PROCEEDINGS

CONFERENCE ON

“WASTE TO ENERGY FOR CLEAN ENVIRONMENT”

@ Federation of Gujarat Industries (FGI),
Gotri - Sevasi Road, Gotri, Vadodara, Gujarat

29-30 July 2025 (Tuesday - Wednesday)

Jointly Organized by
The Society of Power Engineers (I)
&
Gujarat Energy Development Agency

SPE (I) **GEDA**

The Society of Power Engineers (India) Vadodara Chapter
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2-DAY CONFERENCE ON

"WASTE TO ENERGY FOR CLEAN ENVIRONMENT"

29-30 JULY, 2025, AT FGI, GOTRI, VADODARA

SOCIETY OF POWER ENGINEERS (I), VADODARA CHAPTER

TENTATIVE PROGRAM

TIME	DESCRIPTION
Day -1	**29TH JULY 2025 TUESDAY**
09.00 To 10.00	**REGISTRATION & BREAK FAST**
10.10 To 11.00	**INAUGURATION**
	Invitation To Dignitaries Digital prayers & lighting of lamp Floral welcome Welcome address by Er. Mohan Tilwalli, *Chairman SPE Vadodara* About the Conference by Er. SM Takalkar, *Convener* *1.* **Er. SOMES BANDYOPADHYAY**, *MD, GSECL* 2. Er. **ROBBI RAJASEKHARAM**, *CEO, KPI GREEN HYDROGEN & AMMONIA PVT. LTD* **3. ER. DH VASAVA,** *ED-GSECL* *4.* **Er. P. H. Rana,** *Patron Member, SPE, Vadodara Chapter* *5.* **Er. Bipin Shrimali, IAS, MD, GoMH (On line)** Felicitation of Sponsors *GEDA, GPCL, NTPC, TERAS, ATMOS, BA PRERNA, UK PANDYA* Vote of thanks National Anthem
11.00 To 11.30	**Networking TEA BREAK**
11.30 To 13.00	**TECHNICAL SESSION - I**
	1) WTE Circular Economy by RN Kansara, GEDA 2) Electricity Generation and Biogas Production Using Waste of Green Vegetables APMC - Dr. Hetal Vala, Ms. Hetal Prajapati, Er. P. A. Shah Parul University 3) Biomass and Waste Gasification Technologies by Gaurava Patel, Ankur Scientifics, 4) Transforming E-Waste in to Energy: A Sustainable Path to a Cleaner Environment by Dr. Ruchi Shrivastava, Parul University
13.00 To 14.00	**LUNCH**
14.00 To 15.30	**TECHNICAL SESSION - II**
	5) Biogas Purification and Bottling Plant For Green and Low Cost Fuel – BY Dr. SS Kapdi 6) Waste-To-Energy In India: Trends, Technologies, And Way Forward by Dr Nirali Rathod and P A Shah 7) Anaerobic Digestion: Harnessing Biogas from Organic Waste – Ms Seema Abhale PRAKRUTI Environmental ENGG 8) Waste To Energy (Electrical) - Ramprasad P Sharma 9) Presentation by NTPC
15.30 To 16.00	**NETWORKING TEA**
16.00 To 17.30	**TECHNICAL SESSION - III**
	10) A Decentralized, Green, Patented Waste Water Treatment Technology Developed in India – Er. Bhavar Upadhyay, TransChem 11) Waste to Energy (Bio CNG) – Er Ajit Kude, Avni Ent. 12) Waste to Power- A Step towards Swachh Bharat – Er. Shubhank S. Takalkar 13) A Comparative Case Study Of Ceramic Heater And Induction Heater in Polymer Industry - Dr Yogesh Prajapati, BVM Vidyanagar 14) Presentation by GPCL

Day - 2	30TH July 2025 Wednesday
09.00 To 09.30	**Networking HI TEA**
09.30 To 11.00	**TECHNICAL SESSION - IV**
	15) Algal Bacterial Symbiosis for Waste-To-Energy Conversion - Dr. Dewang Shah, DJMIT Mogar 16) Introduction to Waste to Energy (WTE): A Sustainable Approach to Waste Management and Energy Generation - Er. U K Pandya 17) Model-Based Optimization Of Energy Use In Wastewater Reuse Systems - Dr. Komal Mehta, Parul University 18) Presentation by TERAS
11.00 To 11.30	**Networking TEA BREAK**
11.30 To 13.00	**TECHNICAL SESSION - V**
	19) Innovation in Gasification & BTG Solutions for converting Biomass/Waste To Energy – Ankur Scientific 20) Eco-Industrial Parks A Collaborative Approaches to Waste Management – Initiatives In Gujarat - Dr. Bharat Jain 21) Waste To Energy Policy And Its Important Clauses - B. N. Raval, Soham Technologies 22) Catalytic Pyrolysis Of Plastic - Dr. Jigisha Parikh, SVNIT, Surat
13.30 To 14.30	**LUNCH**
14.30 To 16.30	**TECHNICAL SESSION - VI**
	23) Presentation by Er. BR Singh ATMOS Power 24) Ongoing Initiatives And Innovations In The Waste-To-Fuel Domain - Mr. Niraj Mithani, DirecTor, BA Prerna Clean Earth Pvt Ltd., Surat 25) Unlocking the Potential of Waste-to-Energy in India: Opportunities, Challenges, and Policy Landscape - Er. R N Pandya, EX GEDA 26) Presentation on Muni Seva Ashram Work - Dr. Deepak Gadhia, Muni Sewa Ashram, Goraj
16.30 onwards	**HI TEA END OF THE CONFERENCE**

NOTE:

- ✓ THIS IS TENTATIVE SCHEDULE.
- ✓ THE TIMINGS AND SEQUENCE MAY CHANGE AS PER AVAILABILITY OF PRESENTER.

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WASTE-TO-ENERGY IN INDIA: TRENDS, TECHNOLOGIES, AND WAY FORWARD

Dr. Nirali Rathod
Asst. Prof. SVIT, Vasad

Er. PA Shah
Practicing Engineer

1. Abstract:

The rapid increase in global waste generation, combined with growing energy demands and environmental concerns, has intensified interest in waste-to-energy (WTE) technologies as a sustainable solution. India is steadily increasing the number of waste-to-energy (WTE) plants, focused on transforming waste into usable energy. The paper discusses critical factors influencing the efficiency and feasibility of these technologies, including feedstock characteristics, environmental implications, and regulatory frameworks.

2. Introduction:

India, with a population exceeding 1.4 billion and rapid urbanization, generates an immense volume of municipal solid waste (MSW), currently estimated at over 160,000 tonnes per day [1]. The increase in industrial activity, changing consumption patterns, and population growth have exacerbated the challenges of waste management, especially in urban areas.

Given the limited availability of land for new landfill sites and the growing energy demands of urban centres, Waste-to-Energy (WTE) has emerged as a promising alternative. WTE technologies offer a dual benefit: they reduce the volume of waste and recover energy in the form of electricity, heat, or fuel. India has a growing number of waste-to-energy (WTE) plants, aimed at converting waste into usable energy with 11 plants generating electricity from Municipal Solid Waste (MSW) as of February-2022. These plants, along with biomass and biogas plants, contribute to the country's renewable energy mix. The first WTE plant in India was established in Timarpur, Delhi, in 1987, with a capacity to process 300 TPD of waste. India has a total of 249 Waste-to-Energy plants, 819 Biomass Power plants, and 50.8 lakh small Biogas plants. As of February-2022, 11 plants with a total capacity of 132.1MW were operational for power generation from MSW, processing approximately 11,000 tons of MSW per day. This review aims to provide a comprehensive overview of the Waste-to-Energy landscape in India.

3. Overview of Waste-to-Energy (WTE) Technologies

Waste-to-Energy (WTE) technologies are designed to convert various types of solid waste into usable forms of energy such as electricity, heat, or fuel. These technologies are categorized based on the method of energy recovery—thermal**,** biological**,** or thermochemical**.** The selection of an appropriate WTE technology depends largely on the composition, calorific value, and moisture content of the waste, as well as economic and environmental considerations.

Waste-to-Energy (WTE) technologies to recover the energy from the waste in the form of Electricity and Biogas/Syngas are given as below: [2].

Biomethanation: Biomethanation is the process of anaerobic digestion, wherein organic materials are broken down by bacteria in the absence of oxygen to produce biogas. This biogas typically comprises around 60% methane, 40% carbon dioxide, and trace amounts of other gases. The process not only generates biogas but also yields nutrient-rich organic manure, making it a dual-benefit technology.

Biomethanation is well-suited for decentralized waste management, especially for the treatment of segregated organic wet waste such as kitchen scraps, food waste from canteens, institutions, hotels, slaughterhouses, and vegetable markets.

The biogas produced can be utilized in multiple ways:

It can be directly burned in gas boilers or burners for thermal applications or cooking.

It can be used in gas engines to generate electricity.

After purification, the biogas can be upgraded to Bio-CNG by removing carbon dioxide and other impurities. This Bio-CNG can be injected into the natural gas grid or used as a fuel for vehicles. As an example, approximately 20–25 kg of cattle dung can generate around 1 cubic meter (M^3) of biogas. This $1M^3$ of biogas can either produce about 2 units of electricity or yield approximately 0.4 kg of Bio-CNG.

INCINERATION:

Incineration is a process of complete combustion of waste—such as Municipal Solid Waste (MSW) or Refuse-Derived Fuel (RDF)—to recover heat, which is then used to produce steam. This steam drives turbines to generate electricity. The flue gases generated during combustion are treated through advanced air pollution control systems to meet environmental standards. The solid residues from the process include ash, which can be processed and utilized as a construction material. Any remaining inert material can be safely disposed of in landfills. Incineration is a well-established and commercially proven technology. In India, it has been successfully implemented in several large-scale projects for the treatment of both municipal and industrial solid waste while also contributing to power generation.

GASIFICATION:

Gasification is a thermal conversion process that operates at high temperatures (typically between 500°C and 1800°C) in a controlled, limited-oxygen environment. Under these conditions, organic materials are broken down to produce synthetic gas (syngas), which primarily consists of carbon monoxide (CO) and hydrogen (H_2).

Feedstock such as biomass, agricultural residues, segregated municipal solid waste (MSW), and refuse-derived fuel (RDF) pellets can be used in gasifiers to generate syngas. This syngas can then be utilized for thermal applications or as a fuel for power generation.

PYROLYSIS:

Pyrolysis is a thermal decomposition process that breaks down combustible materials in the absence of oxygen. It produces a combination of combustible gases (including methane, complex hydrocarbons, hydrogen, and carbon monoxide), liquid by-products, and solid residues.

The primary outputs of the pyrolysis process include:

Gaseous fuel – a mixture of combustible gases
Liquid fuel – commonly referred to as bio-oil or tar
Solid residue – primarily carbon black

The gas produced can be used directly in boilers for heat generation or further treated and used in combustion turbines for electricity production. The main objective of pyrolysis is to reduce harmful emissions while maximizing resource recovery from waste.

For Waste-to-Energy technologies to function efficiently and sustainably, proper source segregation, waste pre-processing, and robust emission control systems are essential. These measures help ensure environmental compliance and enhance operational performance.

Each WTE technology comes with its own set of benefits and limitations. Therefore, the selection of an appropriate technology should be guided by factors such as the local waste composition, available infrastructure, and the level of policy and regulatory support.

4. Waste-to-Energy (WTE) Technologies Used in India (2025 Status)

India has made gradual yet notable progress in implementing Waste-to-Energy (WTE) technologies to address its mounting municipal solid waste (MSW) problem. India had 12 operational and 8 non-operational MSW-based WTE plants, and by May-2023 the installed capacity reached 556MW [3]. However, adoption has been uneven across states, largely influenced by the composition of local waste, policy enforcement, and financial viability.

Incineration remains the most commonly implemented technology in India for large-scale WTE plants. Facilities like the Okhla and Narela-Bawana plants in Delhi, Jawahar Nagar plant in Hyderabad, and the Jabalpur WTE plant are designed to handle mixed municipal waste through mass-burn incineration, producing both electricity and ash as by-products. These plants typically generate between 11–24MW of electricity and are strategically located in urban areas with high waste generation rates.

Biomethanation has gained traction in mid-sized cities and smart city initiatives, especially where high organic content is available in the waste stream. Cities such as Indore, Pune, Surat, and Coimbatore have implemented successful decentralized biomethanation units that convert organic waste into biogas and bio-CNG, fueling municipal vehicles and reducing dependence on fossil fuels [8].

Refuse-Derived Fuel (RDF) plants have been developed in states like Telangana, Chhattisgarh, and Madhya Pradesh, where the non-biodegradable combustible fraction of waste is segregated and converted into fuel pellets. These pellets are either co-fired in cement kilns or used in dedicated RDF-based WTE plants, contributing to the circular economy and industrial decarbonisation goals.

While pyrolysis and gasification technologies are not yet widely commercialized in India, several pilot and demonstration projects have been initiated in Gujarat, Maharashtra, and Karnataka to treat non-recyclable plastics, hazardous industrial waste, and e-waste. These advanced systems offer cleaner thermal decomposition with fewer emissions but require high capital investment and skilled operation, limiting their scalability for now.

The integration of WTE projects with programs like Swachh Bharat Mission, Smart Cities Mission, and the National Bio-Energy and investment. However, widespread deployment still faces challenges related to waste segregation at source, collection infrastructure, public resistance, and environmental compliance. Moving forward, a city-specific, integrated approach to WTE, supported by consistent policy and robust monitoring mechanisms, is critical for long-term sustainability.

5. Government Policies and Regulatory Framework

The Indian government has recognized Waste-to-Energy (WTE) as a critical component of sustainable urban infrastructure and has introduced several policies and regulatory mechanisms to promote its adoption. These initiatives are aimed at reducing the burden on landfills, minimizing environmental pollution, and encouraging the use of renewable energy derived from waste.

One of the key policy drivers is the Solid Waste Management (SWM) Rules, 2016, issued by the Ministry of Environment, Forest and Climate Change (MoEFCC), which mandate the processing of waste before disposal and promote the recovery of energy from non-recyclable dry waste. The rules also encourage local authorities to explore WTE options as part of integrated solid waste management systems.

The Waste to Energy Programme, administered by the Ministry of New and Renewable Energy (MNRE), provides financial assistance for the establishment of WTE plants using technologies such as incineration, biomethanation, and RDF. Under this programme, capital subsidies, viability gap funding, and technical support are extended to both public and private sector projects.

The Swachh Bharat Mission (SBM) and Smart Cities Mission, both under the Ministry of Housing and Urban Affairs (MoHUA), have incorporated WTE facilities into their urban planning framework. Several smart cities have deployed decentralized WTE solutions such as biomethanation and bio-CNG plants for localized waste treatment and clean fuel generation.

Another regulatory mechanism is the Perform, Achieve, and Trade (PAT) scheme of the Bureau of Energy Efficiency (BEE), which allows industries using RDF or other waste-based fuels to earn energy saving certificates. Additionally, the Extended Producer Responsibility (EPR) guidelines under the Plastic Waste and E-Waste Management Rules incentivize industries to co-process non-recyclable waste in cement kilns or WTE plants.

Despite these supportive frameworks, implementation at the ground level faces hurdles such as bureaucratic delays, inconsistent enforcement by local bodies, and lack of coordination among multiple agencies. Moreover, there is a need for stricter emission standards and real-time monitoring systems to address environmental concerns associated with WTE operations.

To accelerate WTE adoption, there is a growing emphasis on Public-Private Partnerships (PPP), ease of permitting, and inclusion of WTE in urban climate action plans. The National Bio-Energy Programme (2022–2026) further aims to integrate WTE into India's broader renewable energy mix, aligning with the country's climate commitments and Sustainable Development Goals (SDGs).

Summary of the sector wise covering urban and industrial sectors mainly for energy potential for India is given as below:

Sr. No.	Sector	Energy Potential in MW
1	Urban Solid Waste	1247
2	Urban Liquid waste	375
3	Paper (liquid waste)	254
4	Processing and preserving of meat (liquid waste)	182
5	Processing & preserving of meat (solid waste)	13
6	Processing & preserving of fish, crustaceans and molluscs (liquid waste)	17
7	Vegetable Processing (solid waste)	3
8	Vegetable Raw(solid waste)	579
9	Fruit Processing (solid waste)	203
10	Fruit Raw (solid waste)	2
11	Palm Oil (solid waste)	24
12	Milk Processing/Dairy Products (liquid waste)	47
13	Maize Starch (liquid waste)	36
14	Tapioca Starch (liquid waste)	15
15	Tapioca Starch (solid waste)	49
16	Sugar (liquid waste)	49
17	Sugar press mud (solid waste)	200
18	Distillery (liquid waste)	781
19	Wine Industry	NA
20	Slaughterhouse (solid waste)	48
21	Slaughterhouse (liquid waste)	862
22	Cattle farm (solid waste)	462
23	Poultry (solid waste)	1
24	Chicory (solid waste)	9
25	Tanneries (liquid waste)	10
26	Tanneries (solid waste)	

The total estimated energy generation potential from urban and industrial organic waste in India is approximately 5690 MW.

6. Significance of Waste-to-Energy Projects in India

Waste-to-Energy (WTE) projects hold significant strategic, environmental, and economic importance in India's ongoing transition toward sustainable waste management and clean energy. With the country generating over 165,000 tonnes of municipal solid waste (MSW) daily and urbanization accelerating, traditional waste disposal methods such as open dumping and landfilling are increasingly unsustainable and environmentally hazardous.

WTE projects offer a dual benefit: they reduce the volume of waste requiring final disposal while simultaneously generating electricity, heat, or biofuels. This contributes directly to energy security, especially in urban areas where electricity demand is high and land availability for waste disposal is limited. Modern WTE technologies such as incineration, biomethanation, and RDF-based co-processing can reduce waste volume by up to 90% and generate significant quantities of renewable energy.

From an environmental perspective, WTE

systems help mitigate methane emissions from landfills, a major source of greenhouse gases, thus supporting India's commitments under the Paris Agreement and its Nationally Determined Contributions (NDCs). Moreover, decentralized WTE units using bio-CNG and biogas help reduce dependency on fossil fuels for municipal fleets and public transport systems, as seen in cities like Indore and Pune.

Economically, WTE projects contribute to the creation of green jobs, improve waste collection efficiency, and promote resource recovery. They also support the goals of the Swachh Bharat Mission, Smart Cities Mission, and the National Bio-Energy Programme by integrating waste processing with renewable energy generation. In addition, WTE plays a key role in establishing a circular economy, where waste is seen not as a liability but as a resource.

Overall, WTE serves as a crucial link between waste management and renewable energy policy in India, and its scaling-up is essential to achieving urban sustainability, climate resilience, and inclusive infrastructure growth.

7. Reasons for the Failure of Waste-to-Energy Projects in India

Despite significant policy support and growing waste generation, the majority of Waste-to-Energy (WTE) projects in India have underperformed or failed to operate sustainably. Several WTE plants across cities such as Delhi (Timarpur), Bengaluru, Hyderabad, and Chennai have faced technical, financial, environmental, and social challenges that hindered their long-term success.

One of the primary reasons for failure is the poor quality and composition of municipal solid waste (MSW) in India. Indian MSW typically has high moisture content (40–60%) and low calorific value (1,000–1,500 kcal/kg), making it unsuitable for direct incineration-based energy recovery without prior segregation or preprocessing. Most WTE plants were designed for waste characteristics typical of developed countries, leading to technical mismatches and inefficiencies.

Another major issue is the lack of waste segregation at source. WTE technologies like biomethanation and incineration require organic or combustible fractions to be separated from inert or recyclable waste. However, in most Indian cities, mixed waste is collected and transported, which reduces the efficiency of the technology and increases wear and tear on equipment.

Inadequate operational capacity and poor plant design have also contributed to failures. Several plants were built without comprehensive feasibility studies or were based on imported technologies that did not align with local waste profiles or climatic conditions. In many cases, low tipping fees, non-bankable power purchase agreements (PPAs), and delays in payments from municipal bodies added financial stress to the project.

Environmental compliance is another critical issue. Several WTE plants have faced closure or public opposition due to emissions of dioxins, furans, and particulate matter that exceeded prescribed limits. The lack of real-time emission monitoring systems, poor maintenance of pollution control devices, and weak regulatory enforcement by Pollution Control Boards exacerbated the situation.

Moreover, many projects suffered due to poor public acceptance and community resistance, often fueled by lack of transparency and fears related to health risks. In several instances, local residents and environmental groups protested against WTE plants located near residential areas or ecologically sensitive zones, citing the "Not In My Backyard" (NIMBY) phenomenon.

Overall, the failure of WTE projects in India stems from systemic issues including weak institutional coordination, inadequate technical planning, poor financial modelling, and low public trust. Addressing these bottlenecks requires a holistic approach encompassing source segregation enforcement, technology localization, robust emission standards, and community engagement.

A key financial obstacle is the high cost of energy production from WTE facilities. Electricity generated from WTE typically costs between Rs.7-8 per unit, which is significantly higher than energy from States' electricity boards buy power from coal, hydroelectric, and solar power plants is around Rs.3-4 per unit.

Environmental compliance is another recurring challenge. Several WTE plants in India have violated emission norms, releasing dioxins, furans, and particulate matter above permissible limits due to poor pollution control infrastructure. The lack of real-time emission monitoring systems and weak regulatory enforcement aggravates public health risks and undermines confidence in WTE solutions.

Way Forward: Strengthening the Waste-to-Energy Ecosystem in India

To unlock the true potential of Waste-to-Energy (WTE) in India, a shift is needed from isolated project implementation to a systemic, inclusive, and sustainable approach. This includes coordinated action by government, industry, and the public.

The following action points are crucial for effective WTE implementation in India:

- People should follow strict segregation practices and also process biodegradable waste locally to reduce the volume of waste reaching central WTE plants.
- Municipality must ensure that only non-biodegradable dry waste is sent to the WTE plant and separately manage biodegradable and recyclable waste streams.
- Municipality or the department responsible for Solid Waste Management should be practical about the high cost of power generation from WTE and work collaboratively with the State electricity department for financial and operational support.

A tripartite agreement between the municipality, the plant operator, and the power distribution agency should be established to ensure responsibility-sharing, financial viability, and long-term sustainability of the WTE project.

Conclusion:

Waste-to-Energy (WTE) offers a promising solution to two of India's most pressing issues: rapidly increasing urban and industrial waste, and the rising demand for sustainable energy. This review has explored the current status of WTE technologies in India, highlighted their sector-wise energy potential, examined the significance of such projects, and analysed the recurring reasons behind the failure of several WTE initiatives.

Despite strong policy frameworks and technological advancements, the widespread adoption of WTE in India has been hindered by poor waste segregation practices, high capital and operational costs, environmental non-compliance, and weak institutional coordination. Many projects have failed due to mismatched technology choices, public resistance, and lack of accountability among stakeholders.

However, the way forward is clear. With strict enforcement of source segregation, localized and appropriate technology selection, rational tariff policies, and transparent stakeholder agreements, WTE can become a cornerstone of India's circular economy and climate resilience strategy.

In conclusion, WTE should not be viewed as a standalone solution, but as a complementary part of an integrated solid waste management system. With collaborative governance, technological adaptation, and citizen participation, India can transform its waste into a resource—and its cities into models of sustainability.

About the Author:

Dr. (Prof.) Nirali Rathod is a Graduate in Elect. Engg., from SP Uni., Post Graduate in Elect. Engg. (Automatic Control and Robotics) from the MSU, Vadodara.

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INTRODUCTION TO WASTE TO ENERGY (WTE) A SUSTAINABLE APPROACH TO WASTE MANAGEMENT AND ENERGY GENERATION

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Abstract

Waste-to-Energy (WTE) technologies present an innovative and sustainable pathway to address two of the most pressing challenges of the modern world: waste management and energy demand. This paper introduces the concept of WTE, outlines major technology types, and highlights their environmental and economic benefits. It also explores the challenges in implementation and the policy landscape shaping this emerging sector in India. The aim is to build a foundational understanding of WTE for engineers, policymakers, and stakeholders attending the "Waste to Energy for Better Environment" conference.

1. Introduction

Urbanization, industrialization, and population growth have led to a substantial increase in municipal solid waste (MSW) and industrial waste across the globe. In India alone, over 150,000 tonnes of MSW is generated daily. Traditional waste disposal methods—landfilling and open dumping—pose significant threats to the environment and public health.

Waste-to-Energy (WTE) refers to a group of technologies that convert waste into usable forms of energy, such as electricity, heat, or fuels. These systems not only reduce the volume of waste but also offer an alternative to fossil fuels, contributing to climate goals and energy security.

2. Waste to Energy Technologies

WTE technologies can be broadly classified into **thermal** and **biological** processes:

2.1 Thermal Technologies

- **Incineration**: Controlled combustion of waste at high temperatures (~850–1100°C) to produce steam and electricity. It is the most widely adopted WTE method globally.
- **Gasification**: Converts carbonaceous waste into syngas ($CO + H_2$) in an oxygen-limited environment. Syngas can be used to generate electricity or produce biofuels.
- **Pyrolysis**: Thermochemical decomposition of organic waste in the absence of oxygen, producing bio-oil, char, and gases. Catalytic pyrolysis is increasingly used for plastic waste.

2.2 Biological Technologies

- **Anaerobic Digestion**: Organic waste is broken down by microorganisms in the absence of oxygen, producing biogas (methane + CO_2), which can be used for heat, electricity, or as vehicle fuel.
- **Fermentation**: Certain waste streams (e.g., food, agricultural) can be fermented to produce ethanol or other bio-alcohols.

3. Advantages of WTE Systems

- **Environmental Benefits**:
  - Reduces landfill dependency and methane emissions.
  - Controls leachate contamination of groundwater.
  - Lowers overall carbon footprint compared to uncontrolled waste disposal.
- **Energy Benefits**:
  - Offers decentralized renewable energy solutions.
  - Stabilizes grid demand with base-load power from incineration and gasification plants.
- **Economic Benefits**:
  - Promotes circular economy and job creation.
  - Revenue from power sales and carbon credits.
  - Reduces cost and land requirement for waste disposal.

4. Challenges and Barriers

Despite the advantages, WTE deployment in India faces several challenges:

- **High Capital Cost**: Initial investment in technology, emission controls, and infrastructure is substantial.
- **Feedstock Quality**: Unsegregated waste hampers efficiency and plant life.
- **Public Opposition**: Misconceptions about emissions and health risks lead to resistance.
- **Policy and Regulatory Delays**: Inconsistent incentives and complex clearance procedures limit investor confidence.

5. Case Studies and Applications

- **Reppie WTE Plant, Ethiopia**: Africa’s first WTE facility converting 1,400 tons of waste daily into 25 MW of electricity.
- **Okhla WTE Plant, Delhi**: Processes 1,950 TPD (tons per day) MSW, generating 16 MW of power.
- **Swachchh Bharat and GOBAR-DHAN**: Government of India initiatives promoting WTE for rural and urban sanitation and energy needs.

6. The Way Forward

To accelerate WTE adoption in India:

- Implement **segregation-at-source** nationwide.
- Provide **financial viability gap funding (VGF)** and low-interest loans.
- Strengthen **public-private partnerships (PPP)**.
- Promote **local entrepreneurship and start-ups** in WTE technologies.
- Enhance **public awareness and community engagement.**

7. Conclusion

Waste-to-Energy is a powerful tool for sustainable urban development and climate mitigation. It transforms liabilities into assets-waste into energy-and aligns with India's energy transition and Swachchh Bharat goals. For engineers, policymakers, and environmental professionals, understanding and implementing WTE is critical to building a cleaner, self-reliant, and energy-secure future.

About the Author

Er. Upendra K Pandya, a free-lancer in Waste to Energy and New and Renewable Resources of Energy Projects, is an under graduate in **Chemical Engineering** from The MSU.

He worked as an Executive Energy Management in R & D Centre, Jyoti Ltd. for about 8 years.

He worked as a Technical Officer with GEDA for about 25 years in various positions.

BIOGAS PURIFICATION AND BOTTLING PLANT FOR GREEN AND LOW COST FUEL

Dr. (Prof.) SS Kapdi
Retd. Professor., Anand Agri. Uni., Anand

Amongst the different sources of renewable energy, biogas technology is one such resource that has the potential to meet the energy requirements. It meets not only cooking and other energy needs in the rural areas, but also improves sanitation and provides manure rich in Nitrogen, Phosphorus and Potassium. Biogas programme has gained roots as an alternative, efficient and to some extent cheap source of fuel. Besides this it provides employment opportunities to rural youth. India has a vast potential of 6.38 x 1010 cubic meter of biogas per annum from 980 million tons of cattle dung produced annually. Till now biogas is mostly confined to small size plants for cooking application. Large size plants installed are not able to properly utilize their gas. Cattle dung is available in plenty in rural areas; the biogas generation at large scale and making it transportable fuel will provide them alternative green and low-cost fuel for their vehicles. If the gas is enriched and then filled in cylinders at high pressure it can become a commercial energy option for transport and other industrial applications.

This whole scenario can be changed if biogas plant can be taken as an industry by installing large size biogas plant and bottled the biogas produce. The bottled biogas can use in energizing irrigation pump sets, as vehicle fuel, generation of motive power for running small rural industries etc. The digested slurry will fetch money by selling as manure. The commercialize biogas technology open up doors of rural employment.

Use of biogas as vehicle fuel, reduce emissions of carbon monoxide, hydro carbons, NOx, carbon dioxide and particles polluting environment and health as per a Swedish study & shown below in Table-1:

Table-1 Exhaust emissions from various fuels after combustion

g/kM	CO	Hydro Carbons	NO_X	CO_2	Particles
Diesel	0.20	0.40	9.73	1053	0.100
Natural Gas	0.40	0.60	1.10	524	0.022
Biogas	0.08	0.35	0.44	223	0.015

Technology of biogas purification and bottling

There are many methods used commercially for removal of CO_2 from biogas. Commonly CO_2 removal process also removes H_2S. Selection of the appropriate process for a particular application depends on the scale of the intended operation, composition of the gases to be treated, degree of purity required and the need for CO_2 removal. Purification is carried out to enrich biogas by scrubbing off the unwanted components i.e. carbon dioxide and hydrogen sulfide. It is essential to have more energy per unit volume of compressed biogas and to get rid of the corrosive effect of H_2S. Various purification processes include absorption into water, absorption by chemicals, pressure swing adsorption and membrane separation.

Water scrubbing method is the most commonly used process for scrubbing of CO_2 from biogas (Plate 1).

Plate-1: Scrubber for purification of biogas

It is simple, cheap and suitable method of CO_2 removal from biogas for rural applications. Pressurized water is used as an absorbent liquid. The biogas is pressurized and fed to the bottom of a packed bed scrubber where water is sprayed from the top. The enriched biogas comes out from the top of the scrubber and collected in pressure vessel for compression and storage in cylinders. Before compression the entrapped moisture is removed using refrigerated gas dryer, as gas is wet. The dried enriched biogas is compressed up to 20 MPa pressure using appropriate compressor and stored in cylinders (Plate 2).

