

# CBG GENERATION FROM SUGAR INDUSTRY FEEDSTOCKS USING ADVANCED CSTR SEMI DRY FERMENTATION PROCESS

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## ABSTRACT

Shrijee-J&F biogas offers CSTR (Continuous stirred tank reactor) based semi dry fermentation process for conversion of feedstock's with high dry matter to biogas. The technology has been in use since last 15 years and close to 100 biogas plants is operation using the technology mainly in Europe. Organic solid feedstock's such as paddy straw, cane trash m, press mud, poultry litter, bagasse ,napier grass have a dry matter between 20 % to 85%. CSTR semi dry fermentation process can be use used for feedstock with up to 35% dry matter without addition of water.

CSTR semi dry fermentation process requires 50% size of digesters in comparison of other technologies, system also requires lower operating costs and there is very minimal or no liquid slurry generated in the biogas plants. This article discusses about the potential for conversion of sugarcane industry based feedstock's such as press mud ,Cane trash/leaves, bagasse to biogas using CSTR based semi dry fermentation process. It is estimated that close to 441,000 tonnes/year of CBG can be alone generated in India using press mud as a feedstock for biogas generation.

## 1.CSTR SEMI-DRY FERMENTATION PROCESS

There are various types of anaerobic digestion technologies which are used for digestion of various organic feedstocks. Choosing the right technology for a specific substrate is very important for the successful operation of a biogas plants. J & F Biogas has developed CSTR based semi dry fermentation process which is specifically suited for organic waste with high Dry matter. The process can handle organic waste up to 30-35% DM without additional water for dilution. Special mixing system was developed for handling high viscosity inside the digester and for handling feedstock with high dry matter..

In the context of sugarcane industry, press mud has 30% DM (Dry matter) and bagasse has 50% DM respectively which can be digested using CSTR Semi dry fermentation process.

### Organic substrate and their Dry Matter (DM)

	Feedstock	DM%
1	Cow dung	15%
2	Press mud (sugar industry)	30%
3	Baggase(sugar industry)	50%
4	Poultry litter	20-30%
5	Paddy straw	85%
6	Food waste	15-20%
7	Napier Grass	20%
8	Maize Silage	30%
9	Cane trash (sugar industry)	85%

Table 1:

## 2.PRESS MUD

Filter cake, commonly known as press mud, is the suspended impurities separated during the process of cane juice clarification by the sulphitation process. Press mud traditionally is used as manure through the biocompost process by spraying spent wash on press mud. Sugar mills that are not attached to distilleries, sell the press mud to the sugarcane growers at concessional rates. For every 100 tons of sugarcane crushed, about 3.5 to 4 tons of press mud cake are generated as a by-product. It is a soft, spongy, amorphous and dark brown material, containing sugar, fiber and coagulated colloids, including cane wax, albuminoids, inorganic salts and soil particles. It consists of 70-73% water and 0.9 -1.5% sugars, organic matter, nitrogen, phosphorus, potassium, calcium, sulphur, coagulated colloids and other materials in varying amounts.

In the context of the sugar industry, press mud is one of the byproducts where the potential is not completely realized. Press mud is rich in organic matter, and the macro and micro nutrients are a good substrate for production of biogas through an aerobic fermentation.

## 3.CSTR SEMI DRY FERMENTATION TECHNOLOGY FOR CONVERTING PRESS MUD TO BIOGAS

Press mud has close to 70-75% moisture, 25-30 % dry matter and 75-80 % organic dry matter. With SEMI DRY Fermentation process press mud with 30% DM can be digested without adding any water. Press mud with 30 % DM when fed in to the digesters decomposes to close to 20% DM inside the digester. The 20% DM inside the digester is mixed with high viscosity mixing system for a reaching a uniform mass. Proprietary mixers are used for mixing of high viscosity substrates in the digesters.

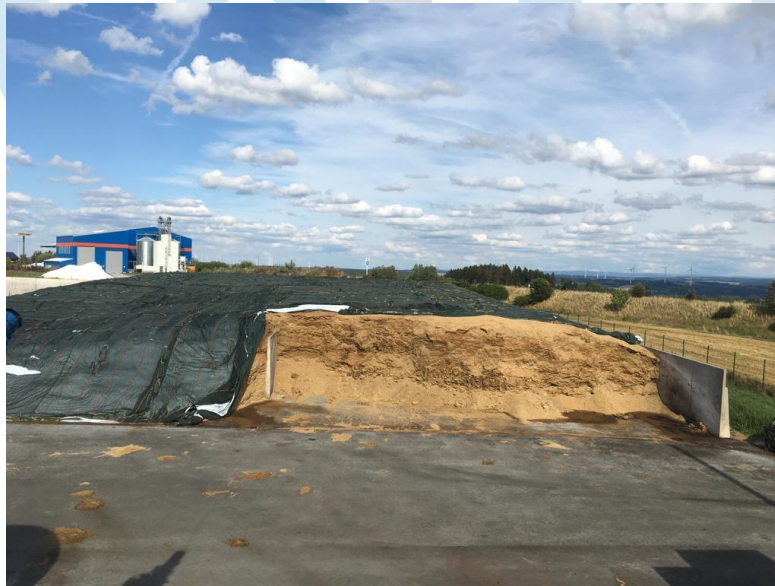
The digestate generated post digestion has close to 20 %DM (Dry matter) and 80% moisture. The digestate generated is in form a thick sludge which can be further dried and can sold as high value organic manure. There is no liquid slurry generated using CSTR based semi Dry fermentation process. The liquid slurry handling process is very minimal.



