ISSN: 0379-5462
IPPTA: Quarterly Journal of Indian Pulp and Paper Technical Association
Vol. 34, E3, 2022, p. 138-141

PAPER INDUSTRIES EFFLUENT TO CBG / BIOCNG FOR HIGHER PROFITABILITY & DECARBONISATION OF THE PAPER INDUSTRY

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Abstract:

Paper Industries are very complex and energy-intensive, ranking the highest final energy consumption in the industry. Biogas, as an energy source, can provide a buffer against energy security concerns and can help in reducing the paper mill's dependency on fossil fuels. Biogas development offers a hedge against fossil fuel price hikes & volatility.

The biogas produced by anaerobic digestion can be upgraded & Biogas upgradation has been a relatively new process in the Indian Market. With the improvement in technology, increased awareness for green energy, and reduced production cost for equipment, biogas upgradation has now become a possibility for developing countries such as India.

KIS Group focuses on climate change efforts through Energy transition & Decarbonisation of various Industries such as Agricultural waste, Sugar, Palm, Rice, Paper Industry, MSW, Cow Dung, poultry waste, etc. in a responsible manner by adopting advanced technologies with reduced dependency on fossil fuels.

We are contributing towards net carbon zero efforts by implementing India's and Asia's first: Paper mill effluent to BioCNG/ CBG.

Keywords: Fossil fuel, Organic Waste, Paper Industry, Sustainable, Biogas, BioCNG, Circular Economy, Decarbonisation.

Introduction:

The Indian Paper Industry is the 15th largest paper manufacturing hub in the world and accounts for about 3% of the world's paper production. So the generation and disposal of paper and pulp industry wastewater are very high.

Pulp and paper mills produce enormous quantities of organic waste that could be transformed into an energy source in the form of methane. The pulp and paper industry is a water-consuming industry, that creates various types of wastewater with different qualities, at different stages of paper making process [1].

Paper mill effluent contains a high amount of organic matter and hardly degradable compounds. The generated effluent is polluting and hazardous in nature, it should be treated before being released into the environment.

Anaerobic Digestion is favourable for high COD (Chemical Oxygen Demand) concentration wastewater treatment to reduce the organic matter as compared to the activated sludge process.

This digestion process using various anaerobic bacteria produces biogas including methane that can be an alternative source of energy.

Nowadays, biogas production is advanced technology already implemented in many fields, but still behind in terms of the pulp and paper mill effluent industry. Due to the high moisture content of sludge, anaerobic digestion shows great potential.

The main objective of this paper is to investigate the potential for improvement of energy efficiency in integrated pulp & paper mill wastewater treatment.

Anaerobic Digestion:

The typical data is collected from the paper mill (Kraft paper from Agro residue & waste paper) based in Haryana, India. The effluent is from wet washing for raw material (wheat straw) and paper machine backwater.

The installed higher-rated Anaerobic digester has design capacity of 18 MT COD load and flow of 4500 m^3/day at COD is 4500 mg/l. The COD reduction is in the range of 65-70% for the digester and raw biogas generation in the range of 6000-7000 m^3/day with

methane content 60-70%, which is presently being flared. So, we have planned to install BioCNG to utilize clean and green energy to contribute towards carbon emission reduction, which is a better utilization of biogas than producing electricity and burning in a boiler. The produced BioCNG compressed biogas can be a promising candidate as vehicle fuel in replacement of fossil fuel. This paper mainly illustrates the potential of BioCNG conversion from Biogas.

Figure 1: Overall Schematic Process

Operational Parameters of ETP Plant:

Below are the operational parameters of the running plant i.e. digestor inlet, digestor outlet & final outlet

Table 1: Operational Parameters

Parameters	UOM	Digestor Inlet	Digestor Outlet	Final Outlet
pH		5.6-5.8	7.2-7.3	6.8-7.0
Temp	°C	37	36	29
TSS	PPM	350-400	450-500	6-8
TDS	PPM	1900-2000	1900-1950	1950-2000
COD	mg/lt	4500-5000	1200-1500	170-180
BOD	mg/lt	1500-1600	700-750	10-15
Calcium	PPM	350-400	350-400	350
Chloride	PPM	800-1000	750-800	600-700
Color	Pt-Co	7000-7500	7000-7500	180-200
VFA	meq/L	31.2	BDL	-
Alkalinity	meq/L	6.78	32.74	-

Design Data (Inlet Parameters) for BioCNG Plant:

Below are the inlet parameters for the BioCNG plant i.e. flow rate and gas content

Table 2: Inlet parameters

Sr. No.	Parameters	Unit	Value
1.	Biogas Flow Rate	m^3/day	7200
2	Pressure	mmwc	<40
3.	Temperature	Deg. C	Amb
4.	CH_4	%	60-70
5.	H_2S of raw Biogas	ppm	20000
6.	CO_2	%	30-40

***Note:** To treat the above-mentioned quantity of Raw Biogas, we have proposed a comprehensive treatment scheme of the BioCNG System (Biogas- 300 m^3/hr). Plant Operations is considered 24 hrs/day.

Enrichment of Biogas & Handling System:

The plant in this study is generating biogas from the reactor and will be desulphurization and upgraded the biogas containing >60% methane to 96% methane content.

