia constant

The setting thresholds should be such that the loss of grid supply should be detected. After installation, the setting should be periodically reviewed to ensure that they are adequate to detect an islanding event, but not too sensitive such that unwanted tripping occurs during normal load switching.

Vector Shift Relay

Vector shift relays continuously monitor the duration of each cycle of the voltage signal from each phase.

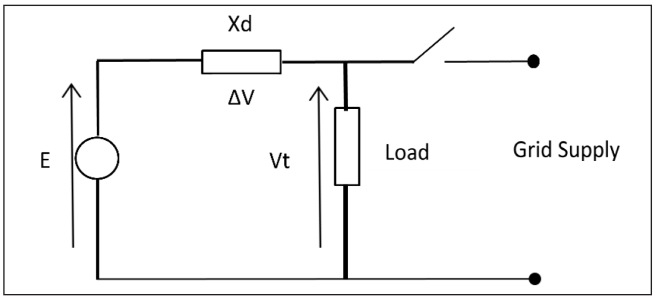


Fig. 6: Equivalent circuit of the synchronous generator operating parallel with the grid

The duration of the present cycle is compared with the previous cycle. In an islanding situation, the cycle duration can be either shorter or longer depending if there is excess or deficit of active power in the islanded system. If the measured vector shift angle exceeds the predetermined threshold, a trip signal is immediately sent to the circuit breaker.

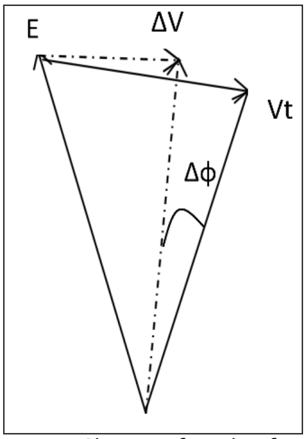


Fig. 7: Change of angle after loss of grid

As shown in Fig. 8 in the voltage time diagram, the instantaneous value of voltage jumps to another value and

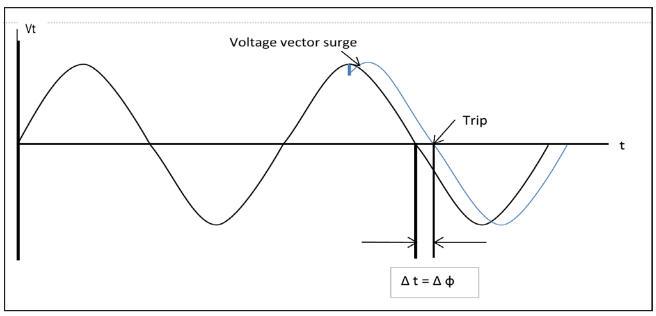


Fig. 8: Vector surge

the phase position changes. Vector surge relays measure the cycle duration. New measurement is started at each voltage zero passage. In case of vector surge as shown in Fig. 8, the zero passage occurs either earlier or later. This deviation in cycle duration is proportional to the vector surge angle.

The recommended setting of vector shift is 6 to 7 degrees, but on a weak system it may be increased to prevent maloperations when switching on or off heavy consumer loads.

It is possible to detect each of the above functions by individual relays. However numerical/microprocessor-based relays capable of performing mathematical algorithms, offer a very high degree of accuracy and resolution. As most of the microprocessor-based relays have all the functions incorporated and give more than one level/element of each protective function, they also provide the great flexibility to make the different configurations as per the system requirements. To avoid the generator breaker tripping during grid faults, it is required to make the correct coordination between the generator protection relays and grid interconnection relays. As generator protection also has the functions of under and over frequency/under and over voltage, there should be clear discrepancy in the magnitude and time of generator protection relay setting and grid disturbance protection relay setting to avoid any nuisance tripping of the generator breaker.