Plate 2: Compression system for enriched biogas bottling

The biogas filled cylinders can be tested for running auto rickshaw, car, engine pump-set for water pumping and electricity generation. The self-sufficiency in energy area in villages is improved by utilization of purified biogas filled in the CNG cylinders. This will also add a new scope for rural entrepreneurship development for utilization of animal dung and agricultural wastes available in the rural area. The burden of CNG import can be minimized through this BIO-CNG. The digested animal dung slurry can be used as fertilizer.

In chemical scrubbing method, chemicals like mono ethaloamine (MEA), diethanolamine (DEA) or di glycol amine are used; even NaOH and KOH are used for absorption of CO_2 from biogas. The dissolubility is more CO_2 per unit volume as compared to water. Operating pressure around 1 atmosphere is required. Pre-treatment of H_2S is also recommended. By this scrubbing about 90% CH_4 yield is obtained with 99% purity.

In pressure swing adsorption technology, adsorbents materials are able to selectively retain some compounds of a mixture by molecular size. Molecules of CO_2 have smaller size than molecules of CH_4, only the molecules of CO_2 are captured in a proper adsorbent material. Adsorbents like molecular sieves, zeolites and activated carbon are used commercially. PSA also enable to remove N_2 and O_2 Operating pressure is 4 - 10 bar. CH_4 yield is 91% and CH_4 purity is 98%.

The membrane separation technology is a low capital cost technology with high energy efficiency. It requires simple process equipment, relative ease to operate and control. Thus ease in processing of biogas. Polymeric membranes, such as UOP Separext cellulose acetate (CA) membranes are widely used for CO_2 separation. However low membrane selectivity compromise purity of CH_4 and amount of upgraded biogas. Multiple steps are required to reach high purity and also have much CH_4 losses.

Applications of bottled biogas

The bottled biogas can be utilized for various purposes such as supplied to mid-day meal scheme, mess, hotel, industries etc. for various purposes such as cooking & heating etc. Biogas bottling plants are one of the most potent tools for mitigating climatic change by preventing black carbon emission from biomass chulha. The CBG cylinders can be used as an alternative. This will open up a new era of rural employment and decentralized source of power from the animal waste abundantly available in rural areas.

Conclusions

India has second largest biogas programme in the world at rural and as well as urban levels. Many technologies/models have been successfully developed in India for biogas. There is need to develop a sustainable renewable energy programme on biogas for replacing petroleum products by utilization of biogas in the country. This will help in green energy technology and reducing greenhouse gases emissions. Biogas is a potential renewable energy source for rural India and other developing countries. Biogas generation and subsequent purification & bottling will cater the energy needs of villages, supply enriched manure and maintain village sanitation. The purified biogas can be used to have a system that will work as a decentralize source of power with uninterrupted supply using local resources, generate ample opportunities for employment and income of the rural people.

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ANAEROBIC DIGESTION
HARNESSING BIOGAS FROM ORGANIC WASTE

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Abstract

Anaerobic digestion (AD) is a biological process that converts organic waste into biogas and nutrient-rich digestate. This paper explores the scientific basis, reactor technologies, feedstock characteristics, energy recovery, and environmental benefits of AD. It highlights the potential of AD as a sustainable waste-to-energy solution that contributes to climate change mitigation and circular economy.

1. Introduction

The growing urban population and increasing waste generation present critical challenges for sustainable waste management. Organic waste—including food scraps, agricultural residues, and sewage sludge—forms a significant portion of municipal solid waste. Organic materials have a natural tendency to biologically degrade, mostly anaerobically and thus emit methane in atmosphere. The atmospheric lifetime of methane is approximately 12 years which is low as compared to Carbon Dioxide, however, its Global Warming Potential of Methane gas is 28-36 over 100 years meaning it is 28 to 36 times more potent than CO_2 at trapping heat and is one of the major contributors of Green House Gases.

Waste-to-energy (WtE) projects can lower global warming potential (GWP) by reducing methane emissions and displacing fossil fuel-based energy generation. Methane, a potent greenhouse gas, is released when organic waste decomposes. By converting waste into energy, WtE projects significantly decrease methane emissions. Additionally, the energy produced by WtE plants can replace energy generated from fossil fuels, further reducing greenhouse gas emissions.

Anaerobic digestion (AD) provides a viable solution by breaking down biodegradable matter in an oxygen-free environment, producing biogas (a mixture of methane and carbon dioxide) and digestate.

AD is gaining traction globally due to its dual benefits: waste stabilization and renewable energy generation. In India, despite policy incentives, the full potential of AD remains untapped due to technical, financial, and institutional barriers.

2. Anaerobic Digestion Process Overview

AD involves a complex microbial process that occurs in four stages:

Hydrolysis: Breakdown of complex organic polymers into simpler soluble organic molecules.

Acidogenesis: Conversion of small soluble organic molecules into volatile fatty acids (VFAs), alcohols, CO_2, and H_2.

Acetogenesis: VFAs are converted into acetic acid, H_2, and CO_2.

Methanogenesis: Methanogenic archaea convert substrates into methane and carbon dioxide.

Typical biogas composition is: 50–70% CH_4, 30–50% CO_2, with traces of H2S and water vapor. The calorific value of biogas is around 20–25 MJ/M^3.

3. Feedstock for Anaerobic Digestion

AD systems accept a variety of organic substrates viz. Agricultural waste (Surplus crop Residue and Energy crops like Napier grass), Livestock Waste (Cattle dung and poultry waste), Municipal waste (organic fraction, sewage sludge from STPs), Agro-Industry waste (Press mud sugar).

Important feedstock parameters considered for AD include; Moisture content: 70–90%, Volatile solids (VS): Indicative of biodegradable content, C/N ratio: Optimum is 20–30:1 for microbial balance.

Different substrates have varying biogas potentials, primarily due to their organic composition and biodegradability. Substrate-

Specific Biogas Potential is as mentioned in Table: 1.0.

Table-1.0: Substrate-Specific Biogas Potential

Feedstock type	Biogas Potential, M^3/kg
Agriculture Residue	0.22
Press Mud	0.088
Sewage Sludge	0.11
Bagasse	0.22
Municipal Solid Waste	0.088
Fruit & Vegetable Waste	0.02
Cow Dung	0.044
Napier Grass	0.22

4. Reactor Technologies

Various reactor configurations are used depending on feedstock type and scale:

Reactor Type	Description	Application
CSTR (Stirred Tank)	Continuously mixed slurry reactor	Municipal/ Agri. waste
UASB	Up flow with sludge granules	Industrial waste water
Plug Flow	High solids	Livestock & Agro Industry Waste
Fixed Film	Attached microbial growth on media	Low-load wastewaters

5. Biogas Utilization and Digestate Management

Biogas can be, used directly for cooking and heating, converted to electricity via gasengines or turbines and Upgraded to bio-CNG for vehicle fuel or grid injection. Digestate is the nutrient-rich byproduct that can be, applied as organic fertilizer or can further be composted or vermicompost for value addition. Effective use of both outputs enhances system sustainability.

6. Environmental and Economic Benefits

AD contributes to several environmental and economic benefits. Environmental benefits include; reduces greenhouse gas emissions, diverts of organic waste from landfills, improves soil health, reduces odors and pathogens, conserves agricultural land and contributes to a circular economy by transforming organic waste into valuable resources, minimizing waste generation, maximizing resource utilization, and promoting sustainable production and consumption patterns.

Economic benefits include; generation of renewable energy, reduction in waste disposal costs, creation of new income streams, boosting local economic growth and job creation, provision of energy independence and security and promotion of investment and qualifies for incentives.

7. Challenges and Opportunities

Anaerobic digestion (AD) offers a promising solution for waste treatment and renewable energy production, but it also faces challenges related to feedstock variability, process instability, efficiency, digestate management, capital investment and safety. Opportunities exist in, decentralized AD units for institutions, hotels, and rural clusters, co-digestion of multiple waste streams to improve efficiency and policy support and PPP models under Swachh Bharat Mission and Sustainable Alternative Towards Affordable Transportation (SATAT) schemes.

8. Case Study

The Navsari Nagarpalika, through Gujarat Energy Development Agency (GEDA), had set up a decentralized Biogas plant using KVIC type floating dome reactor to treat 8 TPD of fruit and vegetable market waste under National programme on Energy Recovery from Urban and Industrial Wastes scheme of Ministry of Non-Conventional Energy Sources during the year 2002-2003. Fruit and vegetable market waste has potential to generate 20 M^3/T of waste. 2 reactors of $85M^3$ capacity were installed to generate $160M^3/day$ of biogas; which was used as cooking gas for 6 no. of 100 CFT/hr. burners and fuel for 1 no. of 12kVA DG set for electricity generation. Digestate was given to market cooperative farmers as organic manure. However, due to lack of facilities for waste segregation, collection and trans-portation to the biogas plant site, consistent yield of biogas was not observed.

Conclusion

Anaerobic digestion is a robust technology that addresses waste management, renewable energy, and environmental protection simultaneously. With proper policy, investment, and public engagement, it can significantly contribute to India's sustainable development goals and climate commitments.

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MODEL-BASED OPTIMIZATION OF ENERGY USE IN WASTE WATER REUSE SYSTEMS

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Abstract

Water reuse is an essential sustainability practice in industrial sectors. This paper presents a mathematical modelling-based approach for optimizing energy use in Common Effluent Treatment Plants (CETP) through pilot-scale reverse osmosis (RO) treatment. Regression-based prediction models were developed to determine energy-optimal pressure requirements for desired Total Dissolved Solids (TDS) reduction. The study shows how advanced modelling can reduce chemical use, improve membrane efficiency, and halve treatment costs—supporting energy and resource conservation in industrial wastewater reuse initiatives.

1. Introduction

The increasing scarcity of freshwater resources necessitates innovative solutions such as wastewater reuse. CETPs play a key role in treating effluents from small and medium enterprises. However, energy consumption remains a major challenge, particularly in membrane-based tertiary treatment systems. The present work highlights the development and implementation of a statistical model to optimize energy use during RO-based wastewater treatment.

2. Objective

- Develop a mathematical model using multiple regression to relate TDS removal to pressure inputs.
- Reduce energy consumption by optimizing operational pressure in RO systems.
- Demonstrate the reuse potential of treated CETP wastewater in agriculture and industry.

3. Methodology

- Data Collection: One year of lab-scale data from a CETP sewage treatment plant.
- Model Development: Regression analysis was used to correlate TDS reduction with pressure.
- Assumptions: Constant membrane area, pH, and flux; varying only TDS and pressure.
- Software: IMS Design (Hydranautics, 2012) was identified as the most reliable simulation tool.

4. Mathematical Model & Results

A linear regression equation was derived to relate pressure and TDS:

$P = 67.61435 + 0.003224 \times TDS$

This equation helps estimate the minimum pressure needed, avoiding overuse of pumps and unnecessary energy expenditure.

- Energy Saving Observations:
- 50% reduction in unit cost of treatment
- 98% reduction in sludge volume
- Elimination of lime and alum dosing
- Energy input optimized by matching pressure to TDS needs

Mathematical Model & Insights

The developed regression equation is:

$$\mathbf{P = 67.61435 + 0.003224 \times TDS}$$

This model predicts required operational pressure (P) for a given TDS level in mg/L.

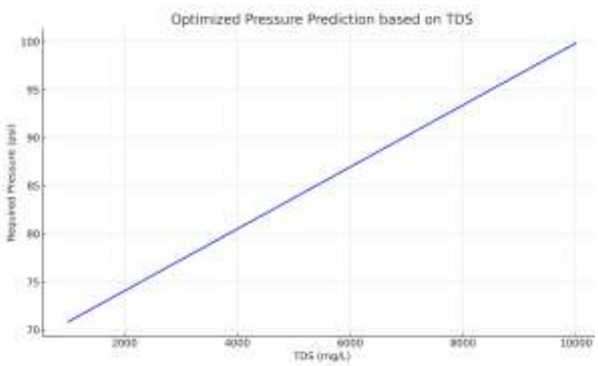

Fig.-1 Pressure production model for optimized RO performance

5. Energy Saving Impact Summary

Parameter	Before Optimization	After Optimization
Average Operating Pressure	~160 psi	~100 psi
Chemical Use (Lime/Alum)	Required	Eliminated
Sludge Disposal Volume	100%	2%
Unit Cost of Treatment	₹10/M^3	₹5/M^3
TDS Reduction Efficiency	Variable	Stabilized at 90%+
Reusability of Treated Water	Marginal	Suitable for Agriculture / Industry

6. Conclusion

Mathematical modelling and optimization of RO systems in CETPs can significantly improve energy efficiency and cost-effectiveness. This aligns with the conference's theme by demonstrating how data-driven approaches in wastewater reuse contribute to environmental sustainability and energy conservation. The model aids CETP operators in designing and controlling treatment processes with minimal energy input and maximum resource recovery.

7. Keywords

Wastewater reuse, Reverse Osmosis, Energy Efficiency, CETP, Regression Analysis, Mathematical Modelling, TDS, Water-Energy Nexus

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UNLOCKING THE POTENTIAL OF WASTE-TO-ENERGY IN INDIA OPPORTUNITIES, CHALLENGES, AND POLICY LANDSCAPE.

Er. Rajendra Pandya

Introduction

India is undergoing rapid urbanization and industrialization, leading to an exponential rise in the generation of municipal solid waste (MSW), agricultural residue, and industrial waste. Waste-to-Energy (WTE) technology presents a unique opportunity to address two critical challenges: waste management and clean energy generation. This paper explores the potential of WTE in India, current policy support, and the challenges impeding its growth.

Current Waste Scenario in India

India generates more than 150,000 tonnes of municipal solid waste per day, a figure expected to double by 2030. However, only about 25% of this waste is scientifically treated. Most waste ends up in overflowing landfills, contributing to land degradation, water pollution, and greenhouse gas emissions. The need for effective waste management solutions is urgent, and WTE is emerging as a promising option.

Waste-to-Energy Technologies

WTE technologies convert waste into usable energy in the form of electricity, heat, or fuel. The main types include:

1. **Incineration:** Burning waste to generate heat or electricity.
2. **Bio-methanation:** Anaerobic digestion of organic waste to produce biogas.
3. **Gasification and Pyrolysis:** Converting organic material into syngas or bio-oil under controlled conditions.
4. **Refuse-Derived Fuel (RDF):** Processing waste into combustible pellets.

Installed Capacity and Project Status in India

As of 2025, India has an installed WTE capacity of approximately 200MW. Several projects have been initiated in cities like Delhi (Okhla), Pune, and Hyderabad, but progress has been slow. Over 100 projects have been approved, though many face implementation hurdles.

Policy and Regulatory Framework

India has a supportive policy environment for WTE:

a. **Solid Waste Management Rules, 2016:** Mandates waste segregation and scientific processing.
b. **Electricity Act, 2003:** Recognizes energy from waste as a renewable source.
c. **National Bio-Energy Mission:** Encourages deployment of bio-energy projects.
d. **SATAT (Sustainable Alternative Towards Affordable Transportation):** Promotes production of compressed biogas (CBG).
e. **State-level policies** and **urban local body mandates** further support WTE implementation.

Incentives and Financial Support

a. Viability gap funding for capital-intensive projects.
b. Generation-based incentives for power producers.
c. Priority sector lending for WTE projects.
d. Renewable Energy Certificates (RECs) for grid-connected projects.

Opportunities and Untapped Potential

India's WTE potential is estimated at over 500 MW from MSW alone. With proper waste segregation, around 30–35 million tonnes of usable waste could be harnessed annually. Rural areas offer scope for biogas from cattle dung and agri-waste. WTE can contribute significantly to energy diversification, methane reduction, and job creation.

Key Challenges

I. Inadequate waste segregation at source.
II. Public opposition to incinerators due to emission concerns (NIMBY).
III. High capital and operational costs.
IV. Limited availability of proven and scalable technologies.

V. Weak institutional capacity at the local level

Recommendations

I. Enforce strict segregation of waste at source.
II. Promote public-private partnerships with risk-sharing models.
III. Provide performance-linked incentives.
IV. Strengthen capacity-building for ULBs and project developers.
V. Integrate WTE with Smart Cities and Swachh Bharat initiatives.

6. Conclusion

Waste-to-Energy holds immense promise for India as it strives to meet its renewable energy goals and manage its mounting waste problem. With the right policy push, technological innovation, and public participation, WTE can become a cornerstone of India's circular economy and contribute meaningfully toward its net-zero targets by 2070.

About the Author:

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WASTE TO POWER – A STEP TOWARDS SWACHCHH BHARAT

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1. INTRODUCTION:

1.1. The Government of India (GoI) has taken up a big initiative in making the country very clean. Many programmes are run by the GoI and all the state of governments. This includes clean cities, clean public places, toilet in every house, waste management etc.

1.2. Lot of waste and garbage is generated every day in cities, towns and villages. All the degradable material like food wastage from houses/eateries, vegetable wastage from markets, dung from animal herds generates stink and pollute the air. This can be used to generate gas and power.

1.3. There are other means to generate power from non-degradable wastage such as plastic, clothes, rubber material wood and metallics. This material can also be used to generate combustible gas and generate power.

1.4. Other material such as Starch Industries Waste Water, Food Processing Industries Waste, Sugar Factory Spent Wash/Press mud, Sewage Treatment Plant Sludge, Dairy Effluent, Poultry Litter/Droppings, Agriculture Waste, Paper Industry Waste, Bio-Degradable Municipal Solid Waste and Night Soil/Human excreta can also be used for generating gas and power.

1.5. The paper here under presents basic information about various ways and means to generate power from the wastage material in different forms. The paper also presents case studies of the work being done by the companies owned by the authors, in India.

2. Process of Bio-Gas Creation and Utilization:

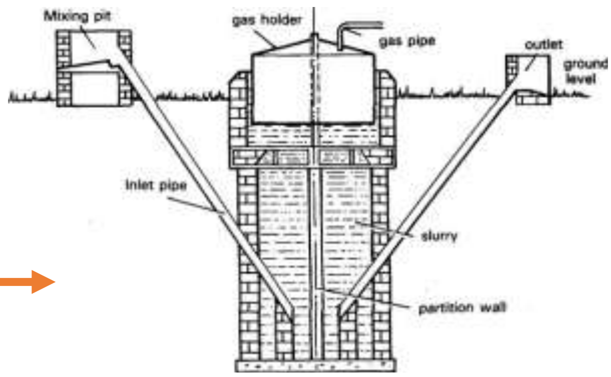
2.1. Bio-Gas results from anaerobic fermentation of organic material. As a metabolic product of the participating methanogens and acidogenic bacteria, the prerequisites for its production is absence of Oxygen, a pH value between 6.5 to 7.5 and a constant temperature of 35–45^{0}C (mesophilic) or 45–55^{o}C (thermophilic). The digestion period or retention period is typically between 20 and 45 days depending upon the type of digestion employed. The anaerobic digestion systems in India operates largely within the mesophilic temperature range.

2.2. Disposal and treatment of bio-degradable waste represent a major challenge for the waste industry. For a wide range of organic substances from agriculture, foodstuff of feed industries, anaerobic digestion is a superior alternative to aerobic composting. Biogas–a mixture of methane, carbon dioxide and other gases is created during anaerobic digestion and serves as a high–energy renewable fuel that can be used as a substitute for fossil fuels. Biogas can be used to fuel gas engines as well as a thermal applicant incorporates and industries for sustainable and economical energy supply.

2.3 The Bio-Gas generated form the plant can be utilized for cooking, heating or any process of generating steam as also for commercial food production. The gas can also be used to generate power by connecting the gas pipelines to the turbo generating unit. If the production of Bio–Gas is in large quantity, bottling of Bio-Gas can be done for the commercial use in kitchen and vehicles. The generated power can be utilized for all types of applications including street light.

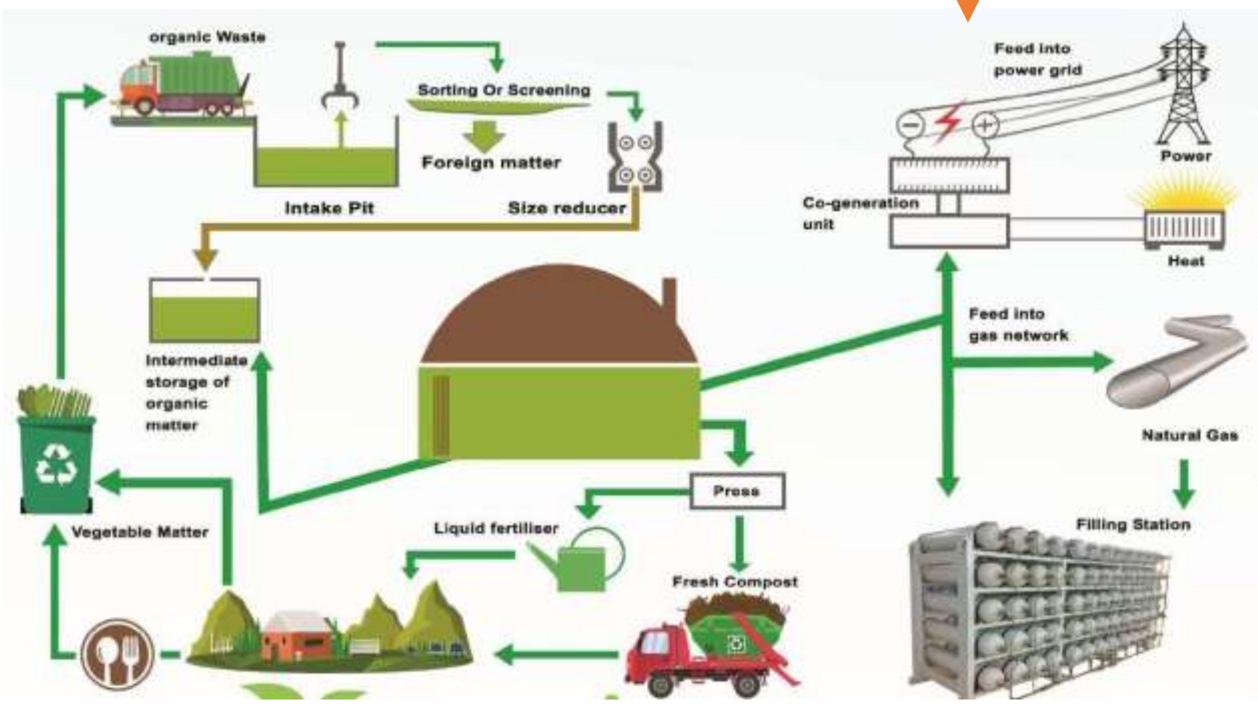
2.4. The non-degradable materials as described above, is crushed to a paste using crusher / mixer. Appropriate amount of water is added to convert paste in to a thick slurry. This slurry is poured at the bottom of half vertical compartment of the digester. The slurry is allowed to remain in the compartment for about 20 days. Fermentation takes place during this period and the gas starts to produce. A gas holder collects the produced gas and lifts up floating on the water, creating pressure. A control valve directs the pressured gas through a pipeline network for desired application.

The gas can be further purified or scrubbed according to the end usage. After the gas is released from the fermented feed, the feed than jumps over to the second compartment of the digester. Once, the second completely filled, the feed in form of slurry starts going out from the bottom of the second compartment through a pipe to the slurry pond. (See Figure)



2.5. The residual sludge post digestion process is neutralized in a semi-liquid form, which can be screened to recover solids to be used as organic manure and liquids be used as recycled water for digestion process, which in turn increases gas production

2.6. A schematic diagram illustrating the above process is given in diagram below.



3. Policy of Government of Gujarat (GoG)

1. The Gujarat Energy Development Agency (GEDA)-a GoG enterprise under the climate change department, is taking various initiatives for introducing energy recovery through renewable sources, one among which being Bio–Methanation Waste–To–Energy Projects. Under the scheme of large size Bio–Gas plants GEDA has introduced aforesaid mentioned various capacities. The scheme is active for more than two decades in Gujarat and numerous Bio–Gas plants have been installed.
2. The policy under GEDA has been classified for two sections of organizations, which are as under
   - I. Non–profit motive organizations (Gaushalas, pinjrapole, trust, government universities etc.).
   - II. Profit motive organizations (Hotels, corporates, private limited companies, etc.).
3. The financial assistance provided by GEDA is available only to above mentioned organizations to the extent of 75% to the non-profit motive and 50% to the profit motive organizations, on the basic design of Bio–Gas plant.

4. Plant capacities as defined in the policy of GEDA are given below.

Sr. No.	Plant Capacity In CMD	Qty. of reqd. Veg. Waste in Kgs/Day	Qty. of reqd. Cattle Dung in Kgs/Day	Land requirement in Sq. M
1	85	900-1000	1800-2000	15 x 15
2	60	600-700	1400-1600	10 x 10
3	45	450-550	1100-1200	10 x 10
4	35	350-400	875-950	7 x 7
5	25	250-300	625-750	7 x 7

4. Case Studies:

4.1 Agriculture Produce Market Committee, Vadodara - It has been observed since past 12 years that on an average around 8-10 MT of vegetable waste is being generated in marketing yard. Waste is segregated at source into bio–degradable (only vegetable and fruit waste) and non–biodegradable (plastic, glass, debris, etc.).

4.1.1 APMC Market functions from 3am to 10am and 3pm to 10pm daily. Waste collection team starts its cleaning of premises at 10am and collects all the bio-degradable waste by 1pm which is brought to the waste processing site (Biogas site). The classified non–bio degradable waste is sent outside for recycling. Team starts its work of crushing and feeding at 1:30pm till 4pm. The 100% Biogas engine also runs simultaneously generating 10 kW/h electricity which is supplied to crushing machine and

Sewage Treatment Plant which runs for 5 Hours at a stretch. Meanwhile, on the other side fertilizer production team is engaged in manufacturing 100% organic fertilizer in the Bio Fertilizer Unit, where on an average 4MT of fertilizer is manufactured, which is sold to the farmers coming to the market, at a subsidized rate of Rs. 350/50Kg and to the dealers @ Rs. 900/50Kg.

4.1.2 Approximately, 200 units of electricity is generated per day from 8-10 MT of vegetable waste collected from the market. The gas engine is run for 5 hours non-stop at full gas tank. Therefore, it runs for 10 10 hours a day in 5 hours slot. The gas is utilized for powering STP and crusher machine during day time and street light at night. The decomposed waste/digested waste, post treatment comes out as wet slurry from the digester and is sent to the slurry beds. At present, the slurry is sun dried to obtain dried powder which is used as an additive in fertilizer. A vibro screening machine which separate solid organic matters from the liquid, will reduce the water loss. Thus, recovered water from the slurry is stored in the slurry sumps which can be recycled for the next round of feeding. Therefore, 90% of water will be saved everyday i.e. around 4 KL of water savings. The recycled water is rich in organic and microbial properties, reusing it in feeding will increase the gas production by 10%

4.1.3 Some photographs of the plant are exhibited below:

Distant view of the Plant

Rotten vegetable being crushed

Gas holder with lifting arrangement and Gas Pipe

Room for storing excess Gas Balloon

4.2 Ujjain Smart City Limited (USCL), Ujjain: –

4.2.1 USCL had proposed installing Biogas Plant for treatment of vegetable and fruit waste received mainly from four markets viz. Maksi Road Market, Gopal Mandir Market, Freegunj Market and Daulatgunj Market. Project is designed to treat waste up to 5MTD (5000Kgs per Day). Waste is collected through a dedicated vehicle from the sites and brought to biogas plant area where it is weighed, segregated, crushed, digested through Bio-Methanation and convert to recover biogas. Biogas is scrubbed and stored for generation of power through biogas engine. Approx. 300kWh units of power is being generated per day which is being used for street lights. The residual matter or digested slurry is screened for separating solids and liquids. The solids are used as organic fertilizer and liquid leachate is recycled in bio-methanation process or can also be used as liquid fertilizer or even it can be disposed of without any environmental hazard.

4.2.2 Major Components of Project -

i) Crushers
ii) Gas Generation System /Digesters
iii) Biogas Storage Balloons
iv) Biogas Purification / Scrubbing System.
v) Biogas to Power Generator
vi) Slurry Separator / Water recycling System.

4.2.3 Thus, this project not only helps in treatment of waste but also recovers Clean Fuel. It is one of its kind projects taken up by USCL to promote sustainable disposal of waste and initiating step towards Green and Clean Energy development.

Project envisages setting up of a state-of-the-art Biogas Plant to convert vegetable waste to produce the following products:

- 3 x 100 Cu. M/Day (300Cu.M) of Biogas, which is scrubbed and used for power generation of approx. 300 Units per day. The generated power is supplied to nearest distribution board and used for reverse metering in the local grid.
- 5MT of Solid Organic Fertilizer from project monthly as value added by-product (Fertilizer) which may be used in gardens and parks of UMC.
- Approx. 7000 Litres of liquid leachate is recycled in bio-methanation process or used as liquid fertilizer.

The USP of the project is the use of zero cost waste streams such as vegetable waste as feedstock to generate high-value biogas and organic fertilizers.

4.2.4

Biogas storage and generator

Gas Generation System

Waste Crushing System

Slurry Separator

4.3 Bharat Petroleum Corporation Ltd. (BPCL) Mumbai Refinery –

4.3.1 In the year 2001 BPCL refinery Mumbai installed kitchen waste based 85 CMD Bio-Methanation Project in refinery premises. The kitchen waste is collected by the team of the company run by the Authors from the 5 canteens located across the refinery. The plant is operational since past 17 years, which is record in itself. Approx. 900 kgs. Of kitchen waste is collected and fed into the digester daily as per the process given below.

Process:

- Segregated bio-degradable waste is first taken to waste processing site and carried to waste handling platform, from where it is transferred to the segregating chamber.
- Waste is screened for any unwanted particles before sending it into the crushing and mixing chamber.
- After crushing and mixing, the waste is sent for pre-digestion in the pre-digestion chambers.
- Pre-digestion chambers activate solid waste for further treatment by making its pulp.
- Pulp is taken to main anaerobic chamber for final treatment.
- Bio-Gas energy is bi-product of this treatment.
- After digestion, the bio-digested slurry is taken to slurry pits, where water can be separated for recycling and remaining slurry is odorless and environment friendly.
- The remaining digested slurry is rich in organic matters, which can be used as a good Organic Fertilizer.

4.3.2 Major Components of Project –

i) Crushers
ii) Gas Generation System /Digester
iii) Biogas to Thermal Use / Cooking Fuel
iv) Slurry Separator / Water recycling System

4.3.3 The gas generated from the above process is piped 500 mts. Away into the central kitchen where it is used for cooking purpose. A log book is maintained where daily consumption of gas is recorded. The remaining digested sludge is dried and converted into good quality manure which is used in the gardens of refinery. Thus, the process has zero discharged and is socio culturally acceptable and environmentally sustainable.