*Picture 1: Substrate(thick sludge) with 16 % Dry matter post digestion*



Picture 2: CSTR Semi dry fermentation process based plant operating in Germany



Picture 3: Feedstock storage yard model for storing press mud for 6 months during off season

#### 4.COMPARISON OF CSTR SEMI DRY FERMENTATION AND OTHER TECHNOLOGIES

The table below compares some of the key parameters for a 100 tons/day capacity press mud to biogas plant using CSTR semi dry fermentation process and other technologies such as wet fermentation based process

Parameters	CSTR Semi Dry fermentation	Other technologies
Size of digester (m3)	3500 m3	7000 to 10,000 m3
Amount of water/slurry required for press mud with 30% solids and 70%	0	1:1 ratio

moisture		
Dry matter % (digestion capacity)	Up to 35%	10-12%
Co-digestion with Multi feedstocks	Greater flexibility with co-digestion with other feedstocks such as baggase,poultry litter etc	Difficult to co-digest feedstocks with higher dry matter . More water will be required for dilution
Requirement of decanter /solid liquid separator	Not required . Digestate will have 18% Dry matter	Required for solid and liquid generated (additional investment)
Liquid effluent/slurry generated post digestion	Digestate will have 18 % dry matter no liquid generated	40 m3/day liquid slurry generated post recirculation as well
Operation and maintenance	Low	Medium
Liquid digestate storage infrastructure (tanks/lagoons)	Not required	Required to store liquid slurry

Table 2: Technology comparison

## 5.BIOCNG POTENTIAL FROM PRESS MUD IN INDIA

The table here summarizes the total CBG generation potential from Press mud in India.

Sl.no.	Input parameter	Metric	Value
1	Amount of cane crushed/year	Million tonnes	300
2	Filter cake % on cane crushed	%	3.50%
3	Annual Filter cake generated	Million tonnes	10.5
4	Potential to produce CBG	Tonnes	4,41,000

Table3: CBG potential

Domestic production of CBG from press mud generated at sugar mills will save close to USD 270 Million worth of Forex savings per year on natural gas imports.

## 6.BIOGAS FROM BAGGASE

Baggase is another substrate which can be potentially used for biogas generation. Biogas yield tests were conducted based on batch type fermentation process. Baggase has dry matter of 50 %, and Volatile solids are 90 % of dry matter. The biogas yield of baggase using batch type process was 207 m<sup>3</sup> of biogas per ton of fresh matter. Per ton VS(volatile solids) was about 460 m<sup>3</sup> of Biogas. In a continuousfermentation process the gas yield will increase by 10 to 15 %.The estimated yield in a commercial plant will be about 227 m<sup>3</sup> per tonne of bagasse. The biogas yield from bagasse is two times the yield of press mud however the cost of baggase and its alternate applications needs to factored for arriving at suitable application of baggase.

CSTR Semi Dry fermentation will be very much suitable for bagasse digestion. Bagasse has dry matter of about 50%. It is observed that viscosity in the digesters increases significantly during digestion of bagasse, a very strong and high viscosity mixing system is required for bagasse digestion.

## 7. BIOGAS PURIFICATION AND BOTTLING

Biogas generated through the fermentation process can be subsequently upgraded to bio-CNG/CBG (compressed biogas). Upgraded biogas ( $\text{CH}_4 > 95\%$ ) of natural gas quality can be used as a replacement for CNG (Compressed natural gas) and liquefied petroleum gas (LPG) in various domestic and industrial applications. Press mud, cane trash and bagasse based biogas plants would thus eventually generate additional revenues for sugar mills. Government of India is actively encouraging sugar mills to use press mud for bio-methane generation to meet the rising petroleum fuels and natural gas demand in India.



Picture 4: Biogas purification system for CO<sub>2</sub> removal

## 10. CONCLUSION

Sugarcane as a crop is very unique which is used for producing various primary and secondary products. Sugar has been the main product with commercial value for quite a long time. Over a period of time several by products have evolved such as alcohol, power generation from bagasse, ethanol, CO<sub>2</sub> production, organic manure via composting among other products. Press mud along with bagasse have a huge potential for CBG generation from the sugar industry. CBG produced from press mud along with biomanure generated has an enormous potential to add additional revenues stream to sugar industry as whole. CSTR Semi Dry fermentation process will be one of the best suited technology for handling press mud, cane trash and bagasse with lower operating costs, minimal water requirement and higher overall efficiency in the digestion process. In addition to sugarcane industry feedstocks, other organic feedstocks such as paddy straw, poultry litter and Napier grass are suitable for CSTR based semi dry fermentation process.