Suggestions from Experience

Some suggestions to avoid nuisance tripping and to keep the system healthy as per personal experience, are as follows:

- Periodical check of hydraulic accumulators: Most of the steam turbines have nitrogen-filled hydraulic accumulators in their control oil system. Accumulators enable the hydraulic system to cope up with the extreme, during transient conditions. In order to ensure proper transient response, an accumulator must maintain the proper nitrogen pre-charge pressure, preferably at around 80% of minimum working pressure. Accumulators cannot be checked for pre-charge online since the nitrogen pre-charge pressure will be in equilibrium with the accumulator oil pressure. In order to check the pre-charge pressure, the accumulator must be isolated and drained.
- Circuit breakers' auxiliary contacts: Correct feedback plays a vital role in any control system. Selection of mode of operation of governor and AVR depends upon the feedback from the generator breaker and grid tie breaker. Several problems occur due to the malfunctions of these feedbacks. Therefore, proper checking and maintenance of breakers' auxiliary contacts during off-season period helps to maintain trouble-free operation during season.
- Configuration of generator protection relay logic: To avoid the tripping of generator breakers on grid faults, configure the generator protection relay tripping logic; as the first level/element of O/U voltage, O/U frequency, over current and NPS should trip the generator tie breaker.
- Under voltage relay setting: As mentioned earlier, whenever any fault occurs in the grid, there is a fall in the supply side voltage. Hence under voltage becomes very critical to isolate the grid during fault conditions. Fast action of under voltage relay can also minimize the tripping of plant equipment during grid faults. Therefore operating time of under voltage protection should be set as minimum as possible.
- Operation of vector surge relay: Sometimes the vector surge relay operates very frequently during any switching on and off of consumers' feeders at connected substations. This can be minimized by the selection of tripping logic of three-phase instead of single-phase (Please note that this is only recommended when the response to failures is too sensitive with single-phase tripping logic).
- Periodic testing of protection relays and connected system: Preventive maintenance is always crucial to keep the system healthy. Protection systems of the plant should be tested for their functionality and operation timing at least once every two years.

Conclusion

In this article, we have discussed the modes of operation of synchronous generators and the different techniques to secure safe island operation of generators during heavy grid faults and disturbances. There are several types of protection available to detect the island operation and for grid interconnection like Vector surge, ROCOF (df/dt), Under voltage/frequency, etc., but the need is for correct configuration and periodical review of the system. If the protection and control systems are properly coordinated and specified, then there is very little (almost nil) reason why a cogeneration plant should trip with the grid and not go to island operation during grid faults.

Author: Sanu Chaudhary, Manager (Electrical)
Triveni Engineering & Industries Limited
Cogen Power Plant, Deoband 247554, Uttar Pradesh
Cell: 09759600235
Email: sanuchaudhary@dbd.trivenigroup.com

National Cooperative Development Corporation (NCDC)

NCDC was set up in 1963 under an Act of parliament, for planning and promoting programs for the production, processing, marketing, storage, export and import of agricultural produce, foodstuff and certain notified commodities and services on cooperative principles.

NCDC's Schemes for Sugar Cooperatives

- Investment loan assistance to state governments for participation in equity of new cooperative sugar mills
- Term loan assistance to existing cooperative sugar mills for modernization-cum-expansion and for establishment of Ethanol and Cogeneration units
- Short/medium-term loans towards working capital/margin money requirements

Funding Pattern for New Mills/Modernization/ Expansion/By-Product Units

Particulars	Percentage of Project Cost			
	New Mill	Mod-erniza-tion	Moderniza-tion cum Expansion*	Ethanol and Co-generation
Investment loan to State govt. for share capital participation	30			
NCDC term loan		50	65	50
Soft loan from SDF		40	0	40**
Internal accruals/ Member's share		10	35	10

** SDF (Sugar Development Fund) assistance for expansion upto 5,000 TCD is admissible if integrated project, i.e. expansion of capacity along with cogeneration or ethanol project, is taken up.*
*** SDF assistance for cogeneration projects is admissible for boiler pressure not less than 67 ata.*

The following is the eligibility criteria for NCDC assistance:

- No erosion of share capital
- Should not be a defaulter

Conditionalities for Financing Cogeneration Projects

Rate of Interest	As prevailing at the time of release of assistance
Period of Loan	8 years
Moratorium Period	Up to 2 years on repayment of principal (no moratorium on payment of interest)

Releases

- 25% ways and means advance after placement of orders for Plant & Machinery
- Subsequent releases in proportion to expenditure incurred and anticipated expenses for one month as certified by a Chartered Accountant

NCDC has been appointed as the monitoring agency for SDF loans for modernization-cum-expansion, cogeneration, ethanol and Zero Liquid Discharge (ZLD) projects of cooperative sugar mills.