4.3.4 Some photographs of the project are exhibited below:

Waste collection Van

Waste collection from each House/Canteen

Crushing/Mixing Unit with Inlet Chamber

Digester and Gas Holder Tank with outlet Pipe

Bird's Eye view of the Bio Gas Plant

4.4 Kalyan Dombivli Municipal Corporation (KDMC) –

4.4.1 A 10 TPD bio-methanation project has been installed in the premise of KDMC based on biodegradable solid waste received from households and various hoteliers situated in the city of Kalyan. Majority of the waste is segregated at source and final segregation is done at the project site.

4.4.2 The project generates approx. 700M^3 of bio-gas which is used to run 100% gas based engines. The power generated from the project is transmitted into the network of street lights located in the city. The project has completed 5 years of operations and is being further extended.

4.4.3 The photograph of under construction and after completion.

5.0 Conclusion:

5.1 The above model and case studies prove that Waste -to- Energy Projects can run successful with systematic waste disposal norms and proper operation and maintenance of the waste management plant. Various Waste Management Sites are saving cost of waste disposal outside its premises and dumping charges. The projects have become self-sustaining. In the present scenario this kind of projects will help reduce the heaps of waste piling up on our dumping ground which is a major health hazard in the cities and towns.

5.2 These projects not only reduce heaps of wastes rotting in open, but it shows a sustainable way of disposal. We have realized that our waste is not just merely a "waste'' but can serve as a fuel to power our future. Indeed, it is a step towards "Swachchh Bharat Abhiyan" of GoI.

About the Author:

Mr. Shubhank S Takalkar, Proprietor, Aryan Associates & Co.

He is a Graduate in Business Administration & Commerce. Possesses expertise in microbiology related to agricultural organic formulation. After joining the family business, he set up another wing of Aryan Group. Some of the projects executed by him gained recognition nationally and internationally.

Organic fertilizer developed under him was launched by Hon. Narendra Modi in 2013. He has an experience of more than 8 years in the field of Biogas Waste – to - Energy projects.

He has a vision to provide combined solution from waste management to organic farming from rural to urban India and taking up challenges to use waste as a fuel.

ALGAL BACTERIAL SYMBIOSIS FOR WASTE-TO-ENERGY CONVERSION

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The wastes produced by humans and animals are supposed to go back to the soil to complete not only the carbon cycle but nitrogen cycle, Sulphur cycle, etc. and this was our ancient way in India as well as abroad. To completely understand the rationale of the project it is important to understand the rationale of sewage treatment.

Previously from privy, city residents placed "night soil" in buckets along the streets and workers emptied it into "honey wagon" tanks which took it to the nearby village farms. With the advent of industrialization in London apartment system came into existence and privy were replaced with flush toilets. Septic tanks were constructed to handle liquid waste which became the source of pollution and Dr. John Snow identified it as the cause of the cholera outbreak in London.

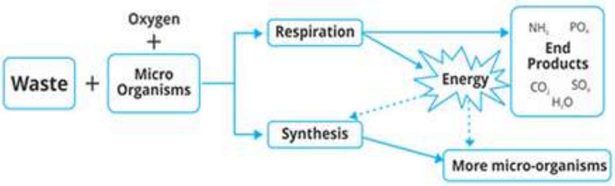
Then existing systems for transporting urban wastes for disposal on agricultural lands were not adequate to handle the large volume of liquid waste generated by the flush toilets.

Faced with this transportation problem, cities began to use natural drainage systems and storm sewers for wastewater carriage against the advice of such men as Edwin Chadwick who in 1842 recommended "rain to the river and sewage to the soil.'

[P. 207 Howard S. Peavy, George Tchobanoglous and Donald R. Rowe's Environmental Engineering]

Even animals put soil after they potty to cover it. Soil bacteria decompose it to the basic nutrients C, H, N, and P. Now as we have mixed water and diluted the night soil it becomes difficult to handle and treat. Construction of combined sewers was commonplace in large cities during the latter half of the nineteenth century. To overcome the problem of excess organic matter creating pollution to the natural water bodies sewage treatment was envisaged.

In a sewage treatment plant, we normally provide favorable conditions for the microorganism to eat up the organic matter. Though UASB and other anaerobic technologies have been invented for sewage treatment aerobic processes are still the first choice.
Now comes the interesting part!!!!!!



The CO_2 emission from STP is approximately 2.4kg/M^3 of sewage. The average carbon footprint of large-scale STPs is 0.78kg CO_2 eq/M^3 and for small-scale STPs it is 3.04kg CO_2 eq/M^3.

A 50 MLD plant will have 120 tons of CO_2 emission every day. No nutrient recovery leads to economic loss and eutrophication of natural water bodies. In India, only 44% of sewage generated from urban areas is being treated. The lack of funds to develop more STPs is a major impediment to achieving 100% treatment capacity.

So, with a view to evaluating the feasibility of macroalgae development to minimize carbon emissions from existing and proposed sewage treatment plants, to recover nutrients and thereby prevent eutrophication of receiving water bodies, to create economic gains from produced macroalgae and most importantly to ensure healthy Carbon cycle the present study is envisaged.

The Gujarat Government is the pioneer in implementing an Environmental Audit Scheme in India which shows its commitment to prevent pollution. The government is committed to developing circular economy concepts and life cycle assessments to achieve sustainable growth.

The state government's commitment to resource recovery and thereby to Sustainable Development Goals has led to the conceptualization and implementation of a treated wastewater reuse policy in 2018. The policy has clearly set milestones and targets of 100% reuse over a period of time. Reducing the cost of treatment and monitoring the nutrient value of sewage will help the government to meet these targets earlier.

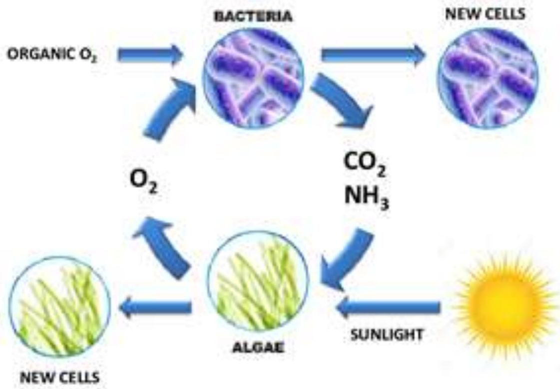
Against the estimated generation of sewage in 2022 of 4003MLD from urban areas the functional capacity is only 2739MLD. This means at present only 68.4% of sewage can be treated. If macroalgae cultivation can be successfully implemented in the existing and proposed plant it can lead to revenue generation and a reduction in pollution. These both are the prime state priorities.

At IIT Hyderabad Dr. Bhattacharya's team has studied green micro-algae and diatoms (brown algae) for the breakdown of organic waste in wastewater. They have also combined bacteria that enable aerobic treatment, with photosynthetic microalgae. In such combined systems, the oxygen produced by the microalgae during photosynthesis is used by the bacteria for aerobic breakdown of organic waste. Carbon dioxide is released during this process. Microalgae also participate in the treatment process by assimilating this dissolved carbon dioxide as well as by taking up nutrients (for example, nitrogen and phosphorus) from wastewater for cell synthesis. Thus, a synergistic relationship is established which is likely to reduce the overall cost of wastewater treatment and also ensure a better-quality effluent for reuse and recycling purposes in 2019.

Researchers at the Department of Biochemical Engineering of IIT-BHU claimed in 2021 that they have successfully applied micro-algae and machine learning to treat wastewater. Under this application, micro-algae in a photobioreactor can clean up to 90% impurity of wastewater by setting the appropriate temperature, light intensity, carbon dioxide content, pH level, which is better than the current bacterial-based water treatment process. "The research has been published in the Netherland-based 'Biochemical Engineering Journal'," as told by leader Dr. Vishal Mishra, assistant professor in the department.

As the separation of microalgae is difficult macroalgae is selected which can be suspended from ropes and harvested easily from time to time. Even before 2008, a project headed by Abhiram Seth PespiCo company initiated macroalgae farming in coastal areas of Tamil Nadu.

The project was yielding 800 tonnes of macroalgae(seaweed) in 2019 and more than 600 fisher folks were earning Rs. 600-700 / day with three hours of work per day from 3M x 3M raft as per the article published in the Better India website.



An algal–bacterial symbiosis (ABS) system is known as a classic water self-purification process in natural water.

Under light conditions, algae can not only remove pollutants through their own degradation ability, such as organic matter (COD), NH_4+-N, total nitrogen (TN), and total phosphorus (TP), but also generate oxygen through photosynthesis, which is used by bacteria in activated sludge to degrade pollutants. Therefore, the ABS not only reduces the amount of aeration but also better removes contaminants compared to the traditional activated sludge process. In addition, such systems are particularly useful in areas with high solar radiation and abundant sunshine. The benefits of algae production are as follows:

1) Algae Grow Fast
2) Algae Can Have High Biofuel Yields
3) Algae Consume CO2
4) Algae Do Not Compete With Agriculture
5) Microalgal Biomass Can Be Used for Fuel, Feed, and Food
6) Macroalgae Can Be Grown in the Sea
7) Algae Can Purify Wastewaters
8) Algal Biomass Can Be Used as an Energy Source
9) Algae Can Be Used to Produce Many Useful Products
10) The Algae Industry is a Job Creation Engine

Thus, algae production will extract the Carbon, Nitrogen, Phosphorus, etc., nutrients from the wastewater and convert them to value-added products, including biofuel, which can be a sustainable form of green energy. Thus, ABS can be a major sustainable contributor to “waste to energy” conversion.

About the Author

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CIRCULAR ECONOMY

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INODUCTION

The concept of a circular economy (CE) has gained remarkable traction in recent years, presenting a compelling vision of our Earth as a closed-system spaceship where resources efficiently circulate. The significance of waste management in achieving optimal environmental outcomes and reintroducing valuable materials into the economy to maintain sustainability. Revolutionary concept rooted in traditional waste management, holds relevance in both municipal and industrial domains. While scholarly discourse revolves around solid and liquid waste management, broader CE discussions, include the ambitious goal of achieving zero waste.

Considering 159 ULB of Gujarat state and more than 7.41 Cr population (42.60% urban) and the waste generated, exemplifies the innovative potential of the CE by harnessing kitchen and garden bio-waste to produce biogas, thereby reducing waste, promoting resource reuse, and achieving local energy self-sufficiency. By focusing on bio-waste and employing a fermentation module for biogas generation, the plant redefines waste as a valuable resource. Transformation of waste into a valuable energy source may offers a pioneering model for sustainable waste management, making it a significant case study with implications for circular economies worldwide. By highlighting waste management's vital role in urban energy self-sufficiency, we emphasize the importance of a balanced approach to waste management and resource utilization. This synthesis provides practical insights into the integration of waste management strategies into the broader context of sustainable urban development. In summary, our fundamental conclusion underscores the imperative for waste management to waste perceive as a dual asset: firstly, as a valuable raw material that can be integrated into the economy and secondly as a potent energy resource capable of enhancing the energy portfolio of cities. This dual perspective on waste not only aligns with the principles of CE but also offers a pragmatic solution to address contemporary challenges related to resource utilization and urban energy self-sufficiency.

Theoretical Framework of Circular Economy

Our planet is basically a huge spaceship speeding through space, recharged by solar energy and equipped with closed-circuit systems is becoming more and more popular in human society. There are many ways to understand and define the CE. One such definition defines the CE as a production and consumption model that involves sharing, borrowing, reusing, repairing, refurbishing and recycling existing materials and products for as long as possible. This extends the product life cycle. In practice, this means minimizing waste. When a product's life cycle comes to an end, the raw materials and waste that comes from it should stay in the economy through recycling. They can be successfully reused, thus creating additional value.

CE is a model of economic development in which–while maintaining the condition of efficiency–the following basic assumptions are met: 1) the added value of raw materials/ resources, materials and products is maximized or the amount of waste generated is minimized, and the resulting waste is managed in accordance with the hierarchy of waste management methods (waste prevention, preparation for re-use, recycling, other recovery methods, disposal).

The **CE** is based on three principles: 1) limit waste and pollution; 2) circulate products and materials (at their highest value) and 3) regenerate nature. The first principle of the CE is to eliminate waste and pollution. Currently, our economy works in a take-make-waste system. We take raw materials from the Earth, we make products from them and eventually we throw them away as waste. Much of this waste ends up in landfills or incinerators and is lost. This system cannot work in the long term because the resources on our planet are finite. The second principle of the CE is to circulate products and materials at their highest value. This means keeping materials in use, either as a product or, when that can no longer be used, as components or raw materials. This way, nothing becomes waste and the intrinsic value of products and materials are retained. The third principle of the CE is to regenerate nature. By moving from a take-make-waste linear economy to a CE, we support natural processes and leave more room for nature to thrive.

There are two main cycles–the technical cycle and the biological cycle. In the technical cycle, products and materials are kept in circulation through processes such as reuse, repair, remanufacture and recycling. In the biological cycle, the nutrients from biodegradable materials are returned to the Earth to regenerate nature.

Specific Examples

1. **Recycling and Up-cycling**

- **Plastic recycling**: Turning plastic waste into new products like clothing, packaging, or furniture. For example, Ecoalf uses ocean plastic to create clothing.
- **Textile recycling**: Brands like for Days are closing the loop by offering clothing made from recycled materials or taking back old clothes for recycling.
- **Up-cycling food waste**: Finding new uses for food that would otherwise be discarded, like turning food scraps into animal feed or using food waste to create biogas.

2. **Product-as-a-Service**:
- **Philips's "selling light" model**: Instead of selling light bulbs, they sell the service of lighting, incentivizing them to produce durable, long-lasting bulbs.
- **Michelin's tyre service**: Michelin provides a tyre service for trucks rather than just selling tires, encouraging them to design for durability and longevity.

3. **Collaborative Consumption and Sharing**:
- Car sharing: Services like Zipcar allow people to rent cars on as-needed basis reducing the need for individual car ownership.
- **Home sharing**: Platforms like Airbnb enable people to rent out spare rooms or entire properties, maximizing the use of existing spaces.

4. **Renewable Energy**:
- **Transitioning to solar, wind and hydro-electric power:** This reduces reliance on fossil fuels and promotes a more sustainable energy system.

5. **Sustainable Agriculture**:
- **Organic farming**: Practices like crop rotation, composting, and using cover crops help to maintain soil health and reduce the need for synthetic fertilizers.
- **Local food systems**: Shorter supply chains reduce transportation emissions and support local economies

6. **Circular Product Design**:
- **Adidas's "made to be remade" running shoe**: Designed for recyclability, the shoe can be returned to Adidas, broken down, and remade into a new performance shoe.
- **Modular design in electronics**: Making devices with easily replaceable and upgradeable components, rather than discarding the entire unit when a part fails.

7. **Industrial Symbiosis**:
- **Waste heat exchange**: Companies in close proximity can exchange waste heat, reducing the need for separate heating systems

8. **Packaging**:
- **Reusable packaging**: Encouraging the use of reusable containers and packaging materials.
- **Recycled content in packaging**: Using recycled materials in packaging and reducing overall packaging waste

9. **Construction**:
- **Using sustainable building materials**: Choosing materials that are renewable, recyclable, or have a low environmental impact.
- **Demolition waste recycling**: Recovering materials from demolished buildings for

for reuse in new construction.

These are just a few examples of how the circular economy is being implemented across various industries and sectors. The key is to move away from a linear "take-make-dispose" model and adopt a more sustainable approach that minimizes waste and maximizes the value of resources.

Case of the Japanese city of Kamikatsu, where a special recycling center has been set up, where over 30 waste fractions are sorted. Thanks to such solutions, as much as 80 percent waste produced by the local community is reused, recycled or composted. Only 20% goes to landfills. Kamikatsu inspires other cities, including Turkey and San Diego, where a plan was announced to reduce landfilled waste by 75% by 2030. By 2040, it would become completely zero waste. New York has similarly ambitious plans—it wants to reduce the amount of garbage to zero in the next 15 years.

IKEA is at the forefront of sustainability through its commitment to renewable energy, circular economy initiatives, and innovative product development aimed at inspiring sustainable living,

Number of initiatives and a clear commitment to sustainability, IKEA not only enhances its corporate image but also serves as a model for other companies in the retail industry, demonstrating that sustainable practices can be integrated effectively into business without compromising growth. As it works towards a more sustainable future, IKEA remains dedicated to making a lasting positive impact on both society and the planet.

Case of Ahmadabad Municipal Corporation sweeping success through comprehensive waste collection: Door to door service for 20 Lakh residential and 5 Lakh commercial units with 1850+vehicle ensures100% GPS-monitored coverage for segregated waste.

Extensive cleaning operation: A force of 9000 manual and 4800 night sweepers, plus 56 mechanical sweeping machines, clean over 1,500 kM roads daily.

Pirana Dump site cleaning:12.5 million metric tonnes of legacy waste fully processed via biomethanation,transforming it into refuse derived fuel(RDF) and inert material.

Waste to energy: a 1000 MTD waste to energy plant generate 15MW of electricity. Nine Material recovery facilities(MRFs) operated by women process dry waste.

Citizen engagement: 'Reduce, reuse, recycle (RRR)' and 'My Thaili' initiatives (producing cloth bags form old cloths) actively involves citizens.

Enforcement: Swachhata squads have collected over Rs. 12 Crore in fine for cleanliness violations.

Improved Infrastructure: Over 250 public toilets were renovated. 'Pink toilets" for women were launched and 'waste to Art' projects were initiated.

Recommendation for more efficient Circular economy

1. The design of incineration plants should assume the shortest possible payback period for investment outlays.
2. It is postulated to reconstruct each wastewater treatment plant so that it produces a larger amount of biogas than its own needs, also using industrial bio-waste.
3. Fermentation plants for the production of biogas from solid bio-waste should be built at each waste collection facility. This biogas would be used to produce heat and electricity for own needs and for sale, including as biofuel for engines.
4. Packaging should consist of materials that can be easily sorted. Disseminate the so-called sorting at source using efficient logistics.
5. "Sustainable resource management" (SRM): SRM is an integrated approach that manages materials/resource life cycles aiming to achieve economic efficiency and environ-mental sustainability. Implementing SRM will support producers and suppliers in identifying inefficiencies in the production processes,

reducing production and waste costs, increasing competitiveness and improving the producers.

6.The implementation of integrated waste management, energy, and fertilizer production in large centralized (regional) units or smaller decentralized local units, such as farm scale or industrial districts. This strategy can transform the current linear production system utilized in the industry to a roundput production system where the organic food wastes and wastewater are treated to produce energy, recycled water, and fertilizer, which are later returned as valuable inputs.

7.Increase of biofuel/bioenergy production, using available, nonfood biomass by-products generated by the agro-food industry.

8.Government should distribute financial incentives for constructing bio-refineries. These bio-refineries will transform organic materials, such as agricultural residues and food wastes, into valuable biofuels and chemicals.

9.The Government should invest in research, professional training, and dissemination of the “mixed farming system” (MFS). This system will minimize the costs and emissions generated by transportation of feedstock that is required to feed the livestock raised in feedlots system

About the Author

Er. Rajesh N Kansara is a Chemical Engineer from Gujarat University.

He was with GEDA for about 30 years and became rich in field of **Bio Energy, Solar Energy, Energy Conservation** and **Energy efficiency** in industrial sector

He was involved in execution of various state and central level sachems/projects like Biomass Gasification, SWHS, EC and E-mobility throughout the state.

A COMPARATIVE CASE STUDY OF CERAMIC HEATER AND INDUCTION HEATER IN POLYMER INDUSTRY

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Abstract

In the polymer industry, optimising heating systems for plastic extrusion is crucial for efficiency and energy use. This study compares ceramic and induction heaters in an industrial extruder, focusing on electrical power and thermal performance. Electrical metrics such as voltage, current, power factor, and energy consumption (kWh) were measured, while thermal imaging assessed heat distribution and retention. Results show that induction heaters are more energy-efficient, reducing unit consumption by 47% and process time by 32% compared to ceramic heaters. Additionally, induction heaters offer better thermal control, reducing heat loss and cooling time. This study suggests that induction heating provides notable advantages over ceramic heaters in energy efficiency, process optimisation, and thermal management.

1. Introduction about the Extruder machine

An extruder is a critical component in plastic manufacturing, responsible for transforming raw materials into continuous forms such as pipes, tubing, sheets, and films. The process starts by introducing plastic pellets, granules, or powder into the extruder's hopper [1]. A rotating screw then transports the material through the barrel, where it is subjected to heat and pressure until it melts. The molten plastic is then pushed through a die at the end of the barrel, which shapes it into the desired profile. Afterward, the shaped plastic is cooled and solidified, typically using water or air, before being cut or spooled to meet specific dimensions. This makes extruders indispensable for producing a wide variety of plastic products [2].

1.1 Basic Working Principle of Plastic Extruder Machine:

The core function of a plastic extruder is to heat, melt, and shape thermoplastic materials. The process begins with feeding granular or pelletized raw materials into the extruder, where they are heated and thoroughly mixed. The molten material is then extruded through a die, forming it into a continuous profile. Maintaining precise control over temperature and pressure is critical to ensuring consistent quality and uniformity in the final product. This method effectively converts raw materials into the desired forms [3].

1.2 Core Components of Plastic Extruder Machine and Their Functions

Fig.-1.1 illustrates the core components of a plastic extruder machine, each playing a vital role in the extrusion process:

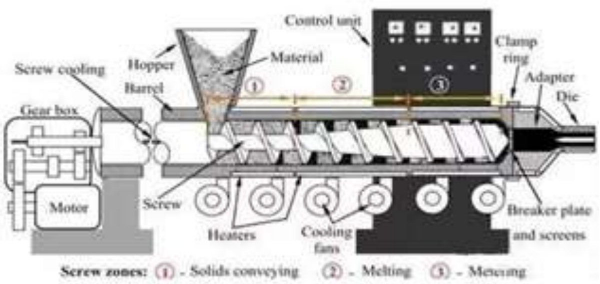


Fig-1.1 Core Components of Plastic Extruder Machine

- **Hopper:** Serves as the entry point for raw materials, maintaining a consistent feed [4].
- **Screw:** The core component, responsible for transporting, melting, and mixing the materials [5].
- **Barrel:** Encloses the screw and contains heating and cooling elements, crucial for controlling extrusion quality [6].
- **Heater and Cooler:** Manage the barrel's temperature to melt and cool the material effectively [7].
- **Die:** Moulds the molten plastic, determining the complexity of the final product's shape [8].
- **Drive System:** Consisting of a motor and

gearbox, it regulates screw speed, impacting the overall efficiency of the extruder. These components work together to ensure efficient plastic extrusion [9].

2. The Extrusion Process Flow:

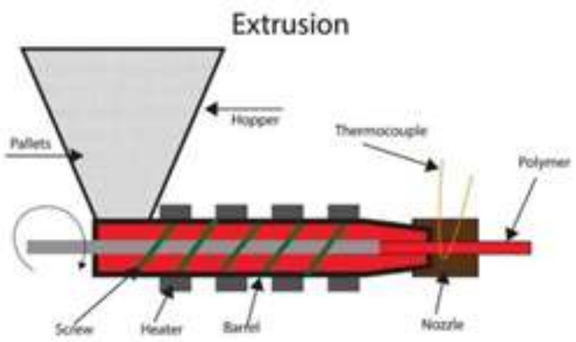


Fig-1.2 Extrusion Process

The extrusion process begins with the introduction of materials into the hopper, which directs them into the barrel [10]. As the material advances through the barrel, the rotating screw generates heat, causing it to melt. Throughout the process, temperature and consistency are carefully controlled [11]. When the molten plastic reaches the die, it is shaped before undergoing cooling and solidification. Fig-1.2 depicts the step-by-step progression of the extrusion process [12].

2.1 Screw Design and Its Importance

The dimensions of the screw, including its diameter, length, and pitch, are essential to the extrusion process. These parameters influence heat generation, mixing efficiency, and pressure development within the barrel, and must be adapted according to the specific material being processed [13].

2.2 Thermal Management

Effective control of heating and cooling within the barrel is vital for optimal extrusion. Heaters are used to achieve the necessary material temperature, while cooling systems are critical to prevent thermal degradation, ensuring consistent extrusion quality [14].

2.3 Die Configuration and Product Formation

The design of the die is crucial as it determines the extruded product's dimensions, shape and surface texture. Complex profiles necessitate sophisticated die designs to achieve the desired characteristics [15].

2.4 Extruder Applications

Extruders are employed across various industries, including construction, automotive, and consumer goods. They are used to manufacture a range of products such as pipes, insulation materials, automotive parts, trims, plastic bags, and toys, demonstrating their versatility and ability to handle different materials and design requirements [16].

3. About the Heating

3.1 The ceramic heating

The ceramic heater ring operates by elevating the temperature of plastic pellets inside the extruder barrel, causing them to soften and melt [17]. As the molten plastic moves through the extrusion die, it is moulded into the desired shape [18]. Fig-1.3 illustrates the ceramic heater's design. Its effective heat transfer capabilities are crucial for maintaining accurate temperature regulation, which is essential for consistent material properties and high-quality end products throughout the extrusion process [19] [20].

Fig-1.3 Ceramic Heater

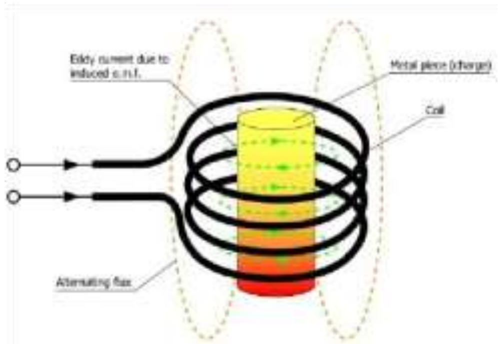


Fig-1.4 Heat Produced by Induction heating

3.2 The Induction Heating

The induction heating system efficiently generates heat directly within the extruder barrel, leading to reduced start up times and lower energy usage [21]. Unlike conventional heater bands, induction heating utilizes alternating current passed through coils surrounding the barrel [22]. This process induces eddy currents, producing heat internally within the barrel [23]. Figure 4 provides a depiction of the induction heating mechanism and its components [24]. As shown in Figure 1.5, heat is generated in areas where eddy currents flow due to their interaction with the metal's electrical resistance.

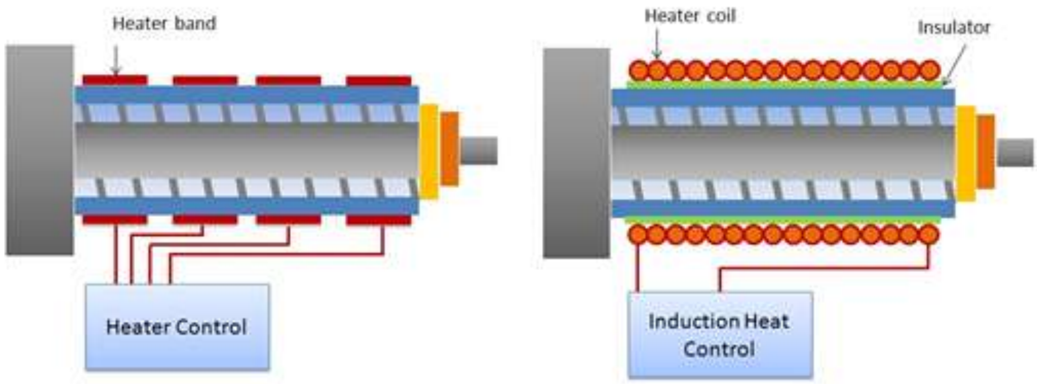


Fig-1.5 Cross section of extruder barrel shown the comparison of classical heating and induction heating.

4. Comparative Analysis of Ceramic Heater and Induction Heater

A comparative evaluation was performed between ceramic and induction heaters, focusing on two primary aspects: Electrical Power Analysis and Thermal Performance Analysis [25-28]. Electrical parameters including voltage, current, power factor, real power, reactive power, total power, voltage harmonics, current harmonics, and energy consumption (kWh) were measured using a Power Analyzer Model ALM 36. For the thermal analysis, thermal images were captured with a thermal imager to assess temperature variation and heat distribution.

4.1 Electrical Power Analysis

An assessment of the heater's energy consumption was performed for an output of 122kg. This total includes 100kg of finished product and 22kg of waste derived from the initial 122kg of raw material. The die employed in the process has a diameter of 150 HOL.

4.1.1 Induction Heater based Extruder – 2

The extruder's heater and the PQA meter that was fitted for recording purposes are shown in Fig-2.1 and Fig-2.2 below.

Fig-2.1 Existing Induction Heater

Fig. 2.2 PQA Meter Installation

The unit consumption cycle recorded throughout the testing period is shown in the following Table-1.

Table 1 Induction heater cycle

Sr. No.	Process	Activity	Start Time	Stop Time	Time (Min.)	Temperature (0^0C)	Unit Consumption (kWH)
I	Heating Cycle	Heating Start & Stop	08:18 AM	08:30 AM	12	Zone 135/270 Zone 2-47/275 Zone 3-60/280 Zone 4-106/285	3.546
II	Die setting Cycle	Manually setting of Die	08:30 AM	09:50 AM	20		9.993 – 3.546 = 6.447
III	Thread setting Cycle	Thread setting	09:50 AM	10:34 AM	45		14.288 – 10.026 = 4.262
IV	Production Cycle	Production Start & Stop (0-122kG)	10:34 AM	11:20 AM	46		21.765 – 14.288 = 7.84
	Total	**122kG**			**122**		**21.735**

The energy consumption pattern and current consumption pattern is presents for Sr. No. 1 to 4 are presented bellow from fig-2.3 to fig-2.8.