The raw biogas from the existing anaerobic digester is transferred to the new scrubber system for the removal of H_2S content. The process is a modified liquid red-ox process to remove H_2S in Biogas using chelated polyvalent metal ions with a stabilizing agent. The process utilizes the oxidation-reduction potential of chelated iron in an aqueous medium for scrubbing hydrogen sulphide from the biogas. The sulphur present in the hydrogen sulphide is precipitated as elemental sulphur, which has commercial value as fertilizer.

The purified biogas after scrubber is collected in the double membrane gas holder as a buffer before taking into the biogas upgradation system.

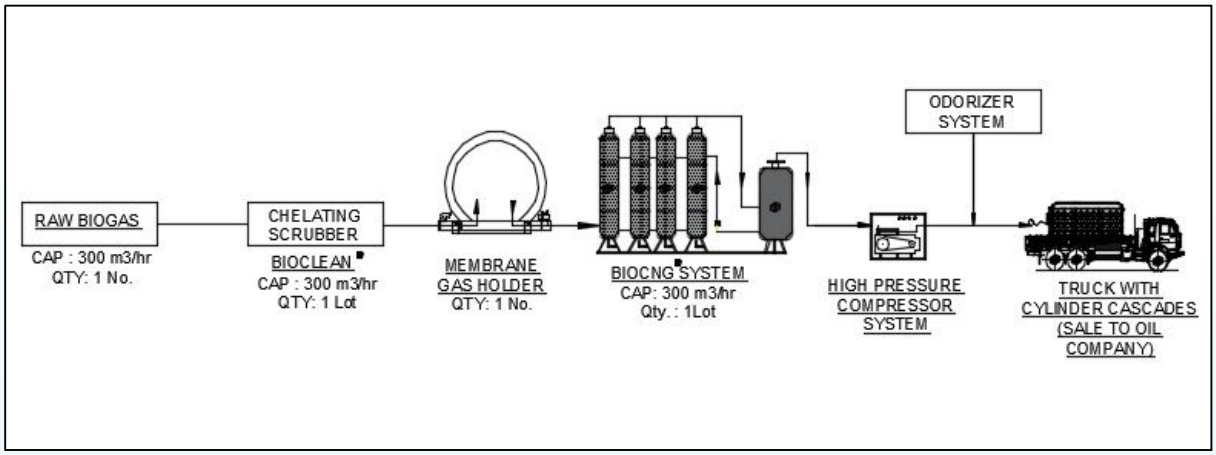

Figure 2: Process Flow Diagram (BioCNG)

Bio CNG Generation (PSA)

The biogas is entering into the Pressure Swing Adsorption System, the raw purified biogas is passed through different units like Disulphide, moisture separator, Chiller, Pre-Filters, GDU units & PSA Towers .After Passing through all these systems methane is purified to the purity of 96%.

This purified methane is stored in the Surge & Storage Tank. Further, the compressor takes the gas from the storage tank stored in cylinder cascades to supply BioCNG to the nearby Oil Company. The final product specifications will adhere all the quality and safety guidelines as notified by Government (IS 16987:2016)

Outlet Parameters:

The output after cleaning and upgradation is mentioned below;

Table 3: Outlet Parameters

Sr. No.	Parameters	Unit	Value
1.	BioCNG	kg/day	3100
2.	CH_4	%	>96
3.	H_2S outlet	ppm	<10
4.	CO_2	%	<4

Emissions in Paper Industry:

As paper production is projected to increase by 2030, significant efforts must be made to reduce the emissions intensity of production. This can be accomplished primarily by moving away from fossil fuels as an energy source and towards the use of net zero emissions alternatives [2]. Also, the most potent tools for mitigating climatic change by preventing carbon emission from vehicles by replacing fossil fuels with BioCNG. The carbon emission reduction from methane capture is 25,860 Tonnes/year and from fossil fuel replacement is 3012 Tonnes/year

Utility Requirements

Below mentioned is the utility requirement for setting up BioCNG plant along with details:

Table 4: Utilities

Sr. No.	Items	Specifications
1.	Power	3336 Kwh/day
2.	Area requirement for BioCNG Plant	800 m^2 + Cascade shed area
3.	Water Requirement	4 m^3/day DM water 10 m^3/day for cooling Tower & Chiller

Typical R.O.I (Cost Economics) for Paper Mill BioCNG Project

Economics plays a major role in determining the viability of a project. In the case of BioCNG, economics is critical as the sector is just emerging.

Below is the typical R.O.I for Complete BioCNG Plant for the existing Biogas projects; in which Capex includes mainly is Scrubber System, Biogas Management System, PSA System & related equipment's/instruments.

Table 5: Typical R.O.I

Biogas	7200 m^3/day
BioCNG	3.09 Tonnes/day
Capex	₹ 7.5 Crores
R.O.I	Less than 2 years

***Note: The calculations are inductive in nature & may vary depending upon the size & variable parameters.**

Conclusion:

The pulp and paper industries are growing day by day. Growing while achieving zero net emissions and zero waste, and improving overall resource efficiency are key drivers of sustainability in the industry.

For decarbonization and energy transition, it's a good opportunity for the pulp & paper industry to make BioCNG from the paper mill effluent. The BioCNG project is a beneficial return on investment along with revenue from carbon credits. The BioCNG industry has huge potential for India as the country moves toward its goal of generating clean & green energy. Net zero is ambitious, but with a BioCNG ecosystem, it is achievable. It will play a key role in transitioning from fossil fuels to green energy. In the future, CO2 can be captured further to use in the industry's purposes.

References:

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2. https://www.iea.org/reports/pulp-and-paper