SDF Assistance for Cogeneration

SDF assistance is limited to 40% of the normative project cost, depending on the boiler pressure. It has recently revised the normative cost of bagasse-based cogeneration projects as per the details given below:

Boiler Pressure (ata)	Normative cost per MW generation (Rs lakh*/MW)
Below 67	Not eligible
67 to 86	385.00
87 to 109	442.00
110 and above	543.00

* 1 lakh = 100,000

SDF Assistance is normally released in two installments. Security will include mortgage of assets on pari-passu 1st charge or bank guarantee.

Other terms & conditions are:

- Rate of interest – 2% below bank rate
- Period of loan – 7.5 years
- Moratorium – 3 years
- Repayment of loan – 10 half-yearly installments
- Payment of interest:
  - During moratorium period: Annually
  - After moratorium period: Half-yearly with installments

In respect of bagasse-based cogeneration projects for which the term loan is provided by NCDC, the Ministry of New and Renewable Energy (MNRE) subsidy is routed through NCDC.

NCDC-assisted Bagasse-based Cogeneration Power Projects

- Tamil Nadu: MR Krishnamurthy CSM, Cheyyar CSM, Subramaniya Siva CSM, Kallakurichi II CSM
- Maharashtra: Jawahar SSK, Pandurang SSK, Rajarambapu SSK, Shri Vighnahar SSK, Malegaon SSK, Yashwantrao Mohite Krishna SSK, Kisanveer SSK, Godganga SSK, Kumbhi Kasari SSK, Nira Bhima SSK, Vitthlrao Shinde SSK, Sant Tukaram SSK, Siddheshwar SSK, Dnyaneshwar SSK
- Andhra Pradesh: Chodavaram CSM
- Karnataka: Nandi SSK, Krishna SSK
- Punjab: Bhogpur

Courtesy: Mr RK Mangla
Deputy Director (Sugar)
National Co-operative Development Corporation (NCDC)
4, Siri Institutional Area, Hauz Khas, New Delhi 110016
Tel: 26962478, 26960796; Web: ncdc.in

Diversification: The Need of the Hour

India is one of the largest producers of ethanol in the world and possibly the second largest in Asia. Ethanol supply to oil marketing companies (OMCs) for blending with petrol was expected to rise 71 per cent in the 2017-18 season to touch a record 113 crore litres, helping sugar mills to earn Rs 4,500 crore* revenue, according to Indian Sugar Mills Association (ISMA). Around 66 crore liters of ethanol were lifted by OMCs for the ethanol blending program in the 2016-17 season (December-November). The previous record was 111 crore liters in 2015-16. ISMA attributed the jump in ethanol supply during 2017-18 to improvement in ethanol procurement price by almost 5 per cent over last year and increase in sugarcane availability giving more molasses production.

Cogeneration equipment/services companies and Shri SC Natu, Cogen India look on while Dalmia Sugars shares experiences

Though alcohol production from starchy material is also practiced in India on a very limited scale, most of the Indian distilleries use sugarcane molasses as raw material. Unfortunately, distilleries rank as the topmost industry among the list of 17 heavily polluting industries identified by Ministry of Environment, Forests & Climate Change (MoEF&CC), Government of India. Spentwash generated from distillation process has very high pollution potential. It is not only high on organic and inorganic loading, but also has a dark brown colour even after bio-methanation. In some parts, where land application of distillery waste water is practiced, the colour problem in ground water is so acute that distilleries have to provide potable water to surrounding villages. Many physico-chemical and biological methods for the removal of colour from distillery spentwash were tried, but a cost-effective and efficient treatment method is still awaited. If disposed untreated on land, it reduces alkalinity of the soil, and crops may be destroyed. It behaves much more hazardously when disposed into water bodies, since it may result in the complete depletion of dissolved oxygen and aquatic life will be destroyed.

* 1 crore = 10,000,000

In line with the above, a business meet for promotion of distillery/ethanol projects, along with incineration boiler-based cogeneration power plants in sugar factories/distilleries in the north Indian States, was organized by Cogeneration Association of India (Cogen India), in association with National Sugar Institute (NSI) and All India Distillers Association (AIDA) at Lucknow on March 15, 2018. It was very well attended by all the stakeholders including sugar factories and distilleries (from the States of Uttar Pradesh, Uttarakhand, Bihar, Punjab and Haryana), sugar mill/distillery associations (Cogen India, NSI, UP Distillers Association and Sakhar Sangh, Maharashtra), as well as technology/equipment suppliers (Excel, Mojj, Chem Process, Man Turbo, Isgec Heavy Engineering, Fives-Cail KCP, Thermax, Cheema Boilers, SITSON, SS Engineers, etc).