I Heating Cycle

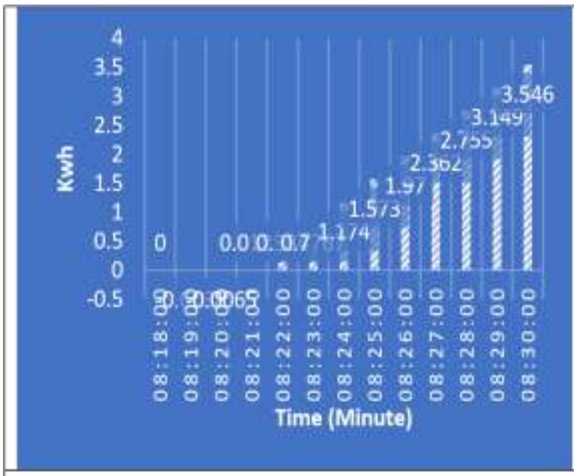


Fig. 2.3 Unit Consumption (Kwh) during the Heating Cycle (Unit = 3.546 kwh, T=12 min)

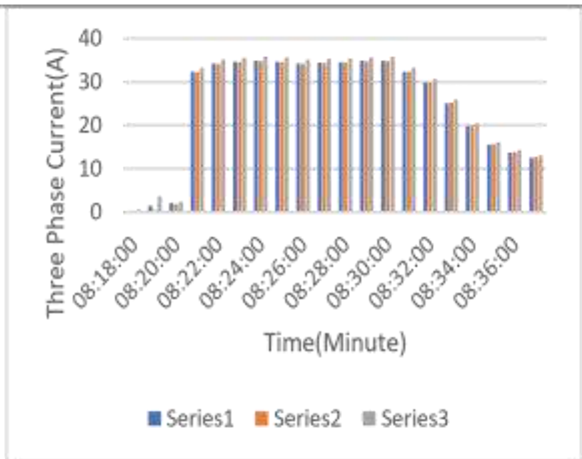


Fig. 2.4 Three Phase Current During the Heating Cycle (A)

II Die setting cycle

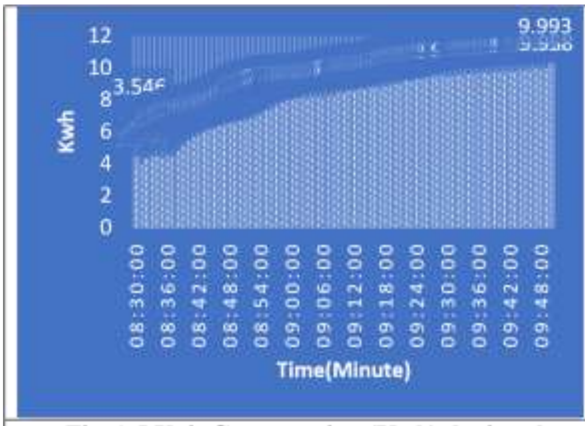


Fig. 2.5 Unit Consumption (Kwh) during the Heating Cycle (Units = 9.993 – 3.546 = 6.447 kwh, T=20 min)

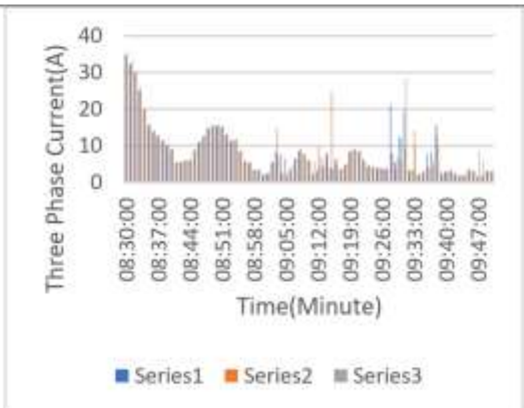


Fig. 2.6 Three Phase Current During the Heating Cycle (A)

III. Thread setting cycle:

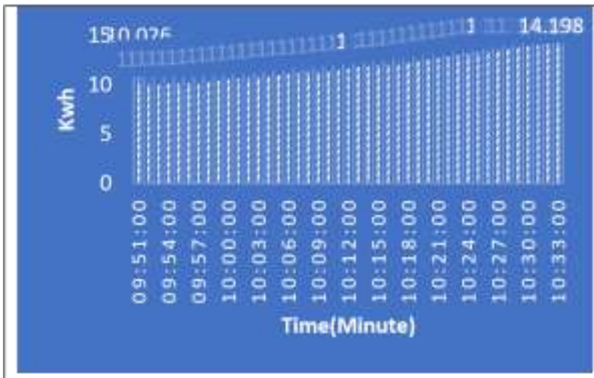


Fig. 2.7 Unit Consumption (Kwh) during the Heating Cycle
Units = 14.288 – 10.026 = 4.262 Kwh, (T= 45 min)

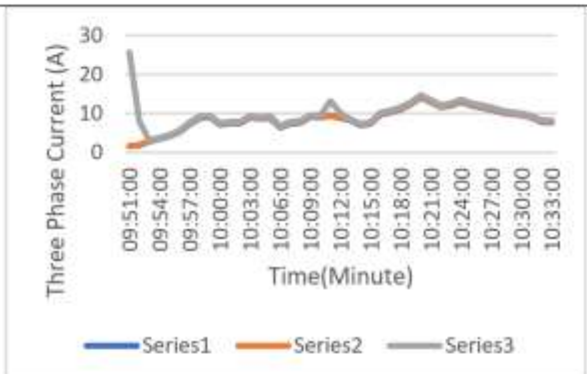


Fig. 2.8 Three Phase Current During the Heating Cycle (A)

IV. Production Cycle

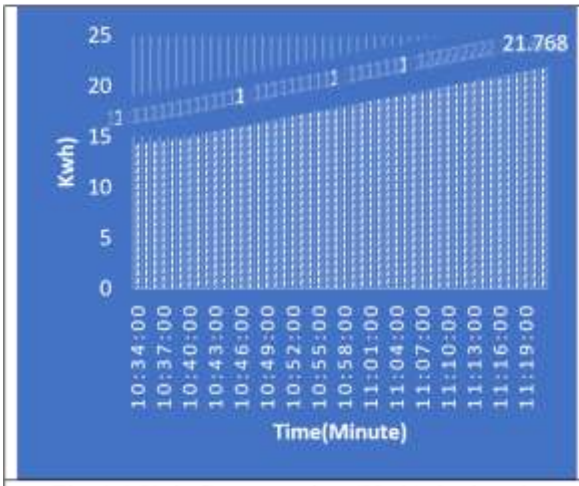


Fig. 2.9 Unit Consumption (Kwh) during the production Cycle
(Production = 122 kg, Units = 21.768-14.288 = 7.84 kwh, T= 46 min.)

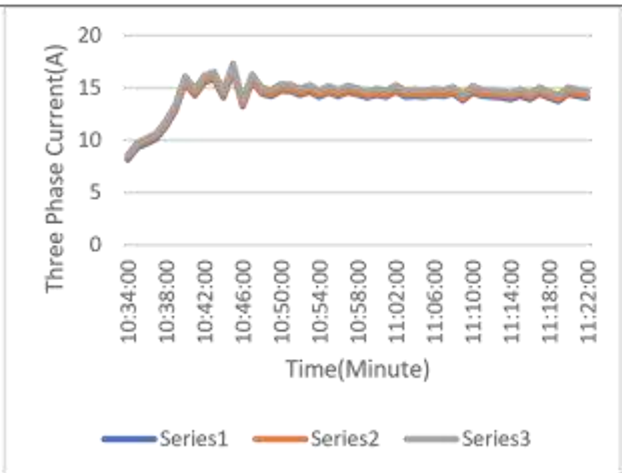


Fig. 2.10 Three Phase Current During the Heating Cycle (A)

4.1.2 Ceramic Heater based Extruder – 2.

The extruder's heater and the PQA meter that was fitted for recording purposes are shown in fig-2.11 and fig-2.12 below

Fig-2.11 Ceramic Heater

Fig-2.12 PQA Meter Installation

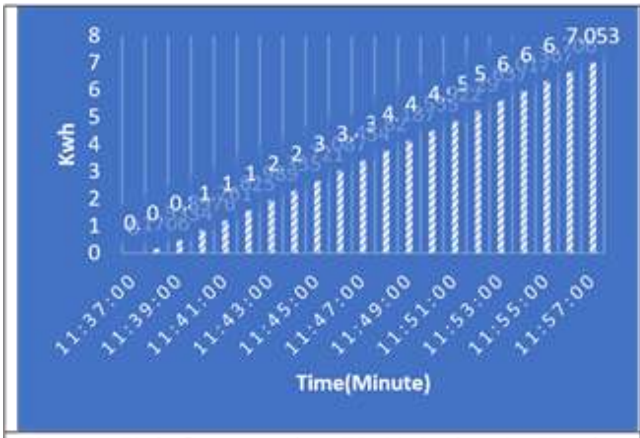
The unit consumption cycle recorded throughout the testing period is shown in the following Table- 2.

Table-2 Ceramic heater Cycle

Sr. No.	Process	Activity	Start Time	Stop Time	Time (Min.)	Temperature (0^0C)	Unit Consumption (kWH)
I	Heating Cycle	Heating Start & Stop	11:37 AM	11:57 AM	20	Zone 1 51/245 Zone 2- 52/250 Zone 3- 58/255 Zone 4- 110/260	7.053
II	Die setting Cycle	Manually setting of Die	11:57 AM	13:06 PM	69		17.398 – 7.053 = 10.345
III	Thread setting Cycle	Thread setting	13:06 PM	14:00 PM	54		25.788-17.698 = 8.09
IV	Production Cycle	Production Start & Stop (0-122kG)	14:00 PM	15:00 PM	60		39.995-25788 =14.207
	Total	**122kG**			**203**		**39.695**

The energy consumption pattern and current consumption pattern is presents for Sr. No. 1 to 4 are presented bellow from fig-2.13 to fig-2.20.

I. Heating Cycle



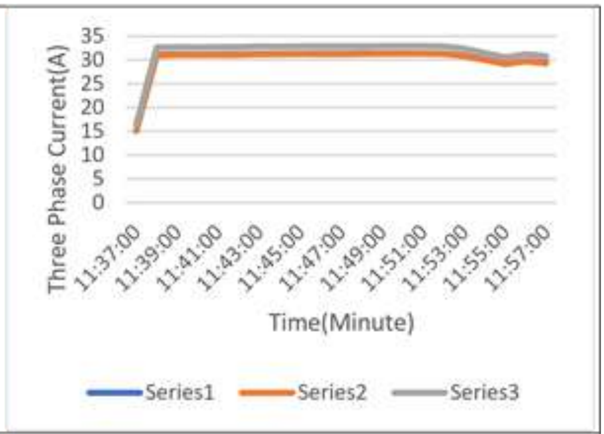
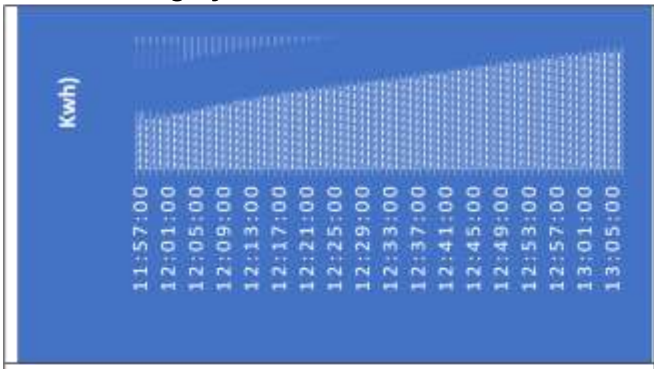


Fig. 2.13 Unit Consumption (Kwh) during the Heating Cycle (Unit = 7.053 kwh, T=20 min)

Fig. 2.14 Three Phase Current During the Heating Cycle (A)

II. Die setting cycle:



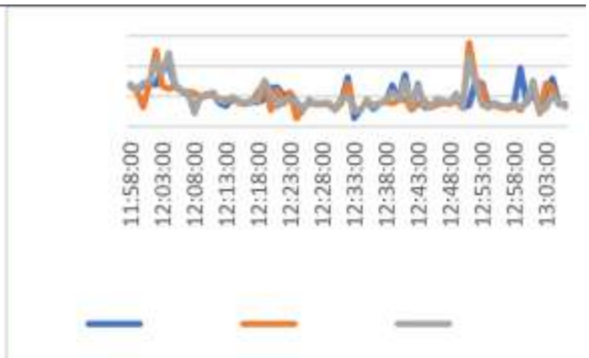


Fig. 2.15 Unit Consumption (kWH) during the Heating Cycle (Unit = 17.398-7.053 = 10.345 kWH, T = 69 min)

Fig. 2.16 Three Phase Current during the Heating Cycle (A)

III Thread setting cycle

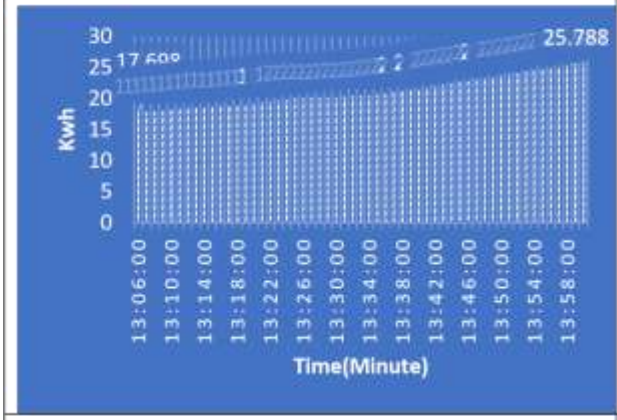


Fig. 2.17 Unit Consumption (Kwh) during the Heating
Cycle (Unit = 25.788-17.698 = 8.09 kwh, T=54 min)

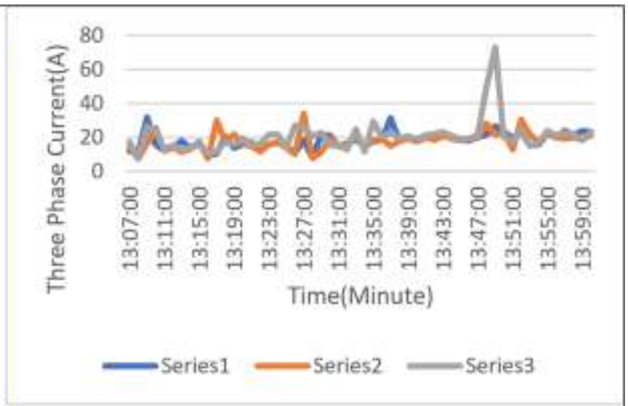


Fig. 2.18 Three Phase Current During the Heating Cycle (A)

IV Production cycle

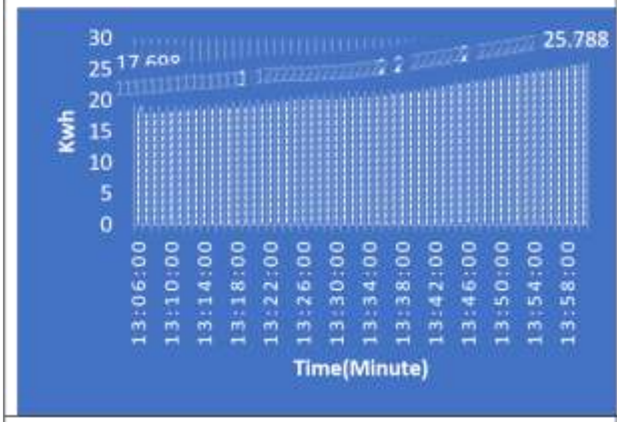


Fig. 2.17 Unit Consumption (Kwh) during the Heating
Cycle (Unit = 25.788-17.698 = 8.09 kwh, T=54 min)

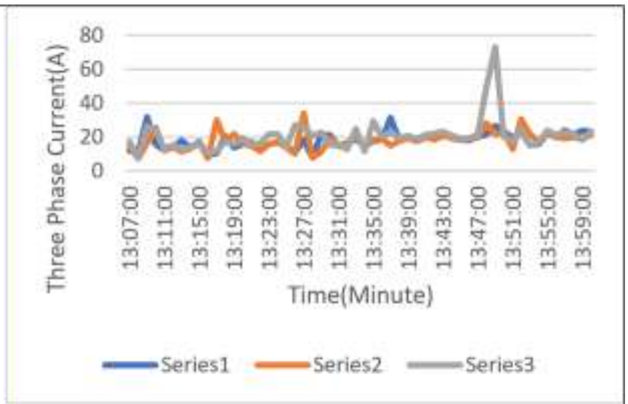


Fig. 2.18 Three Phase Current During the Heating Cycle (A)

4.2 Thermal Analysis

Once the heater reaches the desired temperature, a thermal imager is used to capture an image of the hot area during its operation. The following figures from Fig-2.21 to Fig-2.24 depict the thermal images of the heater cover surface and the heater surface.

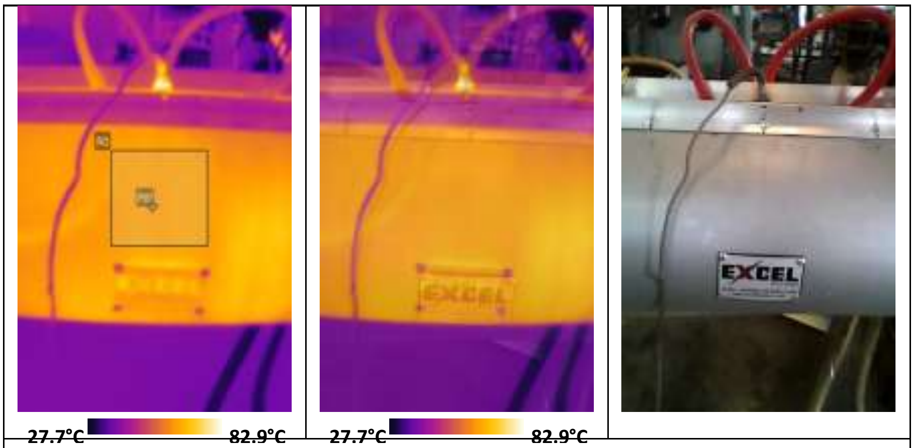


Fig-2.21 Induction Heater Surface Cover

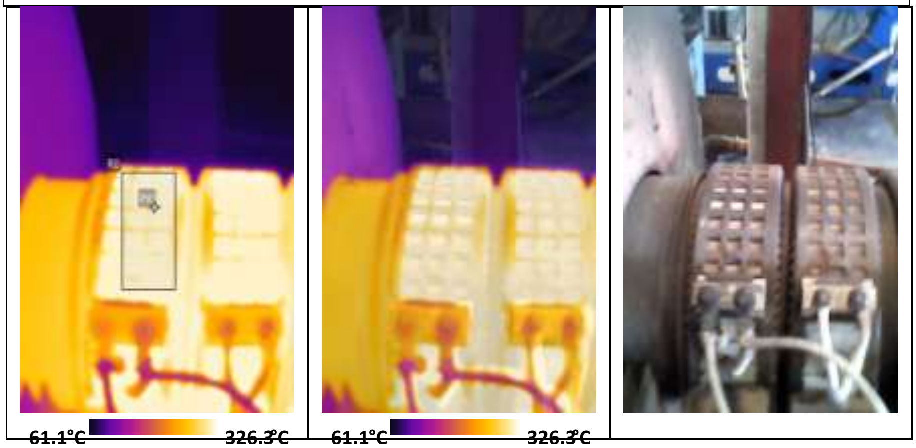


Fig. 2.22 Ceramic Heater Surface Cover

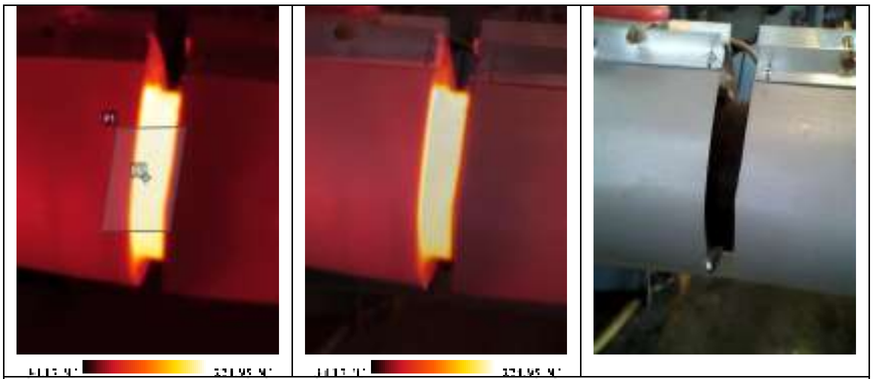


Fig. 2.23 Induction Heater Surface

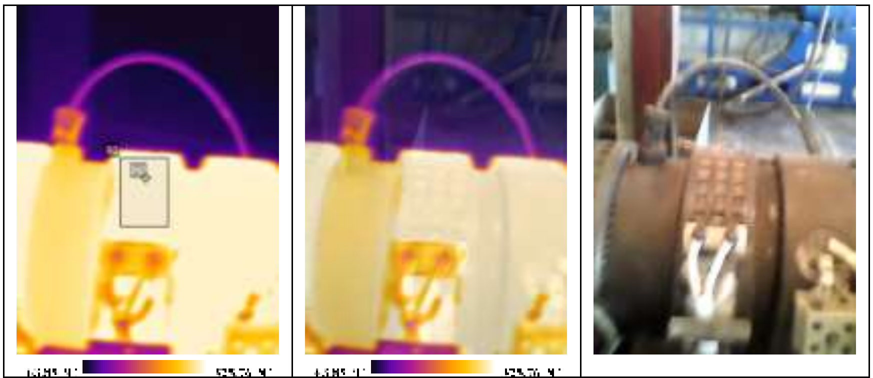


Fig. 2.24 Ceramic Heater Surface

Thermal analysis using a thermal imager has revealed that ceramic heaters emit more heat radiation. The recorded temperatures exceeded 310°C, with specific measurements of 221°C, 325°C, and 328°C. The temperature of the induction heater found near to 120-150ºC.

Conclusion

1. **Electrical Analysis**: The following table 3 summarizes the unit consumption (kWh) and time (minutes) to produce 122 kg.

Table 3 Comparative Analysis of Units and Time for 122 kg production for both heaters.

Sr. No	Process	Induction Heater		Ceramic Heater	
		Time (Min.)	Unit consumption (kWH)	Time (Min.)	Unit consumption (kWH)
I	Heating Cycle	12	3.546	20	7.053
II	Die setting cycle	20	6.447	69	10.345
III	Thread setting cycle	45	4.262	54	8.09
IV	Production Cycle	46	7.84	60	14.207
	Total	**122**	**22.095**	**203**	**39.695**

The thread and die setting cycles are not part of production and are ignored since they are manual processes. Thus, by avoiding these cycles above Table-3 is summarized and presented below in Table-4 and Table-5, considering only the heating cycle and production cycle.

Table 4 Comparative Analysis of Units and Time for Heating cycle and Production cycle

Sr. No	Process	Unit Saving (kWH)	Time Saving (Min.)
I	Heating Cycle	3.507	8
II	Production Cycle	6.367	14

Table 5 Comparative Analysis of Units and Time for Heating cycle and Production cycle in

Sr. No	Process	Unit Saving (kWH)	Unit Saving in %	Time Saving (Minute)	Time Saving in %
I	Heating Cycle	3.507	50%	8	40%
II	Production Cycle	6.367	45%	14	23%
	Total	**9.874**	**47%**	**22**	**32%**

2. **Thermal Analysis:** Thermal analysis can be understood through the thermography report.

   Heat: Using a thermal imager, it was found that ceramic heaters emit more heat, with temperatures over 310°C (221, 325, and 328°C).
   Induction heater temperatures ranged from 120 to 150°C.

3. **Heating time Analysis:** In case of induction heater, the heating cycle time (12 minute) is less as compared to ceramic heater (20 minute).

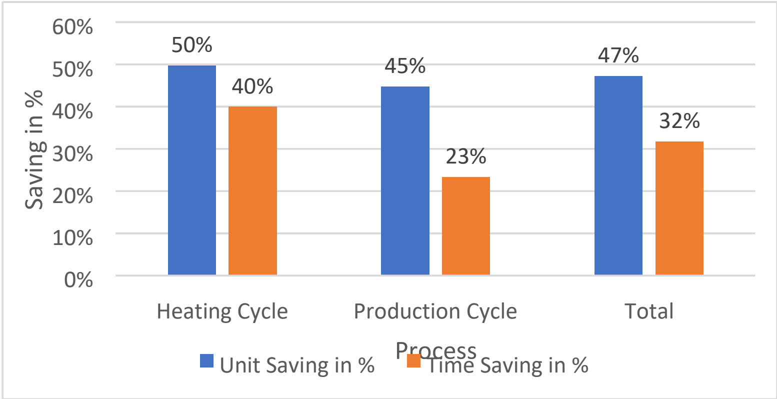


Fig. 25% Saving

For induction heaters, the cooling period after completing the production cycle is around 5-6 hours, compared to 1-2 hours for ceramic heaters. Thus, ceramic heaters have more heat losses, longer heating times, and extended cooling periods. The case study found significant percentage savings with induction heaters over ceramic heaters.

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- Smart Grid

Expert Talk

- Delivers an expert talk in various Institutes.

Publications

- Published papers in various Journals and Conferences.

Electricity Generation and Biogas Production using Waste of Green Vegetables

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The APMC (Agricultural Produce Market Committee) in Vadodara has a biogas plant with an 85 cubic meter capacity to treat organic waste and convert it into electricity and organic manure. This plant utilizes organic waste from the market yard, rendering it waste-free while also producing valuable organic manure. Additionally, the APMC has facilities like a cold storage, ripening chambers, and a soil testing laboratory to support farmers and agricultural practices.

APMC Vadodara Biogas Plant Details and other Facilities:

- **APMC Establishment:**
  The APMC Vadodara was established on January 14, 1958, and is a major marketplace for agricultural produce in the Vadodara district.
- **Large Area**
  APMC Vadodara's Sayajipura Main Market Yard is developed in 30 Acres yard consisting 259 shop-cum-godowns of grains, pulses, spices, dry fruits, oils, atta (flour) etc. 183 shop-cum-godowns of vegetables with attached toilet bathroom, 42 sundry shops with all modern facilities on Ahmedabad - Mumbai national highway No. 8.
- **Organic Waste Converter**
  OWC (Organic Waste Converter) unit to convert organic waste of yard into valuable organic manure without bad smell.
- **Biogas Plant**
  Biogas plant of 85 cubic meter capacity to treat organic waste of yard and convert the gas into electricity and organic manure rendering yard waste free with BEST from the WASTE concept.
- **Rain Water Harvesting**
  Rain Water harvesting by recharge bores in Hathikhana *Market Yards to raise the water table and quality of underground water.*
- **Market Area:**
  The market yard is located near Ajwa Chowkdi on NH-8, Sayajipura, and spans 30 acres. according to www.apmcbaroda.org.
- **Surrounding Villages:**
  Approximately 104 villages are connected to this market.
- **Waste Management:**
  The biogas plant treats organic waste generated at the APMC market yard, effectively managing waste and reducing environmental impact. The APMC also utilizes an Organic Waste Converter (OWC) to convert organic waste into valuable manure.
- **Biogas Production:**
  The plant converts the organic waste into biogas, a renewable energy source.
- **Electricity Generation:**
  The biogas produced is used to generate electricity, contributing to the market's energy needs.
- **Manure Production:**
  The plant also produces organic manure, which can be used as a fertilizer, further promoting sustainable practices.
- **Waste-Free Yard:**
  The overall goal of the biogas plant is to render the market yard free from organic waste, making it a more hygienic and sustainable environment.
- **Collaboration:**
  The APMC partnered with companies like Aryan Associates to design, install, and commission the biogas plant, demonstrating collaboration in sustainable initiatives.

Fig-1 Generator with Gas Engine

Fig-2 Balloon Room to store surplus Gas

Fig-3 Green Waste (duly crushed) added to Gas Chamber

- **Capacity:** 85 cubic meters.
- **Waste Input:** Organic waste from the APMC market yard.
- **Output:** Electricity and organic manure.
- **Fertilizer:** To treat organic waste, reduce waste volume, and generate usable electricity using gas (ethane) engine and fertilizer after generation of gas. The dry fertilizer is sold to the farmer at subsidized rate. Presently 100 bags each of 15 kg of fertilizer are produce from the bio gas as the by-product of the bio gas plant.
- **Power Generation**:
  Earlier 15kVA generator was installed with gas engine. Presently 30kVA generator is installed and working satisfactory. A crusher for cutting the waste from various vegetables like Potato, Tomato, Cabbage, Brinjal, Carrot, Mangoe, Cucumber, Green chili, Battelle Gourd etc. The capacity of crusher is 500kg/hour, there are 2 crushers in the APMC. Presently 4 to 5 ton of vegetable waste per day is being used for production of ethane gas in the bio gas plant with capacity the 85 cubic meters. All street lights (125 to 130) are being illuminated during night hours. The power supply to motors of crushers, pump set and stirrer for the bio gas plant are being given from this generator during day time. Normally 7 to 8 hours the power is being generated from the waste of green vegetables.
- **Additional Facilities:**
  - Cold storage (3,750-ton capacity) for agricultural produce.
  - Ripening chambers (100-ton capacity) for fruits like banana, mango, and papaya.
  - Soil testing laboratory for farmers to assess soil health.
- **Recycling:**
  Sewage water is recycled using an electrolysis method and reused within the market yard.

About the Authors

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ECO-INDUSTRIAL PARKS A COLLABORATIVE APPROACHES TO WASTE MANAGEMENT – INITIATIVES IN GUJARAT

Dr. Bharat Jain

Gujarat has long been recognized as a powerhouse of industrial growth in India, with thriving sectors such as petrochemicals, textiles, pharmaceuticals, and engineering. This development, driven by proactive government policies, strong infrastructure, and investor confidence, has concentrated industrial activity along strategic corridors, most notably the Golden Corridor stretching from Ahmedabad to Mumbai. This corridor encompasses around fifteen major industrial estates, including Vapi, Ankleshwar, Vadodara, and Bharuch, and has historically been at the center of both economic advancement and environmental concern.

As of 2018, the Central Pollution Control Board (CPCB) identified 100 severely polluted industrial areas across India based on the Comprehensive Environmental Pollution Index (CEPI). Alarmingly, 10 of these areas are located in Gujarat, reflecting the state's high concentration of industrial activity and associated environmental challenges. Among these, Vadodara was ranked as one of the most critically polluted zones in the state, highlighting the urgent need for sustainable waste management solutions and stricter environmental oversight within Gujarat's industrial landscape.

As industrialization accelerated, the environmental costs began to surface. Unregulated emissions, hazardous waste dumping, and untreated industrial effluents led to serious degradation of local ecosystems, endangering public health and natural resources. The situation reached a critical point in the 1990s, prompting legal action. One of the most significant judicial interventions came in the form of Special Civil Application (SCA) 770 of 1995, filed in the Gujarat High Court.

A farmer P.J. Patel with other farmers filed Public Interest Litigation in Gujarat High Court in in 1995 – SCA 770/1995. The High Court ordered for sampling of canal water & it was found to be highly toxic & acidic and harmful. As a result, 756 polluting industries of Vatva area was closed immediately.

It was landmark pollution related case for Gujarat. The hearing of the went on for 2 years and court delivered landmark judgment in 1997. Some of the features of judgment were:

- Common Effluent Treatment Plant for each GIDC area or cluster of industries in Gujarat
- Common landfill site for each GIDC area or cluster of industries in Gujarat
- Environment Audit scheme for all scheduled industries in Gujarat
- Regular monitoring of industries.
- 27 kM long pipeline known as 'Mega Pipeline'
- As per Polluters Pay Principle the closed down industries were ordered to submit money of 1% of their last year turnover. The collected fund would be used for pollution control and social welfare work.

This case also brought the spotlight onto rampant pollution in estates like Vapi and Ankleshwar, leading the court to mandate the closure of non-compliant industries and the establishment of infrastructure such as Common Effluent Treatment Plants (CETPs) and Treatment, Storage, and Disposal Facilities (TSDFs). This legal turning point emphasized the need for collective responsibility and cooperation among industries to address waste and pollution.

Following this directive, Gujarat began shifting towards more collaborative and systemic approaches to waste management. Industrial clusters started investing in shared infrastructure such as CETPs, hazardous waste management facilities, and air pollution control technologies. The implementation of these common facilities helped reduce costs for individual industries and improved overall environmental compliance. In regions like Dahej, Jhagadia, and Hazira—

home to large-scale Special Economic Zones (SEZs) and the Petroleum, Chemicals and Petrochemicals Investment Region (PCPIR)—such infrastructural integration became part of master planning, embedding environmental considerations into industrial development.

Currently there are 43 CETPs with capacity of (888.715 MLD), 25 TSDF sites (10 operational, 4 Closed and capped, 2 not in operation, 9 Proposed), 03 deep sea disposal, 17 MEE and 04 common spray dryer.

A critical force driving this transformation has been the Gujarat Cleaner Production Centre (GCPC), established in 1998 through a partnership between the Government of Gujarat, UNIDO, and the National Productivity Council. GCPC has played a leading role in promoting the concepts of Cleaner Production (CP) and Resource Efficient and Cleaner Production (RECP) among industries across the state. It has helped facilitate technical assessments, resource audits, and training programs aimed at reducing raw material usage, minimizing waste generation, and improving process efficiency. The Centre has also been instrumental in disseminating knowledge about sustainable industrial practices and connecting industries with technological and policy support.

GCPC's efforts align closely with the principles of the circular economy, which seeks to close the loop on material flows by turning waste into resources and encouraging reuse, recycling, and redesign. In Gujarat, this has translated into a growing interest in industrial symbiosis—where the waste or by-product of one company becomes a resource for another. This type of collaboration is at the heart of Eco-Industrial Parks (EIPs), which represent a new generation of industrial planning that balances economic competitiveness with environmental steward-ship.

In the context of Gujarat, EIPs are emerging at various scales. At the micro level, individual industries are adopting cleaner technologies and minimizing waste. At the macro level, clusters of industries are exploring ways to exchange materials, energy, and water through integrated systems. On the estate level, entire industrial parks are being designed or retrofitted to share services such as effluent treatment, waste heat recovery, and logistics, thereby reducing their collective environmental footprint. Estates like Ankleshwar and Vapi are now transitioning toward this model, supported by GCPC and international development partners. These efforts are not only improving environmental performance but also enhancing operational efficiency and cost-effectiveness.

The evolution of Eco-Industrial Parks in Gujarat shows how collaborative waste management can drive sustainable industrial growth. Judicial pressure, policy support, and institutions like GCPC have reshaped how industries view their environmental responsibilities. As Gujarat advances circular economy practices, it sets a precedent for other regions, with Eco-Industrial Parks symbolizing a shift toward cooperation, innovation, and shared accountability.

Case Studies:

Case Study: Retrofitting of Naroda Industrial Estate to Eco-Industrial Park

The Naroda Industrial Estate has been successfully retrofitted into an Eco-Industrial Park through several key initiatives:

- **Upgradation of Existing CETP:** Stream segregation was implemented, and highly concentrated streams were sent to the MEE plant for further treatment.
- **TSDF Site Development:** Naroda Enviro Project Ltd (NEPL) developed a Treatment, Storage, and Disposal Facility (TSDF) site for safe disposal of hazardous waste.

The following Industrial Symbiosis options have been implemented:

- **Renewable Energy Generation:** NEPL, with support from GEDA, developed a biogas plant that generates electricity from organic waste, such as banana skins and bread waste. The biogas plant produces methane, which is used to generate power, illuminating the Naroda CETP at night.
- **Waste Museum:** NEPL established a unique "Waste Museum" showcasing hazardous

industrial units, promoting industrial symbiosis and waste reduction.

- **Waste Exchange (Spent acid recovery plant):** Novel Infrastructure Ltd collects spent acid from three industrial estates and produces Ferrous Sulphate and react the it with a calcium-containing base, such as limestone or slaked lime, to precipitate gypsum, which is sold to the cement industry.
- **Iron Sludge Utilization:** Iron sludge from dye intermediate industries is used in road construction and brick manufacturing.
- **Fly Ash Recycling:** Fly ash is sent to brick manufacturing industries for recycling.
- **Drum Recycling:** Used chemical drums are sent to authorized detoxification facilities and reused by industries.
- **Disaster Management:** The estate plans to set up a Disaster Preventive Management Centre under the Gujarat State Disaster Management Policy.

These initiatives have transformed the Naroda Industrial Estate into a model Eco-Industrial Park, showcasing sustainable practices and

About the Author

Dr. Bharat Jain is an **Under Graduate** in **Civil Engineering** with **Post Graduate** and **Ph. D** in **Environmental Engineering**

He is also having **Post Graduate Diploma** in **Business Management** & **Environmental Law & Policy.**

A former Chief Engineer of GIDC, at present he is working as a Member Secretary of Gujarat Cleaner Production Centre, involved in promotion of Resource Efficiency & Cleaner Production in the industries. Presently, he is working on retrofitting of existing Industrial Estates into Eco-Industrial Parks.

He has made several presentations at National & International Forum and published more than 25 papers on Environment Management. He has guided many students for their P. G dissertation and Ph.D.

On invitation of UNIDO, he has travelled places like Singapore, Germany, Switzerland, Bahrain, Mauritius, Sri Lanka, Indonesia, Kenya, Japan, Austria, Thailand, China, France, Republic of Korea and Finland for meeting/discussion on Resource Efficiency & Cleaner Production.

WASTE TO ENERGY POLICY AND ITS IMPORTANT CLAUSES

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The Gujarat Electricity Regulatory Commission (GERC) in Gandhinagar is responsible for implementing the state's Waste to Energy (WTE) policy, which aims to promote electricity generation from Municipal Solid Waste (MSW). The policy encourages private sector participation and aims to manage waste more efficiently while also generating clean energy.

- **Gujarat Waste to Energy Policy 2022:**
  This policy, notified on November 2, 2022, is in effect for five years, until November 1, 2027.
- **Policy Objectives:**
  The policy aims to improve MSW management, promote environmentally friendly disposal, utilize MSW as a renewable resource, reduce land requirements for waste disposal, and encourage investment and employment in the renewable energy sector.
- **Eligible Units:**
  Any individual, company, or urban local body can set up WTE projects.
- **Project Options:**
  Developers can choose to utilize the energy for captive consumption, sell it to a third party, or sell it to distribution companies (DISCOMs).
- **Land Allotment:**
  Urban Local Bodies (ULB) will provide land near landfill sites or other suitable locations for a nominal lease rent of Re. 1 per annum for 25 years.
- **Tax Exemption:**
  ULBs will not levy any taxes, cess, or royalties on the MSW-based power projects.
- **Urban Local Bodies (ULBs):**
  ULBs will identify suitable sites and prepare pre-feasibility and DPR reports for MSW-based power projects.
- **Nominated Agency**
  A nominated agency will purchase power WTE projects and allocate it to DISCOMs based on their previous year's consumption.
- **Mid-term Review:**
  The state government may conduct a review of the policy after two years or as needed.
- **Stakeholder Consultation:**
  The policy allows for clarifications and interpretations by the Energy & Petrochemicals Department to address any difficulties or inconsistencies.
- **Focus on Renewable Energy:** The policy emphasizes utilizing MSW as a renewable resource for electricity generation.
- **Environmental Friendliness:** The policy aims to promote environmentally friendly methods of MSW disposal.
- **Private Sector Participation:** The policy encourages private sector investment in WTE projects.
- **Tariff Determination:**
  The GERC determines the generic tariff for WTE projects and also approves tariffs discovered through competitive bidding.
- **Compliance:**
  The GERC ensures that DISCOMs procure power from WTE projects and that the policy is implemented effectively.
- **Regulation:**
  The GERC regulates the WTE sector to ensure its smooth functioning and to address any issues that may arise.
- **Important Clauses:**

6. Eligible Unit

6.1 Any individual, company or body corporate or association or body of individuals, Urban Local Bodies/Urban Development Authorities whether incorporated or not, or artificial judicial person will be eligible for setting up Power Plants utilizing Municipal Solid

Waste either for the purpose of captive use or for sale of Obligated Entities i.e. Distribution Licensees or any other third party, including Urban Local Bodies/ Urban Development Authorities, subject to the provisions of this Policy and in accordance with Electricity Act-2003, as amended from time to time.

6.2 The use of electricity for own consumption and its end use location/s by the owner of WTE Projects shall be considered as Captive Use

6.3 Only new plant & machinery shall be eligible for installation under this Policy.

6.4 Since the management and handling of MSW is to be as per the provisions of Solid Waste Management Rules-2016, the WTE Projects shall comply with MSW Rules and relevant provisions of Environment related Acts, Rules & Regulations as amended from time to time.

11. Grid connectivity and Evacuation facilities

11.1 The evacuation facility shall be approved by Gujarat Energy Transmi-ssion Corporation Limited (GETCO) / Distribution Licensees after carrying out System Studies, Feasibility Studies etc.

11.2 The WTE Project Developer shall establish dedicated evacuation line for evacuation of power up to GETCO substation, install RTUs (Remote Terminal Units) etc. at their own cost.

11.3 The voltage level for evacuation of power to the grid shall be in accordance with the Gujarat Electricity Grid Code-2013, GERC Supply Code-2015, other applicable GERC orders / Regulations and amendment thereof.

15. Energy Accounting & Surplus Power Injection

15.1 The energy accounting for all WTE Projects shall be in accordance with MOP's Green Energy Open Access Rules-2022 and applicable regulations framed Forum of Regulators/GERC from time to time.

15.2 Banking of energy shall be allowed upon payment of applicable banking charges as determined GERC from time to time.

15.3 For net import of power, Distribution Company will charge applicable tariff of respective category to the consumer including fixed/demand charges, energy charges, peak charge, other charges/ penalty etc. as applicable to other consumers.

15.4 Surplus power (if any), after giving set off, shall be purchased by Distribution Company at rates specified in table herein below. Fixed / demand charge, peak charge, other charges / penalty etc. as applicable to other consumers.

Particulars	Rates of surplus power	Treatment of RPO
Case-1 Consumer not taking RE Attribute for fulfilling its RPO	Rs. 1.75 per Unit	Entire generation to be considered towards DICOM's RPO
Case-2 Consumer taking RE Attribute for fulfilling its RPO	Rs. 1.75 per Unit	Surplus generation to be considered towards DICOM's RPO
Case-3 Consumer registered under REC Mechanism	Rs. 1.50 per Unit	Surplus energy to be considered towards DICOM's RPO

15.5 The rate of surplus power (if any) after giving set off to be purchased by DISCOM in case of MSMEs setting up projects for captive consumption (and not registered under REC Mechanism) shall be Rs. 2.25 per kWH for first 5 years and there after those mentioned at table above.

21. Restrictions

21.1 The power project shall not use fossil fuel in excess of ceiling provided by CERC in line with Policy / Guideline of Ministry of New and Renewable Energy (MNRE)

21.2 Mixing of any waste any renewable nature or bio-mass with the total municipal solid waste shall be allowed up to the percentage ceiling specified/ limit prescribed by the Policy/Guideline of Ministry of New and Renewable Energy (MNRE). The UDD/ULBs shall develop a robust "Monitoring Mechanism" for the same as the main aim of this policy is disposal of Municipal Solid Waste.

About the Author

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ATMOS POWER PVT. LTD.

Committed to the Environment

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- Biogas
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- Syngas/ Producer Gas

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- Separation
- Upgradation

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- Five Manufacturing Facilities
- 120+ Biogas Upgradation Plants
- 200+ Medical O2 Installations
- India's First Landfill Gas Upgradation Plant

Technology (VPSA)

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CATALYTIC PYROLYSIS OF PLASTIC

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Plastic, a synthetic material with versatile applications, has become integral to daily life due to its lightweight, strength, durability, and cost-effectiveness. Its adaptability allows it to be manufactured in various forms with the aid of advanced production technologies. In recent decades, plastic production has greatly increased, and this trend is estimated to exceed 500 million tons by 2050, which might consume approximately 40 % of crude oil. The escalating production of plastics accentuates their contribution to waste generation, making effective plastic waste management a pressing global challenge.

Recycling plastic waste is considered challenging owing to its widespread use and long lifespan in the environment. The non-biodegradable nature of plastics results in only 9 % being recycled, 12 % incinerated, and a staggering 79 % accumulating in the natural environment, contributing significantly to solid waste generation. While many countries emphasize the reuse and recycling of waste plastics, a significant amount is still landfilled or incinerated, which can lead to environmental contamination like generation of residual waste and overflowing landfills, while incineration can contribute to pollution, smog, and PM 2.5 emissions posing threats to marine life and human health.

To address this issue, developing an efficient, cost-effective, and simple technique that simultaneously proposes an alternative fuel source and tackles plastic pollution by converting it into value-added products is essential. This approach could save 3.5 billion barrels of crude oil, equivalent to 176 billion USD.

Among plastic materials, polyethylene (PE) stands as the most prevalent, with low-density polyethylene (LDPE) finding use in flexible applications like agricultural sectors, plastic. wraps, and food packaging. Conversely, high-density polyethylene (HDPE) serves in more durable applications such as manufacturing housewares, pipes, and bottles. However, the widespread applications and properties of PE contribute to it holding the largest percentage in plastic waste, along with other polyolefin compounds, constituting about 65 % of municipal plastic waste. On a positive note, the energy content and hydrocarbons present in plastics are comparable to conventional fuels. This similarity enables the potential generation of value-added products for energy, chemicals, and fuel applications from plastic waste.

The utilization of plastic waste as an energy source is gaining momentum due to its dual benefits in addressing waste management issues and meeting energy demands. This recently motivated a paradigm shift in the perception of waste plastics, transitioning from being viewed as a pollution source to being regarded as a valuable resource. Cement factories increasingly employ plastic waste as an alternative fuel for high-temperature processes, thereby reducing reliance on fossil fuels. Waste-to-energy plants also convert plastic waste into energy through incineration or pyrolysis.

Mechanical recycling is currently the most prevalent recycling technology, but it is mostly limited to polyethylene terephthalate (PET) bottles and some forms of high-density polyethylene (HDPE). This limitation has prompted the development of new recycling methods ranging from improved mechanical recycling to chemical recycling. Among chemical recycling technologies, pyrolysis is one of the few methods that can deconstruct mixed plastics across a broader slate of polymers than those currently eligible for mechanical recycling. Pyrolysis of mixed plastic waste occurs at temperatures from 300^{o}C–700^{o}C in the absence of oxygen and the process typically produces a hydrocarbon based liquid, solid char, and light gases. The hydrocarbon products may be used to create monomers for new plastics or other chemicals, refined to fuels, or some combination of these options. Mixed waste plastics, especially those rich in polyolefins, are a potentially suitable feedstock for pyrolysis because they are inherently difficult to separate, and produce olefinic and aromatic hydrocarbons via pyrolysis due to their high carbon content and relatively low oxygen content. Given that fast pyrolysis of plastics produces a mixture of olefinic and paraffinic hydrocarbons with a broad range of carbon numbers C1–C60 +, and catalysts are used to narrow the product distribution and increase yields of target products.

However, the quality of pyrolysis fuel remains a challenge, as it often contains a mixture of oil components, which may not meet standards for end use applications. Despite these challenges, pyrolysis presents a promising approach to transforming plastic waste into a resource that can alleviate the energy crisis while addressing waste disposal concerns.

The Catalytic Pyrolysis Technology Platform

Catalytic pyrolysis of plastics involves the decomposition of polymeric materials by means of high temperatures when it is applied in oxygen-free conditions. Since pyrolysis relies on the endothermic breaking of covalent bonds the supply of heat is essential to efficiently decompose the material [6].

Numerous studies have investigated the pyrolysis of plastic waste to generate liquid fuel. Pyrolytic oil is synthesized from high-density polyethylene (HDPE) plastic waste using a custom stainless steel reactor at temperatures ranging from 330 to 490^{0}C for 2 to 3 hrs. This process produced solid residue, liquid oil, and flammable gases. The resulting waste plastic pyrolysis oil (WPPO) showed properties suitable for diesel engine use, including a kinematic viscosity of 1.98 cSt at 40^{0}C, a density of 0.75 g/cm^3, sulfur content of 0.25%, carbon residue of 0.5%, and a high calorific value, indicating its viability as an alternative to diesel fuel. Another study exhibited enhanced properties of oil due to the use of catalysts, which resulted in a high calorific value and reduced viscosity, making it comparable to conventional fossil fuels. Catalysts also reduced unwanted compounds like sulfur and nitrogen, yielding cleaner oil for energy use. The catalytic pyrolysis of significantly improved the yields of liquid fuel and gas. The produced oil had favorable characteristics, including low viscosity, appropriate density, and high calorific value, confirming its potential as an alternative fuel source. Some studies examined the pyrolysis of plastic waste to produce diesel engine-grade oil, emphasizing the effectiveness of converting various types of plastic waste into liquid fuel suitable for diesel engines. Key findings indicated that the produced oil met diesel fuel standards, exhibiting favorable viscosity and high calorific value, while also addressing plastic waste management and providing a sustainable energy source.

Some researchers also have attempted to transform waste plastic into synthesis gas through rapid and flash pyrolysis techniques to produce a greater quantity of syngas. Two-step reactor system was emplyoed to increase energy efficiency by catalyst utilization. In a two-stage process, the initial stage operates at temperatures of up to 600 ◦C, where gaseous products are generated. These products are then passed through the second stage, where product refinement occurs. The catalyst and inert gas are introduced and react at temperatures of up to 900 ◦C, fine-tuning the resulting products.

The feasibility of the pyrolysis process, was assessed by examining its operational characteristics. this study particularly delved into faster, intermit, and slower methods. It was found that pyrolysis in faster mode is a better process. Additionally, process optimization strategies were explored to enhance syngas production. Notably, gaseous product yields surpassed 80 % when compared to slow pyrolysis methods.

Catalytic pyrolysis is a highly flexible technology platform where the choice of operating conditions such as pyrolysis or catalytic reactor temperature, residence time, reactor geometry, carrier gas, feedstock choice, pre-processing, pressure, catalyst loading and type can significantly impact the relative amounts of transportation fuel intermediates, light olefins, aromatics, waxes, organic oxygenates, and char produced.

Each of these parameters can be tailored to optimize the product yield and composition as well as reduce the energy requirements. However, temperature and reactor type have the most significant impact on product selectivity.

Temperature: Temperature is probably the most significant operating parameter in pyrolysis recycling since it controls the cracking reaction of the polymer backbone. The pyrolysis temperature range can be broad, between 300 and 900 °C for most plastics, and depends on a myriad of factors.

The selected operating temperature also depends on the target products and distribution. In general, when the pyrolysis temperature is high, there is increased production of noncondensable gaseous fractions and lower liquid yields, such as diesel. Higher temperatures increase the yield of hydrogen, methane, acetylene, aromatics, and soot, whereas lower temperatures favor generation of aliphatic compounds and liquid products.

Reactor type: After temperature, the second most important parameter to consider when designing a pyrolysis process is the reactor type. A pyrolysis process design typically consists of a feeding section, reactor unit, and product collection vessels that contain downstream separation lines for product recovery and purification. Reactor type directly affects mixing of the plastics, quality of heat transfer, and final product yield in the pyrolysis process and requires configurations that have excellent mass and heat transfer characteristics. The type of catalyst that can be used in the process also depends on the reactor type applied. Several kinds of reactors can be used for pyrolysis including those involving high heat and mass transfer rates such as fluidized beds (bubbling and catalytic), autoclaves, melting vessels, plasma reactors, and unique designs to enable vacuum pyrolysis. Similarly, it is also possible to find rotating cone, cyclonic reactors, and ablative process reactors used in pyrolysis processes.

Catalysts play a crucial role in lowering operating temperatures, reducing energy requirements, shortening reaction times, and improving the quality of pyrolysis products. For instance, various catalysts were investigated for syngas recovery from LDPE pyrolysis volatiles, highlighting their performances and tendencies toward coke formation. Metal-organic frameworks (MOFs) and graphene-metal–organic frameworks (GMOFs) emerge as promising catalysts owing to their structural and chemical characteristics, high surface area, and potential to enhance particle collisions and surface reactions during pyrolysis.

The choice of catalyst configuration between in-situ and ex-situ catalytic pyrolysis can also influence the product distribution with longer catalyst contact times leading to more dehydrogenated products but also leading to greater deactivation due to coking and impurities. Similarly, the choice of catalyst also provides significant influence over the product slate. Zeolites, particularly ZSM-5, have been the most commonly used catalysts in catalytic pyrolysis studies, but a wide range of other catalysts, including metal oxides, metal carbides, supported metal nanoparticles, multifunctional materials, and waste materials such as red mud, have been used for the conversion of plastic.

The use of zeolites and metal-loaded catalysts has been widely investigated because it reduces the required energy, alters product distribution, and upgrades oil quality. However, the rapid deactivation of zeolite catalysts due to large coke deposits on their surfaces and their elevated prices have limited their use on an industrial scale. In addition, the application of metal-loaded catalysts is relatively restricted because of their cost and environmental drawbacks, which could make the development unsustainable. Hence, it is necessary to develop alternative catalysts with improved efficiencies and natural abundance.

Carbon-based catalysts derived from renewable sources, also known as biochar, have attracted significant attention for the catalytic pyrolysis of plastic waste, owing to their low cost, porous structure, and ease of modification. Despite the advantages of biochar-based catalysts for various applications, the poor physicochemical properties of raw biochar, such as weak porosity and low surface area, restrict its catalytic applications. It is reported that a high fixed carbon content in biochar might cause coking, resulting in rapid deactivation. Similarly, the physicochemical and structural properties of biochar can be tailored through proper activation, making it suitable for catalytic processes. An earlier study conducted catalytic pyrolysis of waste plastic at 500 ◦C using activated biochar with phosphoric acid and reported a 59.2 % yield of aromatic hydrocarbons from the liquid product. Similarly, the impact of $ZnCl_2$-treated biochar was checked on aromatics generation via catalytic pyrolysis of mixed plastic wastes at 500 ◦C, obtaining approximately 47.5 % aromatics hydrocarbons.

Further, PE pyrolysis in a fluidized bed reactor was explored, reporting gas and liquid yields across a temperature range and specific compositions of derived oil and gas products. Similarly, HDPE pyrolysis study was conducted and highlighted that the volatile fraction and compositions of oil and wax are obtained. Another HDPE pyrolysis, emphasized wax yield and enhanced olefins selectivity using olivine as a catalyst. These studies reveal the potential of deriving fuels from plastic waste, with properties comparable to conventional fuels, highlighting the promise of pyrolysis as a waste management technique.

Summary and future perspectives

Overall, pyrolysis is considered a relatively simple, flexible, and suitable process for recycling plastic waste streams that are difficult to depolymerize. Pyrolysis technologies are leading the way in chemical recycling because of the robustness to contamination and existing infrastructure. However, current energy requirements, variability of the waste streams, poor life cycle assessment metrics, and techno-economics have presented limitations to implementation of pyrolysis as a major recycling route for plastic waste. Many still agree that an improved understanding of the chemistry and more innovative reactor designs are required to realize the full potential of pyrolysis and to achieve lower GHG emissions. Additionally, the absence of an optimum reactor technology to employ catalytic pyrolysis is another major bottleneck in industrial applications. Research must investigate how to maintain catalyst stability alongside recyclability because it affects the economic viability. Studies about implementing plastic waste pyrolysis at an industrial scale, together with its compatibility with current waste management systems, exist in limited numbers.

Further, challenges persist, particularly in managing contaminants from mixed plastic waste feedstock, controlling emissions of volatile organic compounds (VOCs) during pyrolysis, and handling solid residues formed in the process. Addressing these concerns through advanced reactor designs, optimized operating conditions, and effective emission control technologies will contribute to the sustainable and efficient utilization of pyrolysis oil as an alternative fuel.

Despite its promise, certain challenges that must be addressed before catalytic pyrolysis can reach commercial levels of deployment. First, there are no operating commercial scale plants using catalytic pyrolysis. As a result, there is high risk in investing the capital needed to scale up the technology for a pioneer plant. As with other biofuels production and plastic recycling technologies, the feedstocks can be expensive due to the high cost of collecting, transporting, and sorting a dispersed solid resource. As a result, achieving high product yields and atom economies are critical to the overall catalytic pyrolysis economics. Feedstock complexity, exemplified by the mixtures of polymer molecules, additives, dyes, and contaminants in waste plastics, is also challenging. Many of the impurities and heteroatoms found in waste plastics can decrease catalyst lifetimes, thus adding additional cost for either impurity removal or catalyst regeneration and replacement schemes. Furthermore, the feedstock contaminants and heteroatoms can be carried over to the final products, lowering their value. Finally, pyrolysis is an indiscriminate process that produces a broad spectrum of products. As a result, the yield of any single target molecule is low. Catalysts are critical to narrow the product distribution and increase the yield of desirable products. To maximize process profitability, it is important to understand the composition of all product streams and their potential as valuable co-products, soil amendments, or sources of heat, energy, or hydrogen to lower the selling price of the primary product.

WASTE TO ENERGY (ELECTRICAL)

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Synopsis: In day today life lots of waste are generated from forest, agriculture, animal, industrial, hospital and municipal corporations. Disposal of such waste is a big problem. Mostly it is dumped or land filled. They produce a lot of pollutant like gas, bad smell, bacteria etc. which is bad for atmosphere as well as human health. But with proper care such waste can give energy, manure, and other valuable product. Also pollution can be reduced. Humanity is putting lots of effort for such benefit to be derived from these waste.

1. Introduction: As mentioned in synopsis, topic will deal about present scenario in society about generation and utilization of such waste.

As mentioned in Appendix -1 there are various sources of waste, but here we will discuss only about municipal waste as well as agricultural waste.

In general scenario of World as well as India, problem and efforts are almost same. Most of the underdeveloped and developing countries, simply dump the waste over ground/ underground. Some partially dump in landfill pit.

Some developing and developed countries dump in land fill with methane gas recovery'.

Agriculture and wood based waste is palletized and used for power generation. Also by digestion it is converted in to Bio-gas (CBS) or Bio-CNG for fuel use and by product is manure. Even organic, liquid and cow dung waste also pass through such processes.

Very few countries use incinerator for converting the waste through RDF for power generation. Since it is costly and uneconomical, but it is good for cleanliness and atmosphere.

A typical break up of cost and power plant parameters has been mentioned in Appendix-6

2. Present Indian Scenario.

There are 48 Municipal Solid Waste (MSW) based power plants in India with a combined installed capacity of 412.5 MW, and some are under various stages of construction. These plants are being developed under the Swachchh Bharat Mission of the Ministry of Housing and Urban Affairs. Additionally, 47 thermal power plants are co-firing agro residue-based biomass pellets with coal.

The 48 plants under construction represent a significant step towards utilizing waste for energy generation and reducing landfill burden.

- Co-firing with Biomass:

The co-firing of biomass pallets with coal in existing thermal power plants is another approach to reduce reliance on fossil fuels and promote renewable energy sources.

- Policy Support:

The Ministry of Power has issued guidelines to encourage co-firing of biomass pellets in thermal power plants, demonstrating government support for these initiatives. Also mandates of 5% biomass co-firing in Thermal power plans has been issued.

- Environmental Benefits:

These projects not only generate electricity but also contribute to cleaner energy sources and reduce pollution from waste disposal.

3. Method & Execution of different Waste:

a) Torre faction: 200-300^{0}C for wood/ agriproduct. It removes moisture and form briquettes for fuel use.

b) Palletization: (For better efficiency).300-500^{0}C for palletization.

c) Pyrolysis: 400-900^{0}C for syngas & charcoal production

d) Incineration: For steam production

e) Bio-methanation / Anaerobic digestion

f) Composting
g) Landfilling

4. Problem in execution:

1. The biggest problem in execution of solid waste for power generation is collection from source, local storage, transportation at remote shorting point and segregation of organic, plastic, metal, wood etc. for making RDF for furnace/boiler or organic material for digester.

All these are supposed to be done by Municipal corporation through competent and resourceful contactors.

2. Land acquisition for local/ remote storage/ sorting, processing and installation of power plant and landfill.

Protest by local people for pollution due to these facilities.

3. Lack of automation in afore said system.

4. Lack of competent manpower and financial resources with municipal corporations.

5. Higher Cost of power generation; say Rs. 8 per unit compared to Rs. 4 / 3 & 2.5 per unit by conventional coal thermal power plant / wind / solar power plants.

5. Takeaways:

1. Potential of WTE generation is huge. We are using only 10-12% of this potential.

2. For keeping our cities clean and for generation of WTE central & state government should arrange more finance to municipal corporations;

3. Corporation should automate primary and secondary waste collection and transportation to the processing sight. Latest communication should be used for this.

4. Effort should be made for PPP model for power generation plant.

5. Since cost of generation of electricity is very high, hence SPV should be made for purchase and trade the power through power exchanges.

6. With help of CSR of big companies, such projects should be adopted.
Big size NGO should also adopt such projects.

7. Such projects should be considered as welfare for society, not as profit organization.

8. Power generation through thermal plant is better as compared to other option for solid municipal waste. But it is costly.

9. To install a CBG plant is less costly as compared to incinerator based WTE plant. But it is more suitable for liquid based waste as well as for organic waste. Lesser capacity gas engine based power plant is installed wherever required for CHP.

10. In advance countries Incinerator based power plant is installed, since their waste has more wood, paper and plastic, hence calorific value is better.

11. Pallet from paddy, wheat, maize etc. based is available but in less quantity. Since transportation, storage, and putting pallet plant in remote area is difficult, due to unavailability of land and sufficient finance. Farmer co-operative should be encouraged for this.

Such pallets are used in coal fired thermal power plants. Govt. has made it mandatory to use 5% pallet. But availability of pallet is problem.

Appendix -1

Type of waste:

1. Municipal Solid & Liquid
2. Industrial Solid & Liquid

(May be hazardous material also)

3. Bio-medical
4. Animal Based; like cow dung, chicken excreta, product of slaughter house etc.
5. Agricultural: Bagasse, Paddy, maize, wheat stubble, husk etc.
6. Forrest product: wood, wood waste etc.
7. Plastic Waste
8. E-waste

Appendix -2

Scope & Type of Energy Generation in India:

- a) Potential of WTE 5690 MW Thermal.
- b) No of projects under MNRE 90 with 330 MW
- c) CBG: 70 N0 – 83,400 M^3/Day
- d) Bio CNG: 34 No 2,48,000kG/Day

Appendix -3

Type and Quality of Municipal Waste

Organic material, plastic, wood, paper, metal glass

c. Calorific value 2,200 Kcal-1600 kCal/kG.