These projects will certainly give new impetus to the sugar factories for improving their long-term financial sustainability, given the very complex and downward trend of revenues from sale of sugar and cogeneration power exportable surplus, as well as bumper sugar crop in the current and next season, leading to further fall in the prices of sugar in the national/international markets.

The growth in sugarcane/sugar production has also increased molasses availability, particularly in the northern Indian States at cheaper rates, and open up the opportunity for setting up of these projects.

The Indian government has put forth ambitious targets of 10% addition of ethanol in petroleum fuels, which provides an opportunity to the sugar industry. The technologies are matured for highly efficient distilleries/ethanol plants, as well as incineration of the spentwash (in terms of meeting the needs of captive steam and power for the distilleries, as well as an opportunity to export the surplus to the grid) and achieving the Zero

Distillery waste/cogeneration experts along with Shri KP Singh (Balrampur Chini) sharing experiences

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Alcohol Industry: Issues & Remedies

Viewpoint Article by Narendra Mohan, Director, National Sugar Institute, Kanpur

Sugar industry in India has now realized the importance of diversification for sustainability. There is a growing concept of "Integrated Energy Complexes" comprising sugar, power and ethanol units rather than having only standalone sugar factories. Thus, for many reasons, molasses-based distilleries are in the limelight the last few years, as below:

1. As a tool for value addition for sugar factories
2. To cope up with the growing requirement of ethanol for the EBP10 program
3. Providing a better environment through clean and green energy in place of fossil fuels
4. Growing environmental concerns due to liquid waste generated from molasses-based distilleries and the requirement of achieving Zero Liquid Discharge (ZLD) as per Central/State Pollution Control Board norms

As far as value addition and sustainability is concerned, the sugar industry has to see the difference in revenue generation in the two cases, when the by-products are sold as primary by-products, and in case their sale is made as a secondary by-product, in the instant case, primary and secondary by-products being molasses and ethanol respectively. Once the revenue generation from other streams is enhanced, dependency on sugar revenues decreases, and the sugar industry is better placed to withstand the fluctuations in the prices of sugar.

The present requirement of ethanol for EBP10 is estimated to be 3,000 million liters Fuel Ethanol (requirement for 10% blending as per the latest tender floated by the oil companies is 3,130 million liters) per annum, which is expected to grow further due to increase in vehicular population.

Inspite of consistent efforts being made to achieve the blending targets, the same has not been possible till now and has been achieved to the extent of 3-4% only. In the year 2017-18, when record sugar production of approximately 29 million tons has been projected, estimated alcohol production from molasses will be about 2,800 million liters and that from grains may be about 1,500 million liters. Thus, after considering the alcohol demand from other sectors, i.e. potable and chemical sector, to the extent of 3,250 million liters, the shortfall in demand for alcohol is going to be about 2,000 million liters per annum, indicating the increase in demand for alcohol in the country in the coming years.

The Indian government's fuel import bill continued to rise to $140 billion in 2016-17 from $100 billion the previous year, resulting in 82 per cent of its crude oil requirement being imported. Wide variation in ethanol production occurs due to the cyclic nature of sugarcane availability (and sugar production). There is greater need to convert the conventional distilleries into "Smart Distilleries" working on multiple feed stocks. Thus the potential of using other feed stocks is to be harnessed, not only to provide clean and green energy and replace fossil fuels, but to reduce dependency on imported crude and preserve foreign exchange. Balancing of sugar production as per the domestic need, by sacrificing sugar and producing ethanol, will have two benefits: first, it would balance the demand-supply position of the sugar in the country thus stabilizing sugar prices; and second, it will help in boosting ethanol production in the country. Diversion of different streams, e.g. cane juice, secondary juice, filtrate or B-heavy molasses, will however be possible only if the relative economics of diversion are favourable. This shall require policy interventions keeping in view the sugarcane and ethanol price fixation mechanism and other controls.