Appendix -4

Statistics of Waste generation based plant potential and power generation in urban area: India

City	Potential MW	Installed MW
1. Ahmedabad	78	20
2. Surat(Syn gas)	63	16
3. Vadodara	20	Nil
4. Delhi	300	100
5. Jabalpur	20	11.5
6. Solapur	15	3
7. Taloja Industrial & Bio Med		16
8. Hyderabad	78	40
9. Bengaluru	150	11.5
10. Mumbai	175	7
11. Chennai Planned	80	32 + 26

Appendix -5

Statistics of Waste to energy generation (Thermal) in countries of the world

1. China – 24,852 MW (Max 400MW at one city)
2. USA – 2,021 MW (60 Plants), 24MW maximum at one place.
3. EU: 4,921 MW (Germany 1004MW)
4. Japan: 5,840 MW
5. Singapore- 120 MW
6. **India - 556 MW**

(Potential 5,690MW, only 10% capacity utilization) Biggest 40MW at one place

Appendix -6

Typical Capital Costs of 10MW MSW combustion-based power plant:

1. Fuel handling storage and preparation system - 20%
2. Boiler - 26%
3. Steam T-G -15%
4. Stack gas cleanup & pollution control- 20%
5. Field purchase & Construction - 9%
6. Plant Engineering - 9%
7. License for 30 yrs. -1%

Appendix -7

Typical parameters of a MSW 10MW thermal power plant:

y) Steam Presser - 46 Bar

a) Steam Temp – 410^{0}C
b) Stoker Boiler capacity 60 TPH By Hitachi Zosen / Thermax
c) BFW Temp - 130^{0}C
d) Flue gas - 180-190^{0}C
e) Manpower required 70 Nos
f) Boiler Efficiency. 80%
g) Turbo Gen 12.5MW Bleed & condenser type. 1500 RPM
h) Turbine speed 8,000 RPM with reduction Gear
i) Generating Voltage 11kV
j) Main Transformer 11/132kV 15MVA
k) Aux. Transformer 2.5 MVA 11/.415kV
l) EDG set 800kVA ,415V 1 No
m) Per KWH generated electricity cost Rs. 8
n) Per MW capital cost Rs 25 Cr.
o) MSW required 600 TPD for 10MW
p) Ash Generated 225 TPD
q) MSW calorific value 2,200 kCal-1,600 kCal/kg.
r) Moisture in MSW 35-50%, Incombustible 20-35%.
s) 60 TPD MSW required per 1MW
t) Land Required for power plant. 5 Acre/MW
u) Land required for MSW Power preparation 2. 5 Acre/per MW
v) Land required for MSW Power generation preparation 2. 5 Acre/per MW
w) Power generated at present 20% of MSW
x) Land fill required for Inert & ash only

Appendix -7

A) WTE Plant

1. **Ahmedabad** Pirana 15MW WTE Plant require 1,000TPD Solid waste. Cost 375Cr. i.e. 25Cr./MW.
   Incinerator based BTG plant.
   Boiler 65TPH Power to grid. (Nov-2024)
   Vendor: Jindal Urban Development, Pirana 15MW WTE Plant require 1000TPD Solid waste. Cost 375Cr. i.e. 25Cr. / MW.
   Incinerator based BTG plant.
   Boiler 65TPH Power to grid. (Nov-2024)
   Vendor: Jindal Urban Development
2. **Hyderadad** MSW Energy Solutions Pvt. Ltd.
   Expansion of existing RDF based Waste to Energy Plant from

Existing 19.8MW RDF based (Ramky Group)
Existing 19.8MW RDF based plant
(2 x 600TPD MSW consumption)

B) Sangrur (Punjab) CBG Plant

By FDI Verbio AG, Germany
220Cr. Cost
Area 20Acres
Production 6TPD CBD to be expanded 33TPD through paddy straw. It has 8 digesters of 10,000 cu.cm each.

Appendix -8

Statistics:

1. Waste generation 70 TPD per lakh population.
2. Plant cost 25Cr. / MW.
3. 1 cu. M equal to 0.8T.
4. Solid waste having calorific value 1500 kCal / kg and above shall be used as fuel, as per solid waste management rule 2016.
5. MSW required 600 TPD for 10MW
6. MSW calorific value 2,200 kCal-1600 kCal/kg
7. 60 TPD MSW required per 1MW
8. Land Required for power plant. 5 Acres/MW
9. Land required for MSW preparation 5 Acres / per 100 TPD
10. Bio CNG Target !5 MMT by 2024
11. 200 kg Bio-CNG can generate 200kWH electricity.
12. MSW Generated 70TPD/Lakh population
13. Royalty/Tipping Charge Rs 3,000/Ton

Appendix -9

Organization associated with WTE Plan:

1. MNRE
2. IREDA
3. JNNURM
4. CPCB
5. NGT
6. SWM
7. Ministry of Power
8. Ministry of petroleum & Natural Gas
9. MoEF & CC
10. Ministry of Urban Development & Housing
11. Municipal corporations of respective area
12. State Govt. of respective area

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Ankur Scientific
&
Innovation in Gasification & BTG Solutions for converting Biomass/Waste to Energy

Ankur Scientific Energy Technologies Pvt. Ltd.

About Ankur Scientific

Founded in 1986 by Late Dr. B. C. Jain, a gold medalist from BITS, Pilani, Double M.S., Ph. D, & M.B.A. from M.I.T. (Cambridge), an internationally acclaimed technocrat.

Indigenously Developed and Patented Technologies that meet all emission and safety norms.

1000+ systems installed in **35+ countries** worldwide.

Working with various Governments globally, NGOs, agencies of the UN, EU, World Bank, Internationally reputed Universities, the Gates Foundation, various industrial and investor groups and private industry.

Recipient of numerous National and International Awards.

ISO 9001, ISO 14001 and ISO 45001 certified. All equipments are **CE** certified.

What is Gasification?

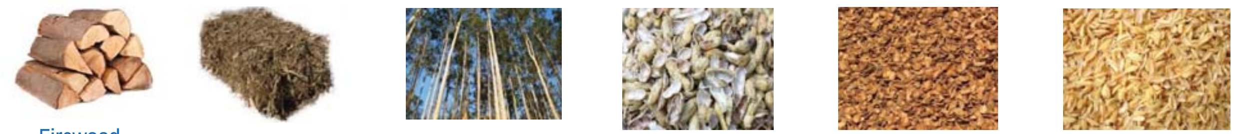
Ankur Scientific Energy Technologies Pvt. Ltd.

What is Gasification?

Gasification is conversion of various biomasses / wastes to a combustible gas called Producer Gas.

This gas can then be burnt in Engine Gensets to produce electricity or can be used for process heat applications or converted to fuels & chemicals.

Designed different Systems to use various feedstocks



Firewood | Sugarcane Bagasse | Eucalyptus | Ground Nut Shell | Almond Shell | Rice Husk

Woodchips | Corn Cob | Grape Pruning | Cashew nut Shell/Cake | Macadamia Shell | Coffee Husk

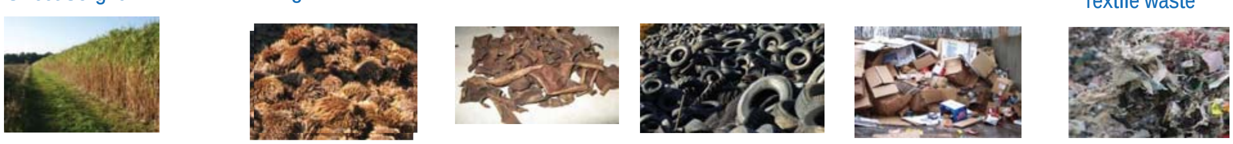
Ply Wood | Prosopis Juliflora | Cotton Stalks | Palm Kernel Shell | Brazil nut Shell | Mustard Husk

Cassis Stem | Bamboo | Cocoa Shell | Coconut Shell | Castor Stalks | Sunflower Husk

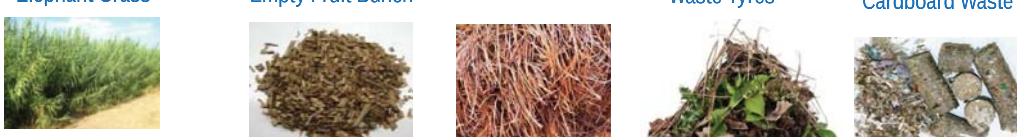
Rubber Wood | Lantana | Areca nut Shell | Peach Pits | Straws | Soybean Husk

Designed different Systems to use various feedstocks

Sweet Sorghum | Mango Seed | Grape Marc | Olive Pomace | Dry Organic Waste | Textile waste

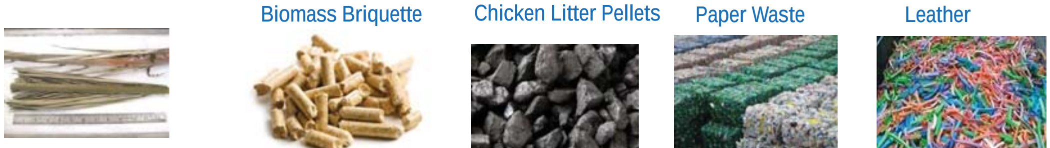


Elephant Grass | Empty Fruit Bunch | Cassava Peel | Waste Tyres | Cardboard Waste | RDF



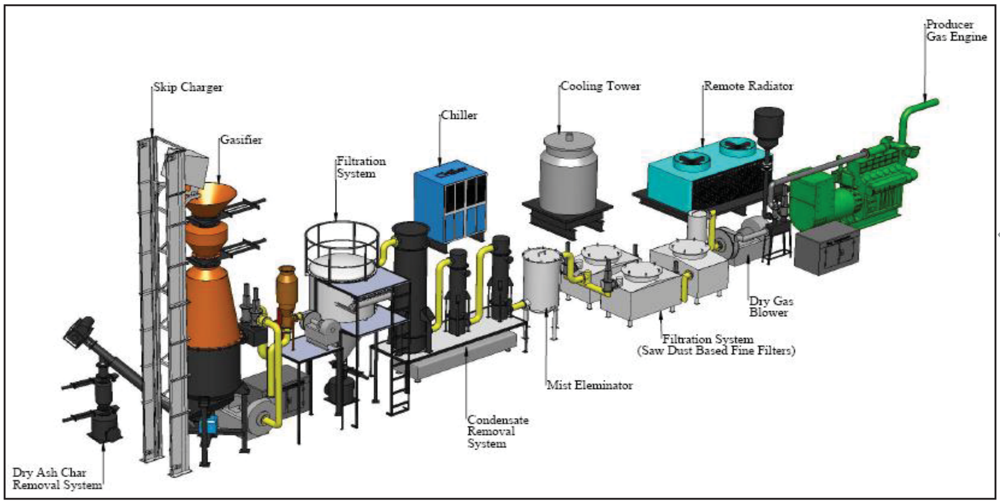
Arundo Donax | Miscanthus | Pine Needles | Dry Garden Waste | MSW / Briquettes

Palm fronds / trunks | Biomass Briquette | Chicken Litter Pellets | Paper Waste | Leather



Dry Palm Leaves | Biomass Pellets | Indonesian Coal | Plastic Waste | Rubber Waste

Indicative Schematic – Power / Biofuel Generation

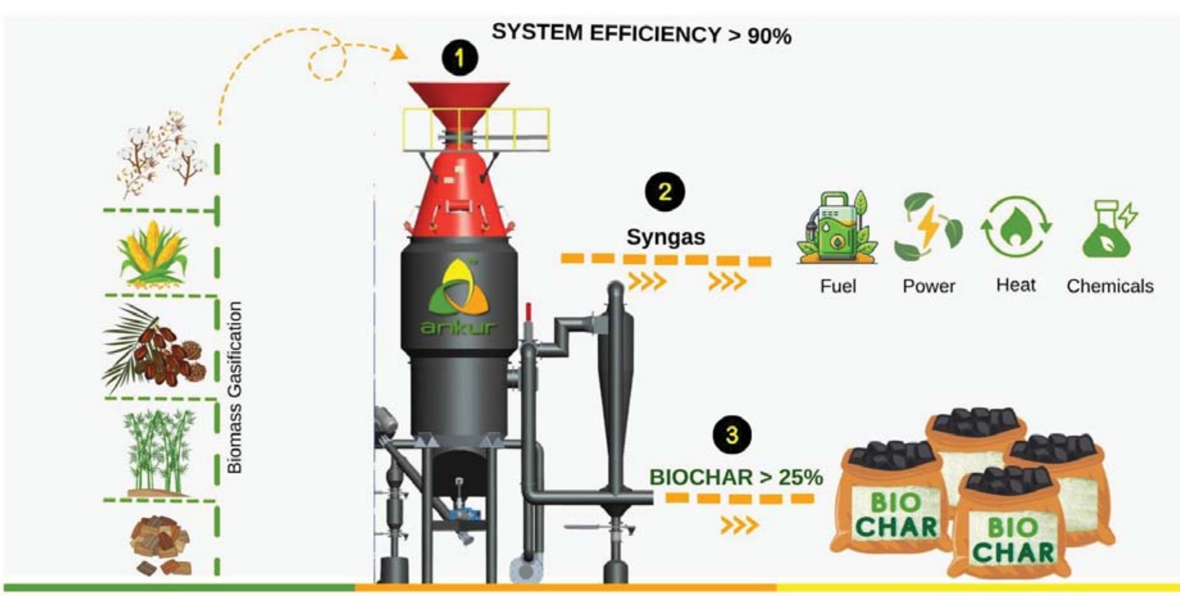


Ultra Clean Gas Mode

Indicative Schematic – Thermal Application

Hot Gas Mode

Convert feedstocks to useful energy



PYRO GASIFICATION: AN ANKUR INNOVATION

LINK TO GOOGLE DOC WITH PROPERTIES OF ANKUR BIOCHAR

Role of Biochar from Gasification Technology in Carbon Sequestration

GHG

- Biochar helps reducing concentration of GHG required to slow down global warming & climate change
- Highly stable against microbial decomposition and hence reduces GHG emissions

Soil Enhancement

- For greenhouse mitigation, application of biochar into the soil is gaining popularity due to several advantages
- Increase in crop yield, nutrient and water use efficiency and several environmental benefits

Fixed Carbon + Yield

- Biochar generated from Gasifiers contains around 75 to 85% of fixed carbon that can be returned to the soil
- The yield could vary from 6% to 25% of feed by weight, depending on the type of biomass and design of Gasifier

Source thru materials available on internet

Waste Processing

Ankur Scientific Energy Technologies Pvt. Ltd.

Waste Processing – the Future?

- Journey started 7 years ago.
- From gasification side we focused on the following feeds:
    - Chicken litter – commercial systems in the field now.
    - EFB – small systems installed, larger ones in pipeline.
    - MSW – few commercial systems in the field now.
    - Waste tyres - small systems installed, larger ones in pipeline.
- Sludge treatment – through the Bill and Melinda Gates Foundation
- The technology is deployed for the first pilot in Vadodara, completely built by us, including the technology being indigenised by us.
- The second project done in Bangladesh and many more being discussed.

ankur

The MSW Technology

Ankur Scientific Energy Technologies Pvt. Ltd.

Existing Technologies are Not Meeting the Needs

ankur

INCINERATION

- Applicable only at larger ratings – 300 Tones / Day and above.
- Not applicable for smaller towns.
- For larger towns waste needs to be brought to 1 location – expensive and dirty.
- Emissions usually an issue.

BIOGAS / COMPOSTING

- Need much more pre processing and segregation.
- Handles only wet waste.
- Slurry has fertilizer value but not always easy to sell/ dispose.
- Substantial fractions of MSW still need landfilling.

Ankur's Solution Works Everywhere, Handles All MSW Related Problems

Ankur's MSW to Energy Solution

Distributed Solution

Relevant for villages, towns and cities of all sizes.
Single Systems to handle
5 to 100 Tons / Day.

Lowest Emissions

No harmful solid emissions.
No liquid emissions – **No Leachate.** Gaseous emissions well within limits.

Volume Reduction

Complete conversion of MSW to energy or usable products. **No Landfilling**.

Financially Viable

Ankur's Plant Capex and Opex ensure **fastest recovery of capital**.

Online

MSW is handled online with minimal pre-processing.

Ankur's Versatile Solution Handles Most MSW Fractions

Syngas to Fuels/ Chemicals

Ankur Scientific Energy Technologies Pvt. Ltd.

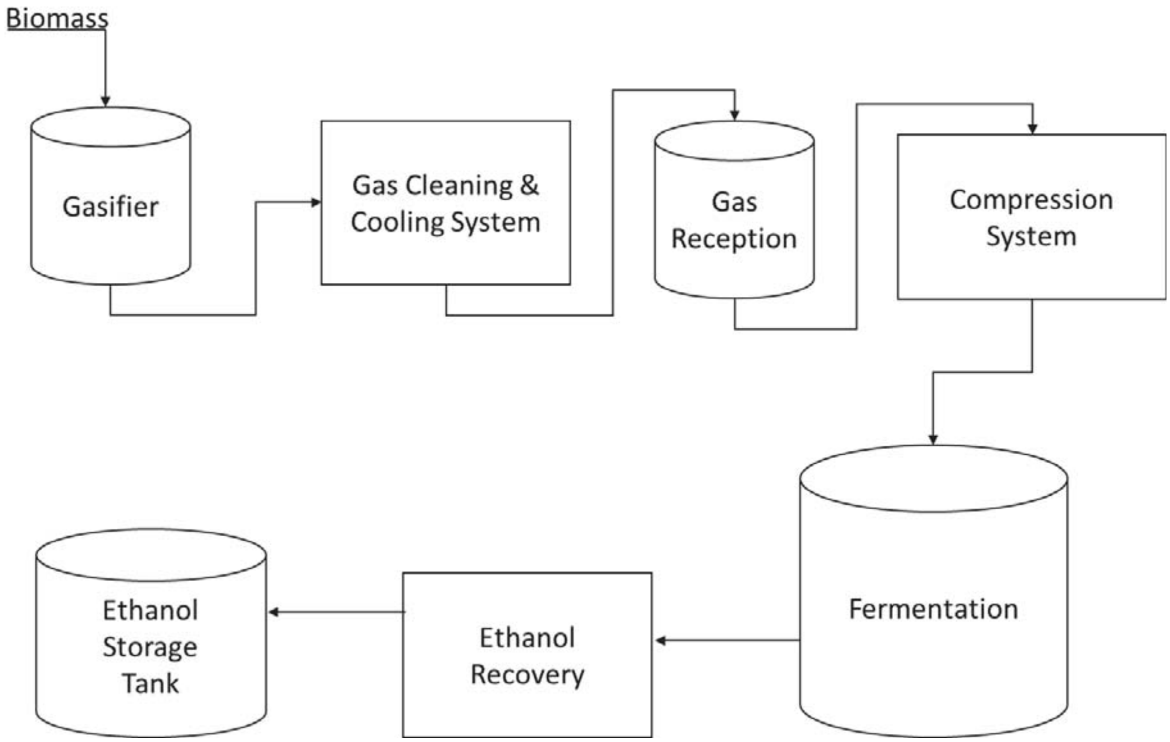
Syngas to Fuels

- After creating a niche in Syngas to Power/ Heat, we are now working on converting Syngas for Fuels/ Chemicals.
- The above allows us to move from a regulated to a more private market.

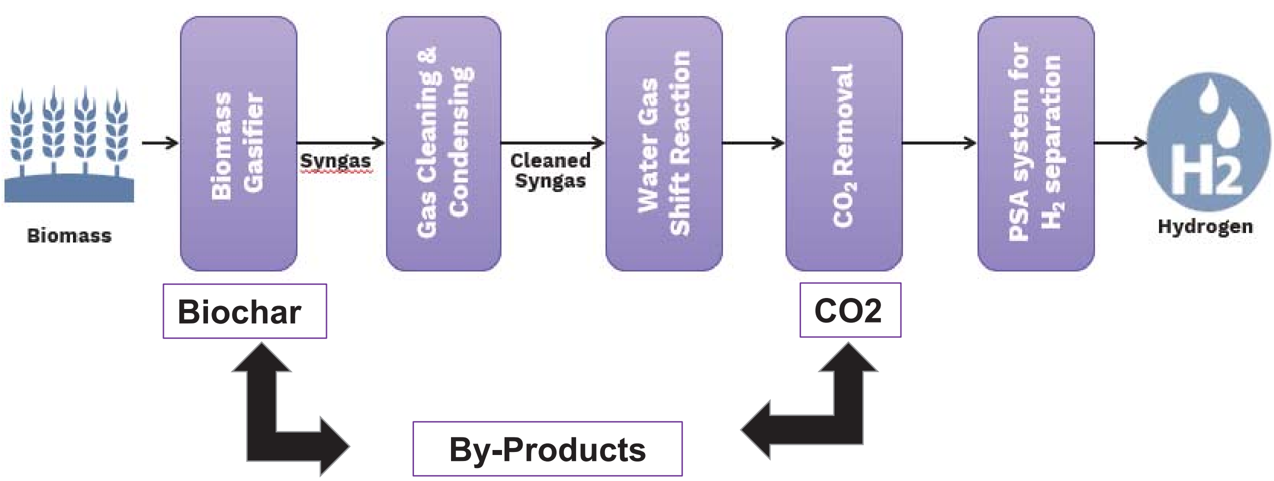
- Areas identified:
  - Syngas to Ethanol.
  - Syngas to H2.
  - Syngas to Methane.
  - Syngas to Methanol etc.

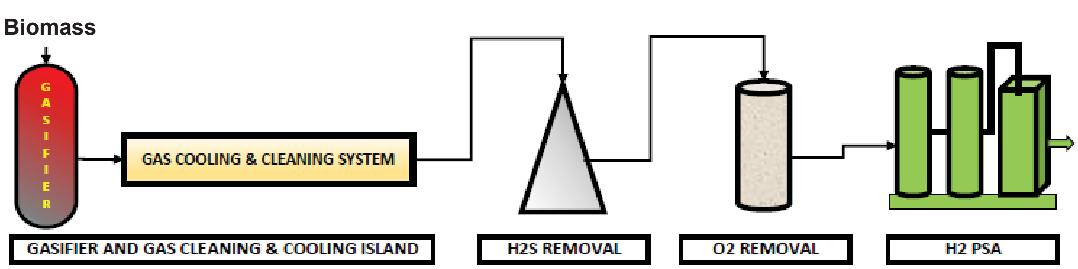
More details can be provided on request.

Syngas to Ethanol – Indicative Process Schematic



Technology – H2 Generation by Biomass Gasification





H2 Pilot Plant – Some Photos

Thank You

Ankur Scientific Energy Technologies Pvt. Ltd.
www.ankurscientific.com
info@ankurscientific.com
Phone No. +91-265-279-3098
Ankur, Near Navrachana School, Sama
Vadodara, Gujarat 390024, INDIA

ATMOS POWER PVT. LTD.

Committed to the Environment

About Us

Atmos Power is a leader in adsorption technology with expertise in making Gas Dehydration, Separation and Upgradation systems for Biogas, Syngas, Landfill Gas, Producer Gas, Natural Gas, Oxygen, Nitrogen, Hydrogen, Methanol, and any other organic solvents. Along with expertise in Biogas Upgradation, AtmosPower also provides Turnkey Solutions for setting up Compressed Biogas Plants Across India.

Areass of Expertise

- Biogas
- Landfill Gas
- Natural Gas
- Hydrogen
- Syngas/ Producer Gas

- Dehydratation
- Separation
- Upgradation

Organization

- Five Manufacturing Facilities
- 120+ Biogas Upgradation Plants
- 200+ Medical O2 Installations
- India's First Landfill Gas Upgradation Plant

Technology (VPSA)

- Highest Methane Recovery
- Lowest Opex
- Remote Monitoring AtmosPower's Strengths
- Turnkey EPC Solutions

Turnkey Solutions
Designing, Manufacturing, Installation & O&M

120+
Biogas Upgradation Plants

300+
Systems Installed

mkt@atmospower.net | +91-9099903701 | www.atmospower.in | C/1, 39/3B & 39/8B, Nana Chiloda Road, Phase 3, GIDC Naroda, Ahmedabad, Gujarat 382330

WHO WE ARE?

Teras New and Renewable Energies is driving **innovation in the renewable energy sector**. We're passionate about building a sustainable future and offering a full range of services, from expert Asset Management to comprehensive EPC solutions.

We manage **premium renewable energy assets** and deliver world-class clean energy projects that contribute to a cleaner, greener world.

Completed & Under Construction Projects	150+ MW
Years of Experience	8
Assets Managed	20+ MW
Employees	50+

TERAS NEW AND RENEWABLE ENERGIES LLP

- **B/203, Yashwant Bhuvan, Near Prabhu Ashish, Ram Mandir, Vile Parle (E), Mumbai 400057**
- **406, Chaitanya CHSL, Opp: Ram Mandir Road, Siddhart Nagar, Goregaon (W), Mumbai, 400104**

trans BIO-FILTER™
WASTE WATER TREATMENT TECHNOLOGY

TRANSCHEM AGRITECH Pvt. Ltd.

MAKE IN INDIA

transBio-Filter

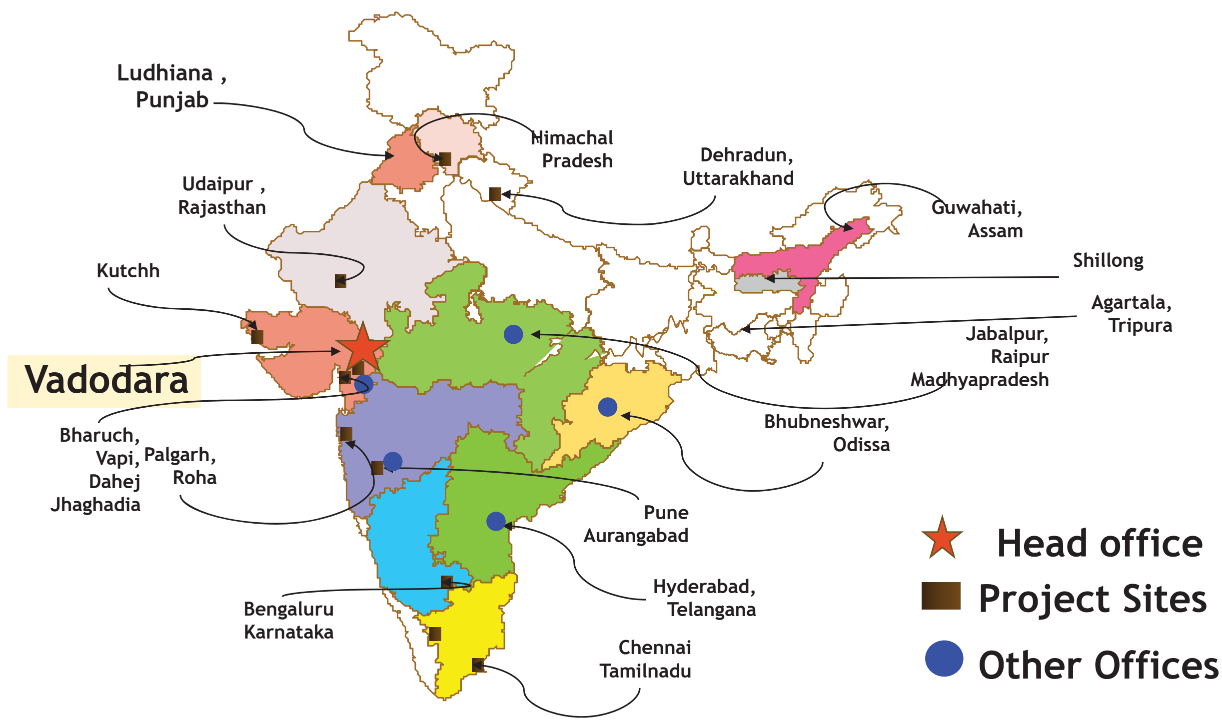
A Decentralized, Green, Patented Waste Water Treatment Technology developed in India.




Green Technology
to sustain Environment

Presence in 15 States & 250+ Plant installation across India

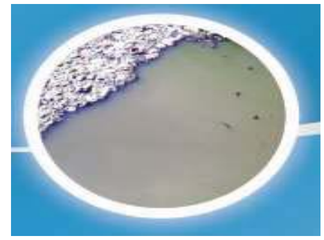
TRANSCHEM AGRITECH Pvt. Ltd.



Tatva Global Environment Ltd

About transBio-Filter

1. The concept is *"Design with Nature"* how to work cooperatively with nature, while at the same time learning the tools of modern science.



2. ***Bio-filter Technology*** is a synthesis process, which harnesses the energy, carbon and other elements of the waste and converts them to precious ***"Bio-nutritional"*** products like energy rich humus & bio-fertilizer and nutrient rich water.

3. The process utilizes the ability of the earthworms and beneficial microbes ***(transzyme)*** to break down organic waste present in the wastewater and transform it into worm-cast.

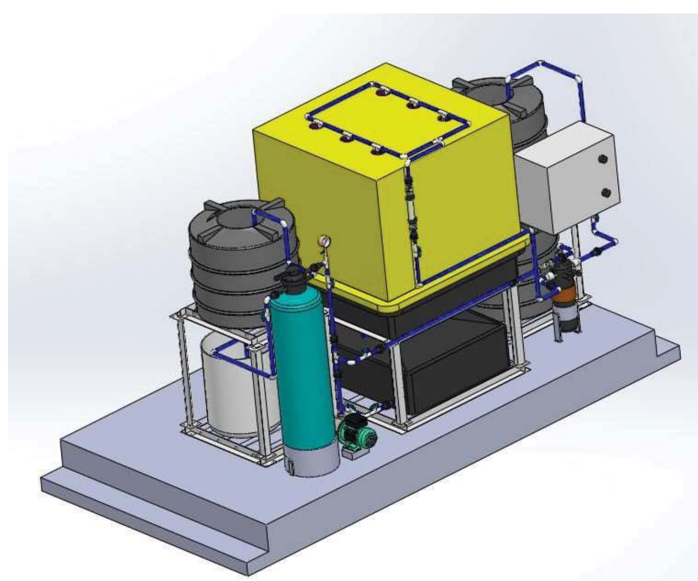
4. It involves removal of organic matter by adsorption and filtration followed by biological degradation and oxygen supply by natural aeration to the treatment system.

Patent No. 393264

Comparison Conventional Vs. transBiofilter

Conventional STP/ETP
(Activated Sludge Process)

Bio-filtration Technology



Comparison of Conventional Vs Decentralized STP's

TRANSCHEM AGRITECH Pvt. Ltd.