Distillation industry of the country has seen significant technological up-gradation over the years in fermentation and distillation technologies. This has helped not only to enhance the yield of alcohol per unit molasses, but also reduce spent wash generation and requirement of utilities, i.e. steam and power. Treatment

Ethanol Demand & Supply Scenario in India

Particulars	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Petrol Sale Projection (8.38 %)	27,596	29,909	32,415	35,131	38,075	41,266
Ethanol Requirement						
(@ 5% blending)	1,380	1,495	1,621	1,757	1,904	2,063
(@ 10% blending)	2,760	2,991	3,241	3,513	3,808	4,127
(@ 20% blending)	5,519	5,982	6,483	7,026	7,615	8,253

All figures in million liters

of spent wash and other effluents from the molasses-based distilleries has assumed greater significance, keeping in view the ZLD necessity. The industry has seen the advent of Multiple Effect Evaporators with falling film and forced circulation-type bodies, the system being "Integral" or "Standalone". The two routes for ZLD, i.e. bio-composting and incineration are to be followed in letter and spirit as per the directions of the pollution control boards. For concentrated spent wash (20 to 30% solids), the filler material (PMC) to spent wash ratio prescribed is now 1:1.6 for 60 days' cycle. It is essential to work on and develop other innovative and cost-effective technologies, e.g. spray drying, etc. Installation of incineration boilers, on the other hand, may have higher capital cost, yet provides another avenue besides ZLD, i.e. harnessing the potential of fuel value of slop. This has led to export of power from the distilleries when the slop is used in a certain proportion with other support fuel, e.g. bagasse or other biomass.

Last but not the least, we now have guidelines at place and the distilleries are well aware also that spent wash generation has to be brought down to a realistic level of 8 liters/liter of alcohol produced after adopting the proven technologies at various unit operations. Similarly, due attention is required to be paid towards drawl of fresh water from natural resources and the same is also required to be brought down by maximizing re-circulation of condensates and other streams after due treatment. The system is required to be upgraded by installing Condensate Polishing Units and with a closed loop system. The industry may avail the financial assistance being provided by the Government of India through Sugar Development Fund for setting up new units and also for upgrading the existing units to achieve ZLD.

Courtesy: Narendra Mohan
Director, National Sugar Institute
Government of India
Ministry of Consumer Affairs, Food & Public Distribution
Department of Food & Public Distribution
Kanpur- 208 017 (U.P.), India
Tel: +91-512-2570730, 2570273
Fax: +91-512-2570247
Email: nmagrawal@rediffmail.com

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Liquid Discharge norms. Consultants (like MITCON, the Patron member of Cogen India) , technology/equipment suppliers and financial institutions are available to support the sugar factories/distilleries to take up these projects in the immediate timeframe.

The case study presentation by Balrampur Chini Mills and further highlights by Dalmia Sugars and HPCL, made key impacts on the delegates, in terms of difficulties faced in implementing such projects. But ultimately success was achieved, primarily due to the total team work with the vendors and other stakeholders of the project.

As per Mr Sanjay Khatal, Executive Director, Cogen India & MD, MSFCSF, "The sugar industry continues to be a strong backbone of Rural India. Also, the sugar industry is probably the only industry in India with a strong supply chain management in place. It has therefore continued to remain contemporary, both in terms of diversification and technological upgradations, which is why sugar factories are no longer standalone sugar producing units and pollutants as they once used to be in the 1950s and 60s."

Participants at the Lucknow Business Meet

In conclusion, a dire need was expressed by all the participants and Cogen India to work together, for pursuing favorable policies and regulatory framework from the Central and State Governments, from time to time. This will enable the sugar factories/distilleries to implement these projects and operate profitably. Cogen India appealed to all sugar factories and vendors to become members, so as to take up the work for creating conducive policy/ regulatory network, both at the Centre and States for promotion of these projects, as well as increasing the awareness by holding regular Meets. Cogen India also appealed to the sugar factories/distilleries/vendors to share the information by way of case studies/success stories/difficulties faced in the Industrial Cogen India quarterly newsletter published by Cogen India, as well as advertise in the same.

Concluding session with various stakeholders and Shri S Khatal, Cogen India

For copies of the complete Proceedings, kindly contact: cogenindia.pune@gmail.com for the charges/mode of delivery, etc.