Details	Conventional Technologies (ASP, MBBR, SBR, MBR etc.)	Decentralized Natural WasteWater Treatment Technologies			
		Soil Biotechnology (SBT)	**Phytorid / CW**	**Dewats**	**trans-Biofilter**
Treatment Method	Primary Settling, aerobic oxidation, secondary sludge settling	Settling of solids, filtration, and biochemical process	Settling followed by plan root zone treatment in specially engineered baffled treatment cells which provides both aerobic and anaerobic treatment	Sedimentation, anaerobic treatment, plant root zone treatment, and oxidation process	Adsorption, Biological degradation & Filtration. **Note: No settling required**
Sludge Removal	Sludge treatment required	Disposal of solids once or twice in a year	Disposal of solids once or twice in a year	Disposal of solids once or twice in a year	No sludge disposal required as all solids gets converted into compost
Oxygen Requirement	Mechanical aeration required on continuous basis	Use of atmospheric oxygen	Use of atmospheric oxygen	Combination of anaerobic process & Use of atmospheric oxygen	Use of atmospheric oxygen

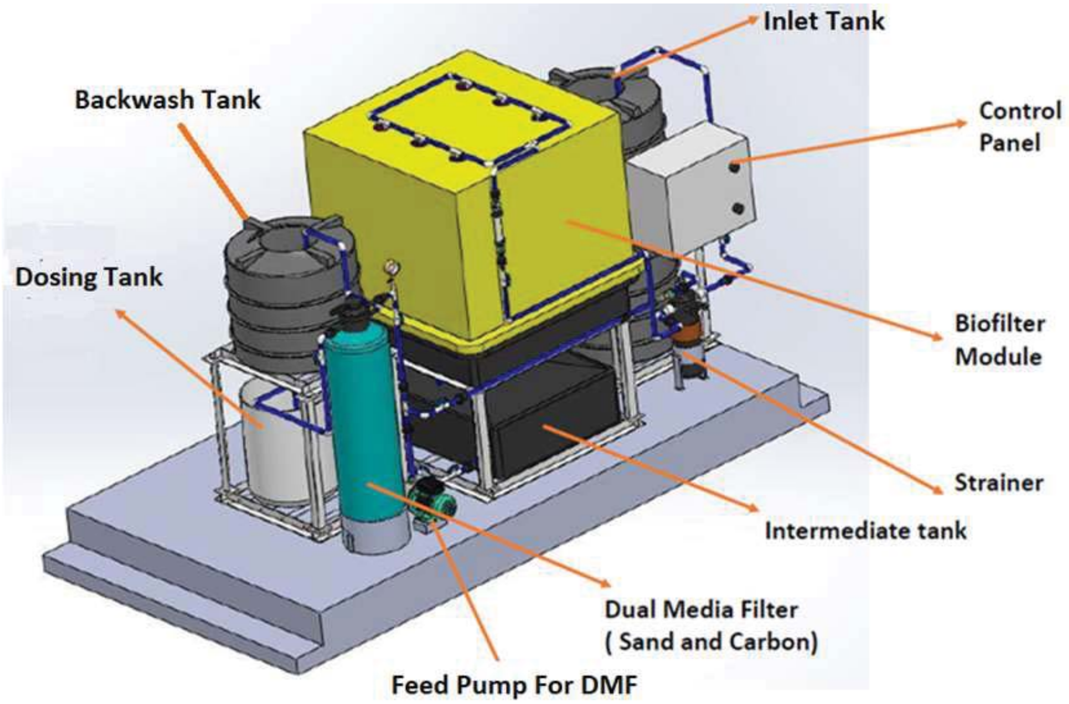
Comparison of Conventional Vs Decentralized STP's

TRANSCHEM AGRITECH Pvt. Ltd.

Details	Conventional Technologies (ASP, MBBR, SBR, MBR etc.)	Decentralized Natural WasteWater Treatment Technologies			
		Soil Biotechnology (SBT)	**Phytorid / CW**	**Dewats**	**trans-Biofilter**
Power Consumption	High to Very High	Low	Low	Low	Low
Land Footprint	Moderate to High	High	High	High	Low
Life Cycle Cost	Very Expensive	Low	Low	Low	Low
GHG Emissions (100 KLD Plant)					
a. CH4 (tCO2/Yr.)	0.7				0.5
b. N20 (tCO2/Yr.)	24.0				17.0
c. Power (tCO2/Yr.)	4.5				0.88
Total	**29.2**				**18.38**

transBiofilter addresses around 5 to 6 Sustainable Development Goals (SDG's) with respect to reduction in waste generation, recycling, reuse, cleaner & greener technologies etc.

Compact Modular Plant



TransBiofilter Plant Designs


Modular / packaged plants

Civil based plants


Lagoon based plants

Key Features of transBio-filter Technology

1.Able to meet pollution control board norms

2. Completely Green Technology – use of no chemicals

3. Use of all material from natural origin which can be locally available

4. Requires very low power and maintenance – no skilled manpower required for operations

5. Able to treat all solids in the same system – therefore no sludge generation

6. Resource generation in form of "Bio-nutritional products (in case of sewage treatment) like:

- **Nutrient rich water**
- **Vermi-compost &**
- **Earthworm biomass**

7. Can be implemented at de-centralized level with economy of scale

Decentralized Treatment Systems

Decentralized wastewater Treatment can be smart alternative for considering new systems or modifying, replacing, or expanding existing waste water systems.

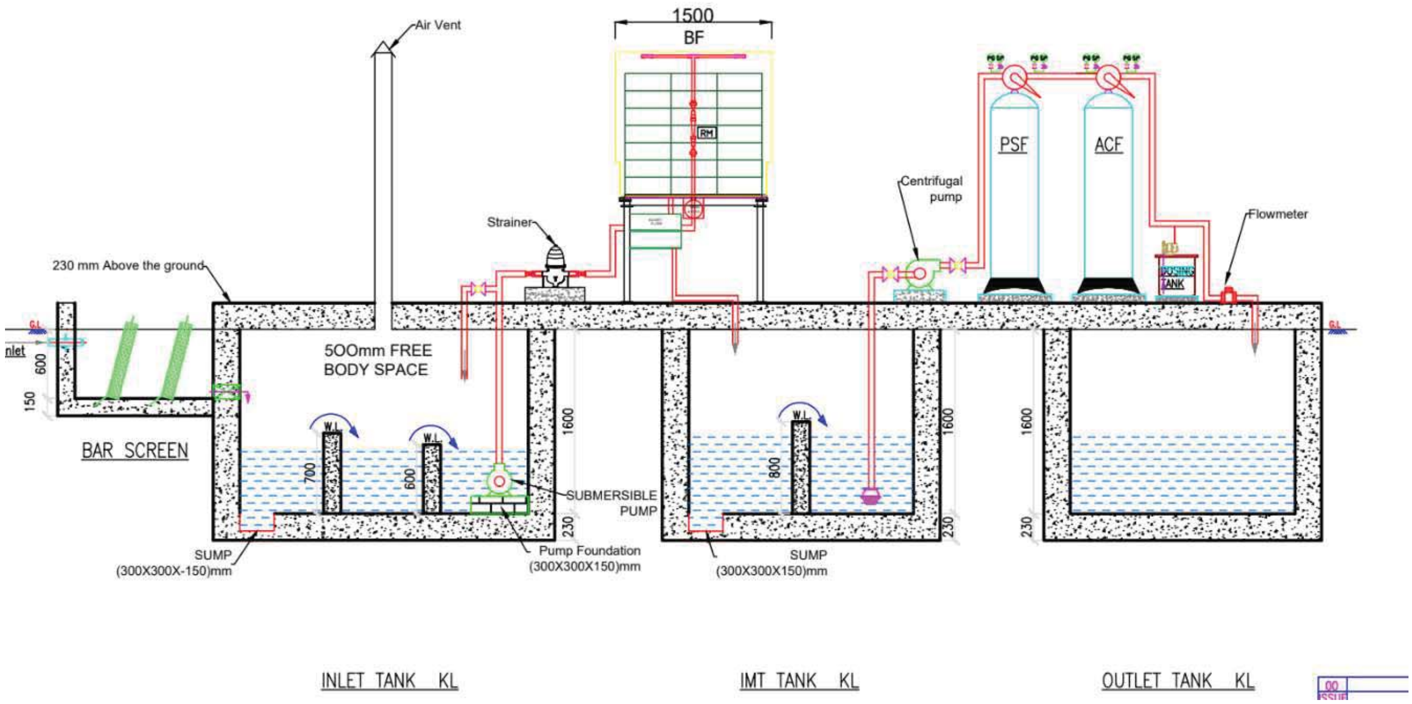
(70-85% of government spending in water goes in transportation of water)

Advantages of Decentralized STP:

1. ***Can be stand alone arrangements for many parts/wards of the city / towns and particularly in high terrain areas.***
2. Easy to handle, operate and maintain
3. Better public participation and acceptance
4. Cost saving in sewage collection piping and in transportation as well as treated water transportations. ***(Treated water can be reused locally for plantations / agriculture / gardening / washing and for flushing)***
5. Better adoption to local contexts and needs
6. Cost- effective and efficient
7. Need smaller areas for treatment (lower foot-print)

TRANSCHEM AGRITECH Pvt. Ltd.

Process Flow Diagram trans Bio-Filter STP



TRANSCHEM AGRITECH Pvt. Ltd.

trans BIO-FILTER™

WASTE WATER TREATMENT TECHNOLOGY

Proof of concept – TransBiofilter installations

Till now more than 250 + installations has been done PAN India, some of the Key success stories are as follows:

Sr.No.	Biofilter Plant Installed	Capacity (KLD)	Year
1.	Excel CropCare Ltd., Bhavnagar - STP	1000	2011
2.	Jubilant Life Sciences, Nira, Maharashtra - STP	600	2019
3.	Delhi Jal Board, Keshvopur - STP	80	2015
4.	Transpek Industry Ltd. Vadodara - ETP	180	2014
5.	Srinivas Dairy, Hyderabad -ETP	35	2018
6.	TML Inudstries, Vadodara - ETP	100	2018
7.	Sumitomo, Gajod - STP	150	2019
8.	Dye Industry, Kutch - ETP	50	2016
9.	Axel Polymer, Moxi -ETP	180	2022
10.	Indofil Ltd and Indo reagens , Dahej STP	15 KLD and 40 KLD	2020-21
11.	Halol NagarPalika	10 KLD 2 Nos.	2024

5KLD & 10 KLD STP (Modular)

Area (mtr.)	Area (m2)	KW
5 x 3.5	17.50	0.80

Area (mtr.)	Area (m2)	KW
5.5 x 3.5	20	1.20

10KLD STP – Halol Nagar Pallika
Plant installed in Garden treating waste water from Toilet Block for reuse in Garden

20KLD Modular STP

Area (mtr.)	Area (m2)	KW
7 x 3.5	24.5	1.80

30/ 40KLD STP Singroli Municipal Corporation , M.P

Area (mtr.)	Area (m2)	KW
6.6 x 4.6	30.36	1.40

50 & 80KLD STP

Area (mtr.)	Area (m2)	KW
9 x 7	63	2.80

600 KLD JUBILANT LIFE SCIENCE LIMITED, NIRA

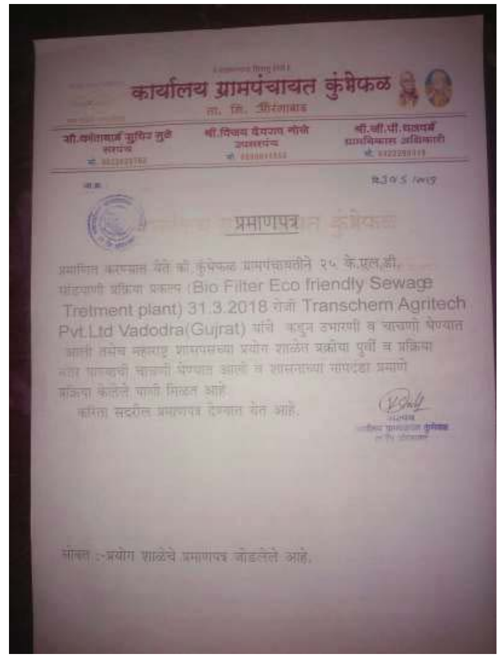
Treatment of sewage from flowing nala




1000KLD STP Sumitomo Chemicals , Bhavnagar


Area (mtr.)	Area (m2)	KW
28 x 22	616	15

Model projects executed in village Kumbephal, Government of Maharastra transBiofilter STP - 25 KLD installed in 2018



कार्यालय ग्रामपंचायत कुंभेफळ

ता. जि. औरंगाबाद

प्रमाणपत्र

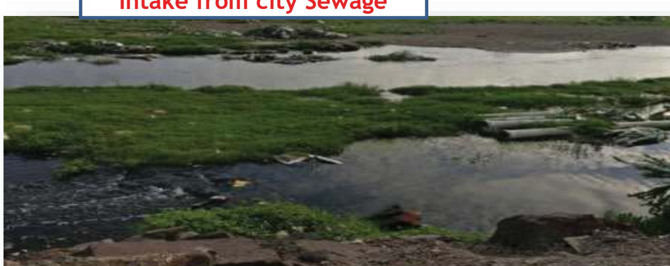
प्रमाणित करण्यात येते की कुंभेफळ ग्रामपंचायतीने २५ के.एल.डी. सांडपाणी प्रक्रिया प्रकल्प (Bio Filter Eco friendly Sewage Tretment plant) 31.3.2018 रोजी Transchem Agritech Pvt.Ltd Vadodra(Gujrat) यांचे कडून उभारणी व चाचणी घेण्यात आली तसेच महाराष्ट्र शासनाच्या प्रयोग शाळेत प्रक्रिया पूर्वी व प्रक्रिया नंतर पाण्याची चाचणी घेण्यात आली व शासनाच्या मापदंडा प्रमाणे प्रक्रिया केलेले पाणी मिळत आहे.

करिता सदरील प्रमाणपत्र देण्यात येत आहे.

सोबत :-प्रयोग शाळेचे प्रमाणपत्र जोडलेले आहे.

transBio-Filter - 100 M3/Day at Krishi Vigyan Kendra, Jalna
(City sewage treated and recycled for Agriculture)

Intake from city Sewage



transBio-Filter Plant

Treated water used for Fodder fields

Plant Running on Solar Panels

TRANSCHEM AGRITECH Pvt. Ltd.

Phone:02482 – 235586, 238266
Fax : 02482 – 237326

KRISHI VIGYAN KENDRA

Marathwada Sheti Sahayya Mandal
Post Box No.45, Kharpudi, Jalna-431 203 (MS)
e-mail:pckvkjalna@gmail.com

No.KVK/Bio-filter/18 /2017 Date:27.01.2017

Performance of Trans-Biofilter Plant

This is to certify that M/s.Transchem Agritech Pvt. Ltd; Baroda installed transBio Filter plant located at Jalna, Maharashtra for treating our domestic sewage waste water.

The plant was installed during June'16 of 100 KLD.

It has been observed that the plant is working efficiently and all the solids are nicely decomposed without formation of sludge. Also the power consumption is very minimum.

We feel that it is an innovative technology for treatment of domestic waste water in a better manner.

The plant is in operation since Eight months.

Place : Jalna
Date :27.01.2017

(S.V.Sonune)
Senior Scientist & Head

Government of Maharashtra
Water Resources Department
Hydrology Project (S.W.)

WATER QUALITY LABORATORY (LEVEL-II), AURANGABAD

Add- Near Hedgewar Hospital, Gajanan Temple to Trimurti chowk Road, Aurangabad.
:- (0240) 2355410, 2321428. Email.:- wqlabad@gmail.com, sdehpsd.aurangabad@mahahp.org Web:- www.mahahp.org

NO/HP/SD/ABD/WQLAB L-II/ 364 Date:- 15.05.18

To,
Rekha Tiwari,
Aurangabad.

WATER QUALITY LAB LEVEL-II ★ Aurangabad ★

Subject:- Analysis Report
Ref:- Your Letter Dated:- 05.05.2018

Sir/Madam,
Please find Sample Analysis Report for the sample submitted alongwith desired parameters

Water Analysis Report

1. Nature of Sample: Sewage Untreated Water (Grampanchyat, Kumbephal, A'bad)
2. Date of Sampling: 05.05.~~17~~ 18
3. Date of receipt of Sample: 05.05.18
4. Sample Collected By: Rekha Tiwari

Sr. No.	Parameters	Results	Units	Method Reference
	Physico-Chemical Analysis			
1	Colour	120	Hazen	APHA, 21st Ed., 2005, 2120-B, 2-2
2	Odour	Unpleasent	--	IS 3025 (Part 5): 1983, Reaffirmed 2006
3	Total Dissolved Solids	1886	mg/L	APHA, 21st Ed., 2005, 2540 C, 2-57
4	pH	7.1	--	APHA, 21st Ed., 2005, 4500-H+- B, 4-90
5	Turbidity	84	NTU	APHA, 21st Ed., 2005, 2130-B, 2-9
6	Dissolved Oxygen	1.8	mg/L	APHA, 21st Ed., 2005, 4500-O, 4138
7	Electrical Conductivity	2910	µmhos/cm	APHA, 21st Ed., 2005, 2510-B, 2-47
8	BOD	120	mg/L	IS 3025 (Part 44): 1983, Reaffirmed 2003, Amds.1
9	COD	468	mg/L	APHA, 21st Ed., 2005, 5220-B, 5-15

Yours faithfully,

V.P. Pawar
Chief Chemist

for Assistant Engineer Grade-I
Hydrology Project Sub-Division Aurangabad

Note:
1.This report is not to be reproduced except in full, without written approval of the laboratory.
2. The official /Department will not be responsible for these report beyond the control of this labarotory.
3. The test result are subjected to the test sample submitted for testing to this labarotory.

transBio-Filter at Keshopur,Delhi Jal Board

''Toilet to Tap'' 80 KLD

TRANSCHEM AGRITECH Pvt. Ltd.

Delhi's first 'toilet-to-tap' plant finds takers among AAP MLAs

- HT Correspondent, Hindustan Times, New Delhi
- Updated: Jul 10, 2015 02:01 IST

Delhi chief minister Arvind Kejriwal drinking water from the first 'toilet to tap' sewage treatment plant in Delhi. (Photo by Sushil Kumar/ HT Photo)

News Paper Clippings

Chief minister Arvind Kejriwal's visit to the toilet-to-tap sewage treatment plant in Keshopur on Wednesday encouraged MLAs to envision similar projects in their constituencies.

Kejriwal on Thursday inaugurated the plant, which treats raw sewage by a multple filtration process to convert it into potable water.

"Neighbouring states will stop giving us water in the coming few years as they need to meet the requirement of their citizens. Waste water reuse and management becomes very important in such a case. Only about 50% of the city has sewer connections. If we plan to expand the network with the current plans, we will need years and around Rs 30,000 crore. The solution is to starts smaller plants like this one. These can be built using development charges," he said.

Dwarka MLA Adarsh Shastri, Shalimar Bagh MLA Bandana Kumari and Tilak Nagar Jarnail Singh were present at the inauguration and expressed interest in starting similar projects in their constituencies.

The plant set up at Keshopur cost Rs 55 lakh and filters around 5,000 litres of sewage every hour to give an output of 4000 litres per hour.

"If this project is up-scaled in a decentralised manner, every home will get sewer and water connections in the next three to four years," Kejriwal said.

The Delhi Jal Board is now planning to use this water in the Delhi secretariat.

"The chief minister drinking this water has sent out a strong message. We will start offering this treated water to people at the secretariat. An awareness campaign will be started to educate people," said Kapil Mishra, water minister.

Calling the pilot project a jump in terms of the way a city thinks about water, DJB CEO SS Yadav said that feasibility of setting up more such projects was being explored.

20 KLD STP plant at Vidya Niketan School , Bangalore

TRANSCHEM AGRITECH Pvt. Ltd.

500 KLD STP plant, Gurunanak Dev Engineering College, Ludhiana

500 KLD STP plant, Gurunanak Dev Engineering College, Ludhiana

TRANSCHEM AGRITECH Pvt. Ltd.

CHANDIGARH POLLUTION TESTING LABORATORY
(Environmental Monitoring, EIA, NOC, ETP, STP)
Website : www.cptl.co.in
H.O. : #372, Sec. 15-A, Chandigarh-160 015 ☎ : 0172-4669295
Lab : E-126, Phase-VII, Indl. Area, Mohali - 160055 ☎ : 0172-5090312; e-mail : sital_cptlmohali@yahoo.co.in, cptle126@gmail.com, lab@cptl.co.in

ISO 14001:2004 EQUALITAS REGISTERED JAS-ANZ M44102108

TEST CERTIFICATE

NAME OF INDUSTRY: M/s. GURU NANAK DEV ENGINEERING COLLEGE STP
C/O ABSOLUTE WATER PVT.LTD,
NEW DELHI.

SAMPLE PARTICULARS

Date of Sample Collection	22.03.2017
Sample Received in Lab	22.03.2017
Type of Sample	Grab
Environmental conditions	Normal
Point of Sample Collection	Outlet of gravity filter
Quantity & Packaging	2 liters in plastic bottle + 250 ml in sterilized glass bottle.
Sample Identification No.	CPTL/2017/03/36(W)
Analysis Duration	22.03.2017 to 27.03.2017
Date of Reporting	27.03.2017
Sample Collected By	Geeta Kumari
Visual Observation	Liquid with settleable matter.

TEST RESULTS

S. No.	Parameters	Results	Test Method
1.	pH	7.55	APHA- 4500 H^+ B, 22nd Edition-2012
2.	Total Suspended Solids, mg/l	30.0	APHA-2540 D, 22nd Edition-2012
3.	Total Dissolved Solids, mg/l	667	APHA-2540 C, 22nd Edition -2012
4.	Phosphate (as P) ,mg/l	1.8	APHA-4500 P-D, 22nd Edition-2012
5.	Total Kjeldahl Nitrogen,mg/l	3.10	APHA-2540 D, 22nd Edition-2012
6.	Chemical Oxygen Demand, mg/l	47.6	APHA-5220 B, 22nd Edition -2012
7.	BOD (at 27°C for 3 Days), mg/l	15.4	IS:3025(Part-44), 1993
8.	Oil & Grease, mg/l	1.9	APHA5520 B, 22nd Edition -2012
9.	Feacal Coliform,MPN/100 ml	715	IS : 1622-1981 ,MPN Method

(Chemist In-Charge)
Date: 27/03/2017

(Authorized Sign)
Date: 27/03/2017
Sital Singh
CEO
Chandigarh Pollution Testing Lab

- The results are related to test items only.
- This certificate is not to be reproduced wholly or in part and cannot be used as evidence in the court of law.
- Sample will be destroyed after retention time unless otherwise specified.

CHANDIGARH POLLUTION TESTING LABORATORY
(Environmental Monitoring, EIA, NOC, ETP, STP)
Website : www.cptl.co.in
H.O. : #372, Sec. 15-A, Chandigarh-160 015 ☎ : 0172-4669295
Lab : E-126, Phase-VII, Indl. Area, Mohali - 160055 ☎ : 0172-5090312; e-mail : sital_cptlmohali@yahoo.co.in, cptle126@gmail.com, lab@cptl.co.in

ISO 14001:2004 EQUALITAS REGISTERED JAS-ANZ M44102108

TEST CERTIFICATE

NAME OF INDUSTRY: M/s. GURU NANAK DEV ENGINEERING COLLEGE STP
C/O ABSOLUTE WATER PVT.LTD,
NEW DELHI.

SAMPLE PARTICULARS

Date of Sample Collection	22.03.2017
Sample Received in Lab	22.03.2017
Type of Sample	Treated sewage (Grab)
Environmental conditions	Normal
Point of Sample Collection	Outlet of STP
Quantity & Packaging	2.0 liters in plastic bottle + 250 ml in sterilized glass bottle.
Sample Identification No.	CPTL/2017/03/35(W)
Analysis Duration	22.03.2017 to 27.03.2017
Date of Reporting	27.03.2017
Sample Collected By	Geeta Kumari
Visual Observation	Treated sewage with very fine suspended particles.

TEST RESULTS

S. No.	Parameters	Results	Limits	Test Method
1.	pH	7.46	6.5-9.5	APHA-4500H^+ B, 22nd Edition
2.	Total Suspended Solids, mg/l	19.0	100	APHA-2540 D, 22nd Edition
3.	Total Dissolved Solids, mg/l	659	---	APHA-2540C, 22nd Edition
4.	Phosphate (as P) ,mg/l	1.2	5.0	APHA-4500 P-D, 22nd Edition-2012
5.	Total Kjeldahl Nitrogen,mg/l	2.52	---	APHA-2540 D, 22nd Edition-2012
6.	Chemical Oxygen Demand, mg/l	38.0	250	APHA-5220 B, 22nd Edition
7.	BOD (at 27°C for 3 Days), mg/l	9.2	100	IS:3025(Part-44), 1993
8.	Oil & Grease, mg/l	1.2	10	APHA5520 B, 22nd Edition
9.	Feacal Coliform,MPN/100 ml	431	---	IS : 1622-1981 ,MPN Method

(Chemist In-Charge)
Date: 27/03/2017

(Authorized Sign)
Date: 27/03/2017
Sital Singh
CEO
Chandigarh Pollution Testing Lab

- The results are related to test items only.
- This certificate is not to be reproduced wholly or in part and cannot be used as evidence in the court of law.
- Sample will be destroyed after retention time unless otherwise specified.

TransBiofilter installations Rural villages
Treating the waste water generated from village and reuse in agriculture

120 KLD STP at Village Chikhodara, Vadodara Gujarat. Under CSR Initiative of IOCL

Area (mtr.)	Area (m2)	KW
12.5 x 5.5	68.75	4

Model projects executed in village Chikhodara , Vadodara, Gujarat

TRANSCHEM AGRITECH Pvt. Ltd.

transBiofilter STP - 120 KLD installed in 2019

CSR FUNDING :

IndianOil

Indian Oil Corporation Limited (IOCL), Mathura

TRANSCHEM AGRITECH Pvt. Ltd.

इंडियन ऑयल कॉर्पोरेशन लिमिटेड
गुजरात रिफाइनरी, डाकघर : जवाहरनगर,
जिला - बड़ोदरा, गुजरात - 391 320

Indian Oil Corporation Limited
Gujarat Refinery, P.O. Jawaharnagar,
Dist. : Vadodara, Gujarat - 391 320

दूरभाष : +91-265-2237106 फैक्स : +91-265-2233326
ई-मेल : gujaratrefinery@indianoil.in वेबसाइट : www.iocl.com

रिफाइनरीज़ प्रभाग
Refineries Division

To Whomsoever It May Concern

It is to certify that the CSR project Viz." Supply , Erection and Commissioning of 100 KLD Waste Water Treatment Plant based on Transbio Filter Technology STP Plant at Chikhodara Village , Vadodara" was awarded on 20.09.2019 vide IOCL WO No. 26118010 which was initiated by Gujarat Government ,Distt. Authorities , Vadodara under deposit work for CSR Project and their request and recommendation vide letter of TDO, Vadodara No. TP/ Panchayat/908/2019 dated 04/09/2019 (copy enclosed) for issuing Work Order to the agency, is executed , as per following details:

Name of the Work	: Supply , Erection and Commissioning of 100 KLD Waste Water Treatment Plant based on Transbio Filter Technology STP Plant at Chikhodara Village , Vadodara
Type of Work	: CSR Activity and execution as per tripartite MOU between IOCL, M/s. Transchem and Gujarat Govt Authority
Work Order No.	: 26118010
Name of the Contractor	: 13230524-Transchem Agritech Private Limited
Original Contract Value	:
Date of Completion (CCD)	: 02/10/2019
Extension granted, if any	: 21/10/2019 (Ref : Letter No. 1177 dated 06/12/2019 of TDO, Vadodara)
Executed Value of the Contract:	(Excluding GST) –

The TDO, Vadodara , Gujarat Govt , Vadodara had confirmed about the Completion of the work and operation of the plant and certification of measurement and verification of payments / invoices / amount vide their letter 1177 dated 06/12/2019 of TDO, Vadodara (Copy enclosed). IOCL has carried out the work under CSR Activity and Maintenance / Operation is handled by Gujarat Govt Authority/ TDO/ Village Panchayat as a part of their responsibility as per MOU.

This certificate is issued to M/s. Transchem Agritech Private Limited , Vadodara as per their request .

16/03/2020
(Rajiv Sharma)
DGM (CC CSR)
IOCL – Guajarat Refinery ,
Vadodara

TALUKA PANCHAYAT VADODARA
SARDAR PATEL BHUVAN, GROUND FLOOR, RAJ MAHAL ROAD, VADODARA-390001.
PHONE NO : 0265-2417556 E-MAIL : tdo-vadodara@gujarat.gov.in

NO.T.P./PANCHAYAT/908/2019
Taluka Panchayat Vadodara
Sardar Patel Bhuvan, Ground Floor,
Date: 04/09/2019

To
Executive Director
Gujarat Refinery

Sub: Sewage water recycling project in Chikodhara village

This has reference to our letter dt.. 05/07/2019 and your letter no. JR/Admn/CSR/2019-20 dt. 11/07/2019. In this regard, we are to intimate you as under:

- As an initiative by the Office of Distt Collector, Vadodara, in line with initiative of the Central Govt. and the water recycling vision of Govt of Gujarat, it has been decided to carry out the job of recycling the waste water generated from villages and reusing the water for irrigation purpose. Towards this, we have given you a letter dt. 05/07/2019 and in reply have received your letter dt. 11/07/2019.
- After detailed discussion and presentation before Distt Collector, Vadodara, it has been decided to get the job done at Chikodhara village by M/s Tranchem Agri Pvt Ltd. for which they have the technical expertise.
- The target for completion and inauguration of the work of supply, erection and commissioning of waste water treatment plant for Chikhodara village has been kept as 02/10/2019 by the office of Distt Collector as water recycle & restoration initiative taken up to commemorate 150th Birth anniversary of Mahatma Gandhi, in line with his vision of a Swachh Bharat.
- Although it has been requested by you for us to carry out the job on depository work basis, it is reviewed at our end and we regret to inform that we are unable to accede to your request and carry out the job on depository work basis. So further work should be carried out by you as a part of tender process.

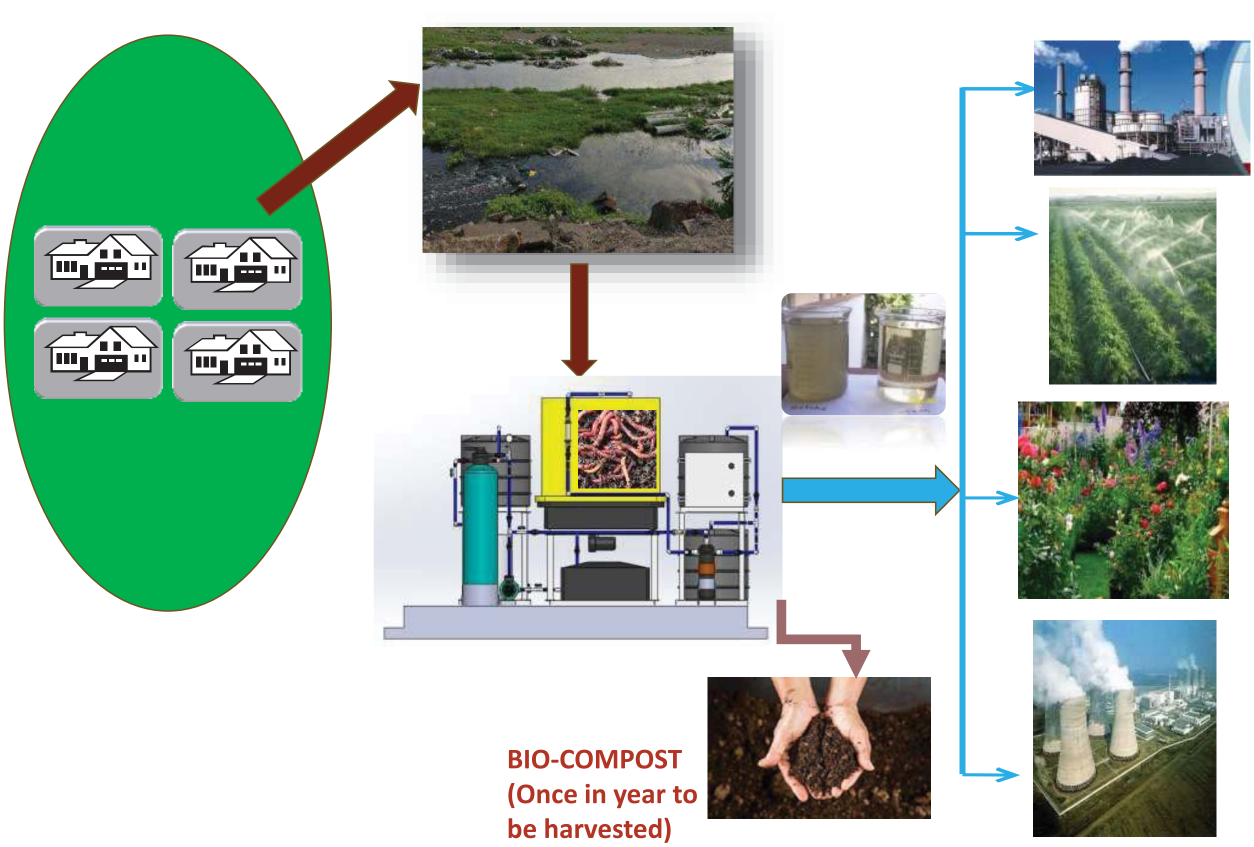
As such, it is requested that IOCL, Gujarat Refinery carry out this job through M/s Transchem Agri Pvt Ltd. according to the planned estimates. The payment may be released to the party based on certification by our office.

Yours faithfully

Taluka Development Officer
Vadodara

C.C.
1) Respected Collector, Kothi Char rasta,Vadodara
2) Respected District Development Officer, District Panchayat Vadodara

Expansion of 20KLD transBiofilter STP to 120 KLD at Khanderaopura, Gujarat



NET ZERO MODEL

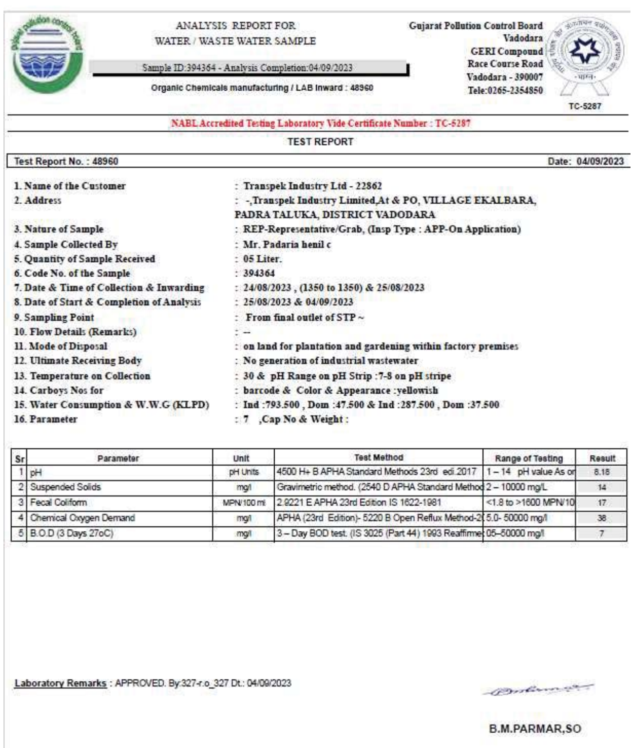
□□□□□□ STP at Trans□e□ Ind□stries □td□□adodara

TRANSCHEM AGRITECH Pvt. Ltd.

□rea (□ tr□)	□rea (□ □)	□□
□□□ □ □□□	174.25	12

□□□ □□□ STP ana□ysis re□orts

TRANSCHEM AGRITECH Pvt. Ltd.



ANALYSIS REPORT FOR
WATER / WASTE WATER SAMPLE

Sample ID:394364 - Analysis Completion:04/09/2023

Organic Chemicals manufacturing / LAB Inward : 48960

Gujarat Pollution Control Board
Vadodara
GERI Compound
Race Course Road
Vadodara - 390007
Tele:0265-2354850

TC-5287

NABL Accredited Testing Laboratory Vide Certificate Number : TC-5287

TEST REPORT

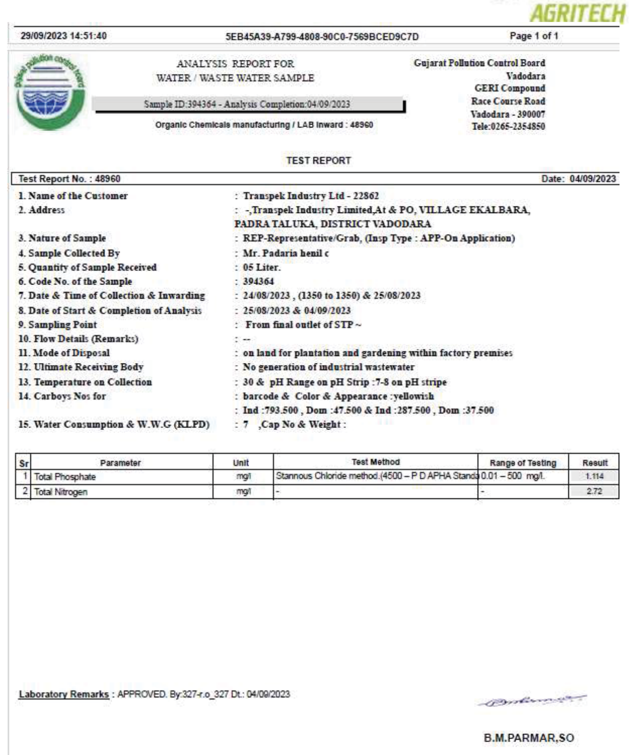
Test Report No. : 48960 Date: 04/09/2023

1. Name of the Customer : Transpek Industry Ltd - 22862
2. Address : -,Transpek Industry Limited,At & PO, VILLAGE EKALBARA, PADRA TALUKA, DISTRICT VADODARA
3. Nature of Sample : REP-Representative/Grab, (Insp Type : APP-On Application)
4. Sample Collected By : Mr. Padaria henil c
5. Quantity of Sample Received : 05 Liter.
6. Code No. of the Sample : 394364
7. Date & Time of Collection & Inwarding : 24/08/2023 , (1350 to 1350) & 25/08/2023
8. Date of Start & Completion of Analysis : 25/08/2023 & 04/09/2023
9. Sampling Point : From final outlet of STP ~
10. Flow Details (Remarks) : --
11. Mode of Disposal : on land for plantation and gardening within factory premises
12. Ultimate Receiving Body : No generation of industrial wastewater
13. Temperature on Collection : 30 & pH Range on pH Strip :7-8 on pH stripe
14. Carboys Nos for : barcode & Color & Appearance :yellowish
15. Water Consumption & W.W.G (KLPD) : Ind :793.500 , Dom :47.500 & Ind :287.500 , Dom :37.500
16. Parameter : 7 ,Cap No & Weight :

Sr	Parameter	Unit	Test Method	Range of Testing	Result
1	pH	pH Units	4500 H+ B APHA Standard Methods 23rd edi.2017	1 – 14 pH value As or	8.18
2	Suspended Solids	mg/l	Gravimetric method. (2540 D APHA Standard Method	2 – 10000 mg/L	14
3	Fecal Coliform	MPN/100 ml	2.9221 E APHA 23rd Edition IS 1622-1981	<1.8 to >1600 MPN/10	17
4	Chemical Oxygen Demand	mg/l	APHA (23rd Edition)- 5220 B Open Reflux Method-2(	5.0- 50000 mg/l	38
5	B.O.D (3 Days 27oC)	mg/l	3 – Day BOD test. (IS 3025 (Part 44) 1993 Reaffirme	05–50000 mg/l	7

Laboratory Remarks : APPROVED. By:327-r.o_327 Dt.: 04/09/2023

B.M.PARMAR,SO



29/09/2023 14:51:40 5EB45A39-A799-4808-90C0-7569BCED9C7D Page 1 of 1

ANALYSIS REPORT FOR
WATER / WASTE WATER SAMPLE

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Organic Chemicals manufacturing / LAB Inward : 48960

Gujarat Pollution Control Board
Vadodara
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: Ind :793.500 , Dom :47.500 & Ind :287.500 , Dom :37.500
15. Water Consumption & W.W.G (KLPD) : 7 ,Cap No & Weight :

Sr	Parameter	Unit	Test Method	Range of Testing	Result
1	Total Phosphate	mg/l	Stannous Chloride method.(4500 – P D APHA Standa	0.01 – 500 mg/l.	1.114
2	Total Nitrogen	mg/l	-	-	2.72

Laboratory Remarks : APPROVED. By:327-r.o_327 Dt.: 04/09/2023

B.M.PARMAR,SO

trans BIO-FILTER WASTE WATER TREATMENT TECHNOLOGY™

Green House Gases (GHG) Emission Potential of Biofilter with other technologies

Sources of Green House Gases Emission

Despite sewage treatment plants (STPs) being the solution for the treatment of sewage, they have been identified as sources of greenhouse gas (GHG) emissions.

GHGs are emitted from a Sewage Treatment Plant through three main mechanisms:

1. Direct Emissions - Biological processes (emissions of CO_2 from microbial respiration, N_2O from nitrification and denitrification, and CH_4 from anaerobic digestion).
2. Indirect Emissions - through consumption of electrical or thermal energy.
3. Indirect External Sources - not directly controlled within the STP (e.g., third-party biosolids hauling, transportation of the sewage to the STP plant, etc.)

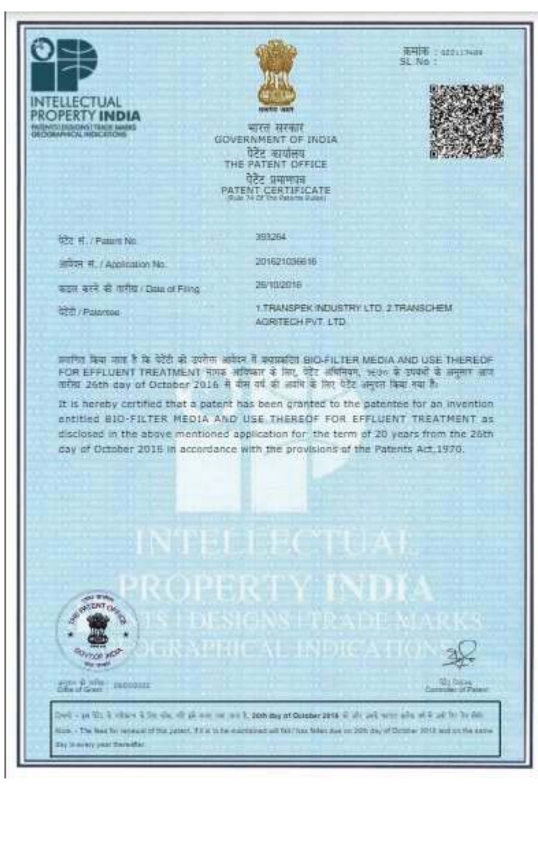
TRANSCHEM AGRITECH Pvt. Ltd.

trans BIO-FILTER™
WASTE WATER TREATMENT TECHNOLOGY

Accreditations and recognitions
Renowned Acknowledgement

PATENT CERTIFICATE

TRANSCHEM AGRITECH Pvt. Ltd.


INTELLECTUAL PROPERTY INDIA

भारत सरकार
GOVERNMENT OF INDIA
पेटेंट कार्यालय
THE PATENT OFFICE
पेटेंट प्रमाणपत्र
PATENT CERTIFICATE
(Rule 74 Of The Patents Rules)

क्रमांक :
SL No :

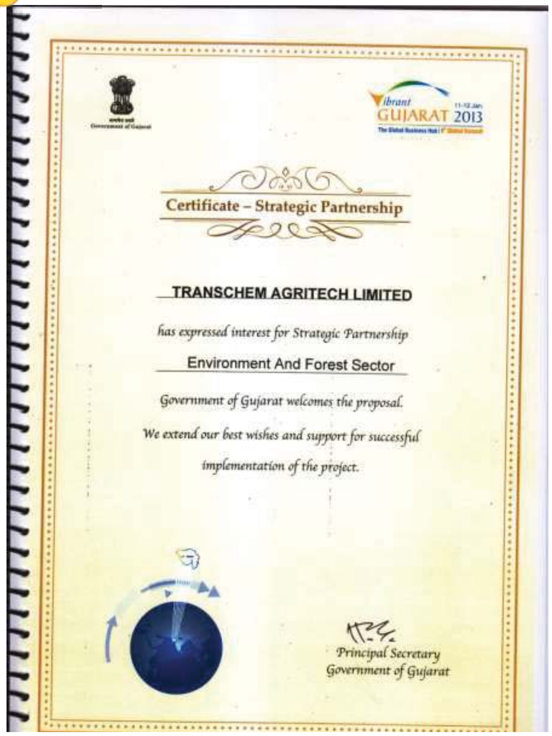
पेटेंट सं. / Patent No	393264
आवेदन सं. / Application No.	201621036616
फाइल करने की तारीख / Date of Filing	26/10/2016
पेटेंटी / Patentee	1.TRANSPEK INDUSTRY LTD. 2.TRANSCHEM AGRITECH PVT. LTD

It is hereby certified that a patent has been granted to the patentee for an invention entitled BIO-FILTER MEDIA AND USE THEREOF FOR EFFLUENT TREATMENT as disclosed in the above mentioned application for the term of 20 years from the 26th day of October 2016 in accordance with the provisions of the Patents Act,1970.

INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

Controller of Patent

Acknowledgments



Certificate – Strategic Partnership

TRANSCHEM AGRITECH LIMITED

has expressed interest for Strategic Partnership

Environment And Forest Sector

Government of Gujarat welcomes the proposal.

We extend our best wishes and support for successful implementation of the project.

Principal Secretary
Government of Gujarat

Certificate – Investment Intention

TRANSCHEM AGRITECH LTD(MOU WITH BHAVNAGR MUNICIPAL CORPORATION)

has expressed interest for investment in Gujarat in

MSME Sector

in the district of Bhavnagar

Government of Gujarat welcomes the proposal.

We extend our best wishes and support for successful implementation of the project.

Industries Commissioner
Government of Gujarat

Accreditation of transBio-Filter Technology

- Patent Application No. **201621036616.**
- Validation by ATIRA (Ahmedabad Textile Industry's Research Association).
- Technology Performance Report certified by Griffith University, Australia
- Awards:
  - **SKOTCH order of Merit award** received in 2018 for 1.2 MLD Bhavnagar STP as "top Environmental Projects of India"
  - **Environment Excellence award** in 2018 ,
  - **Best Water Treatment Technology in India** through ASSOCHAM 2017.
  - **Environment Abatement and Pollution control** in the year 2015

trans BIO-FILTER WASTE WATER TREATMENT TECHNOLOGY

TRANSCHEM AGRITECH Pvt. Ltd.

Awarded 1st Prize in the Innovation in Water Technology Category through FICCI Water Awards in 2018

TRANSCHEM AGRITECH Pvt. Ltd.

Griffith UNIVERSITY

21st June, 2012
18, Randwick Place, Drewvale
Brisbane, QLD – 4116; Australia
Rajiv.Sinha@griffith.edu.au

Dr. Rajiv K. Sinha, Ph.D
Adjunct Senior Lecturer
School of Engineering (Environment), Brisbane, QLD - 4111 (Australia)

To Whom it May Concern

PERFORMANCE REPORT of 'TRANSCHEM Agritech Ltd'., BADODRA, GUJARAT, INDIA

I feel very happy to write about TRANSCHEM Agritech Ltd. of Badodra, Gujarat with whom I have been associated for some years as 'SCIENTIFIC & TECHNICAL ADVISOR' for last few years. I provided them the scientific and technical information about an innovative 'WASTEWATER TREATMENT TECHNOLOGY by EARTHWORMS called 'BIOFILTER' based on my researches done at Griffith University, Australia. It is low-cost & low-energy consuming wastewater treatment plant. There is NO SLUDGE formed and all end-products (treated nutritive water, vermicomposted sludge & huge earthworms biomass) are re-used in agriculture.

Transchem has installed two BIOFILTER PLANTS for sewage treatment – one at Badodra (30 KLD) and other at Bhavnagar (250 KLD). I had an opportunity to visit them this February 2012 to see the PERFORMANCE of the BIOFILTERS. They are working very well giving excellent results & meeting all the objectives of wastewater treatment in terms of BOD, COD, TDSS, Turbidity & Pathogens removals. The Badodra Plant is working for about 4 years and the Bhavnagar Plant since 2011. I am highly satisfied with the results. They have achieved results better than my expectations even meeting the INTERNATIONAL STANDARDS defined by the Environmental Protection Agency (EPA) of U.S. and Australia. They are constantly improving on the technology for achieving better results.

The company has brilliant team looking after on all issues from installation of Bio-filter to their maintenance, management & quality control of the treated water. Scientific maintenance of the BIOFILTER ensuring residency of good population of healthy EARTHWORMS in the VERMIFILTER BED is the key factor for successful operation of the BIOFILTER. I am especially impressed by its Technical Manager Mr. Mandar Prabhune who is also researching in 'VERMIFILTRATION OF WASTEWATER' for his Doctoral Degree in Environmental Sciences. He is always seeking my supervision and has also contributed in preparation of a 'scientific paper' which has been accepted for publication in *International Journal of Environmental Science & Engineering Research* (IJESER). Mr. Vinay Misra is a brilliant 'Economic Planner' with good understandings of 'Environmental-Economics' which is the global theme today for sustainable development. The CEO Mr. Atul Shroff is an internationally known person in the field of 'Environment & Development'. For him 'ecology' comes first before 'economy' and is devoted for the cause of both 'environment & society'.

It is also relevant to mention here that Transchem has SCIENTIFIC SUPPORT of internationally acknowledged biological & environmental scientists of Bihar Prof. Nirmal Kumar Misra (Fulbright Scholar of Bihar 1960s) and Prof. Ashok Ghosh (Erasmus Mundus Fellow, Germany; HOD, Dept. of Environment & Water Resources, A.N. College, Patna who is also on the advisory committee of Dept. of Science & Technology (DST), Govt. of India in matters of 'Water Augmentation Research'. I will be providing all necessary SCIENTIFIC SUPPORT for the BIOFILTER PLANTS in Bihar from Australia through Prof. Misra & Prof. Ghosh and also during my personal visits every year.

It may also be relevant to mention here that with its brilliant national & international reputation made in development of new low-cost & low-energy technology for wastewater treatment without 'sludge' formation (which plagues all developed nations), Transchem is being invited by other States in India and by US, Australia, China & Russia to discuss on the feasibility of installation of BIOFILTER in those nations. I am also working as their 'Technical Ambassador' in overseas nations as I am also committed to the service of 'environment & society' through my researches into 'Vermiculture for Sustainable Development, Economic Prosperity With Environmental Security'.

The world can see our Bio-filter Plant for SEWAGE TREATMENT (250 KLD) at Bhavnagar, Gujarat on **YOUTUBE (*Wastewater Treatment by Earthworms - Rajiv Sinha* with my comments on the technology concluded by Dr. Mandar Prabhune).** More INFO about my scientific works on earthworms is on **GOOGLE SEARCH (RajivSinha.Vermicompost).**

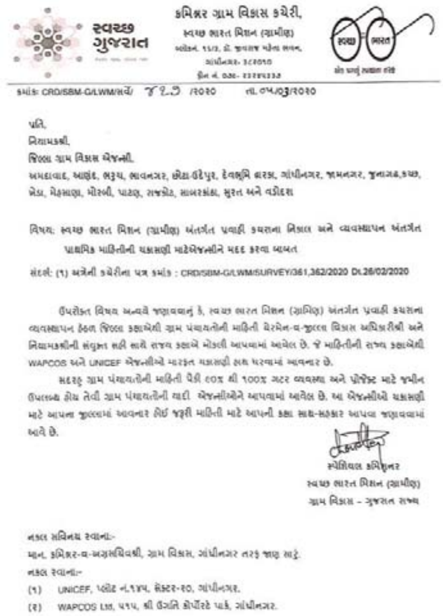
I convey all my best wishes for Transchem and its members to emerge highly successful in its noble objectives to work for the benefit of 'Environment & Society' in Bihar and all over the world.

RKSinha

(Dr. Rajiv K. Sinha)

Way forward to Green Village

□□□□□ Project Completed on Survey □2 villages for Waste Water Generation and Management in villages of Ahmedabad, Anand, Bharuch, Bhavnagar, Chhotta Udaipur, Dwarka, Gandhinagar, Jamnagar, Junagadh, Kutchh, Kheda, Mehsana, Morbi, Patan, Rajkot, Sabarkantha, Surat and Vadodara



કમિશ્નર ગ્રામ વિકાસ કચેરી,
સ્વચ્છ ભારત મિશન (ગ્રામીણ)
બ્લોક નં. ૧૬/૩, ડૉ. જીવરાજ મહેતા ભવન,
ગાંધીનગર- ૩૮૨૦૧૦
ફોન નં. [illegible]

સ્વચ્છ ગુજરાત

ક્રમાંક: CRD/SBM-G/LWM/સર્વે/ ૪૧૭ /૨૦૨૦ તા. ૦૫/૦૩/૨૦૨૦

પ્રતિ,
નિયામકશ્રી,
જિલ્લા ગ્રામ વિકાસ એજન્સી,
અમદાવાદ, આણંદ, ભરૂચ, ભાવનગર, છોટા ઉદેપુર, દેવભૂમિ દ્વારકા, ગાંધીનગર, જામનગર, જુનાગઢ,કચ્છ, ખેડા, મહેસાણા, મોરબી, પાટણ, રાજકોટ, સાબરકાંઠા, સુરત અને વડોદરા

વિષય: સ્વચ્છ ભારત મિશન (ગ્રામીણ) અંતર્ગત પ્રવાહી કચરાના નિકાલ અને વ્યવસ્થાપન અંતર્ગત પ્રાથમિક માહિતીની ચકાસણી માટે એજન્સીને મદદ કરવા બાબત

સંદર્ભ: (૧) અત્રેની કચેરીના પત્ર ક્રમાંક : CRD/SBM-G/LWM/SURVEY/361,362/2020 Dt.26/02/2020

ઉપરોક્ત વિષય અન્વયે જણાવવાનું કે, સ્વચ્છ ભારત મિશન (ગ્રામિણ) અંતર્ગત પ્રવાહી કચરાના વ્યવસ્થાપન હેઠળ જિલ્લા કક્ષાએથી ગ્રામ પંચાયતોની માહિતી ચેરમેન-વ-જીલ્લા વિકાસ અધિકારીશ્રી અને નિયામકશ્રીની સંયુક્ત સહી સાથે રાજ્ય કક્ષાએ મોકલી આપવામાં આવેલ છે. જે માહિતીની રાજ્ય કક્ષાએથી WAPCOS અને UNICEF એજન્સીઓ મારફત ચકાસણી હાથ ધરવામાં આવનાર છે.

સદરહુ ગ્રામ પંચાયતોની માહિતી પૈકી ૯૦% થી ૧૦૦% ગટર વ્યવસ્થા અને પ્રોજેક્ટ માટે જમીન ઉપલબ્ધ હોય તેવી ગ્રામ પંચાયતોની યાદી એજન્સીઓને આપવામાં આવેલ છે. આ એજન્સીઓ ચકાસણી માટે આપના જીલ્લામાં આવનાર હોઈ જરૂરી માહિતી માટે આપની કક્ષાએ સાથ-સહકાર આપવા જણાવવામાં આવે છે.

સ્પેશિયલ કમિશ્નર
સ્વચ્છ ભારત મિશન (ગ્રામીણ)
ગ્રામ વિકાસ – ગુજરાત રાજ્ય

નકલ સવિનય રવાના:-
માન. કમિશ્નર-વ-અગ્રસચિવશ્રી, ગ્રામ વિકાસ, ગાંધીનગર તરફ જાણ સારૂ.
નકલ રવાના:-
(૧) UNICEF, પ્લોટ નં.૧૪૫, સેક્ટર-૨૦, ગાંધીનગર.
(૨) WAPCOS Ltd. ૫૧૫, શ્રી ઉત્ગતિ કોર્પોરેટ પાર્ક, ગાંધીનગર.

7/26/2025

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Email: biofilter@transchem.in
info@transchem.in

Technical Head -
Mandar Prabhune
+91 9898508844
mandar.prabhune@transpek.com

Business Head-
Bhavar Upadhyay
Phone: +91 7069034500
Email: bhavar.upadhyay@transchem.in

THANK YOU

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

Waste to Energy

MSW to BioCNG

Ajit Kude 9322519823
www.avnienviro.in
ajitkude@yahoo.com

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

We **AVNI ENTERPRISES** are pleased to introduce ourselves as WASTE Managers.

The burning desire of environment protection and maintaining the natural resources are the reasons for establishing this organization.

The principle of 3R i.e. Reduce, Recycle and Reuse is used for waste management.

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

In Marathi *Anna, Vastra, Nivara* i.e. Food, Cloth and Shelter are Three Basic Needs of Human Being.

In Sanskrit AVNI means "The Mother Earth"

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

Salient Features

- Well qualified and experienced staff with Technical and Engineering Background
- Working in the field of Waste Management since last 10 Years
- Installed more than 35 NISARGRUNA Biogas Projects
- Supply, Install, Operate and Maintain the Mechanical Composting Systems.
- Sustainable and End to End Solutions in Waste Management.

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

Existing Rule
Municipal Solid Waste
(Management and Handling)
Rules 2000 and 2016

Controlling Authority

- Ministry of Environment and Forest (MoEF)
- State Pollution control Board (SPCB)
- Urban Local Body

Guidelines

- Segregation of Waste at Source
- Closed Vehicle
- Minimum Manual Handling
- Treatment at Site
- Waste Generator is Responsible for Treatment

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

Some of Our Successful Projects

- Pimpri Chinchwad Municipal Corporation – **50 TPD**
- Dhule Municipal Corporation – **30 TPD – WIP**
- Vadodara Municipal Corporation – Dead Animal Disposal- **25 TPD -WIP**
- Municipal Corporation of Greater Mumbai- BARC -**15 TPD Deonar Abattoir.**
- KDMC Ayre Gaon – **10 TPD**
- JNPT Navi Mumbai – **10 TPD**
- Regency Anantam Dombivli – **5 TPD**
- Karjat Municipal Council, Dist. Raigad – **5 TPD**
- Mahad Municipal Council, Dist. Raigad – **5 TPD**
- KDMC – Aadharwadi Slaughterhouse **– 2 TPD**
- Vadodara Municipal Corporation – Dead Animal Disposal- **5 TPD**
- Uran Municipal Council, Dist. Raigad **– 5 TPD**

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THE BEST FROM NATURAL WASTE

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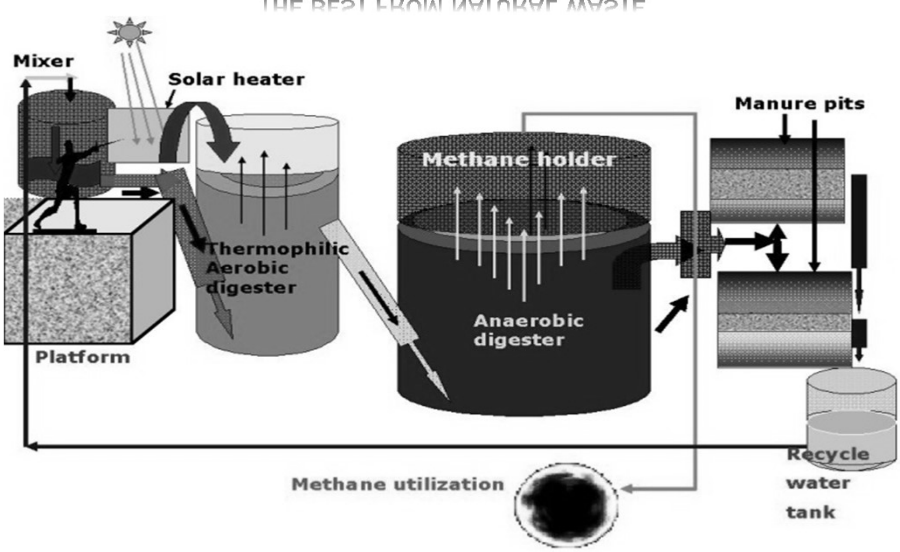
THE BEST FROM NATURAL WASTE



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THE BEST FROM NATURAL WASTE

10 TPD JNPA and 5 TPD Regency Anantam

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THE BEST FROM NATURAL WASTE

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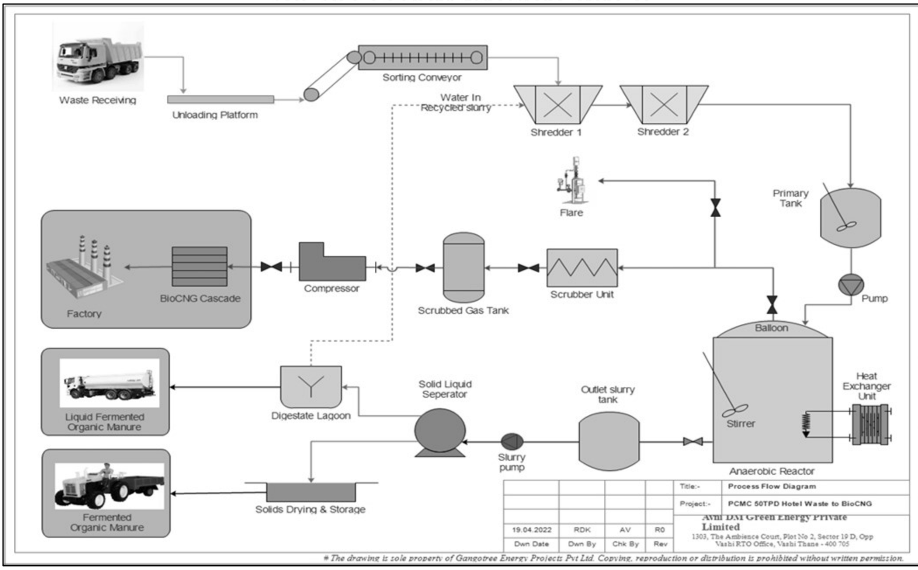
THE BEST FROM NATURAL WASTE



AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

Waste to Bio CNG – The Process

Segregated Collection

Final Segregation

Shredding

Slurry Preparation

Raw Biogas Generation 55 % CH4

Purification(H2S and Co2) 95% CH4

Compression 250 Bar

Cascade filling

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

50 TPD PCMC BioCNG Project

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

50 TPD PCMC BioCNG Project

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

25 TPD VMC BioCNG Project

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

25 TPD Biogas Project Details

Sr No	Description	Quantity	Remarks
01	Input Biodegradable Waste	25 MT /Day	C & T by MC
02	Area Required	1.0 Acre	Leveled & Encroachment free
03	Power Supply Required	250 KVA	To be arranged at Site
04	Fresh Water Required	25000 lit/day	25000 Recycled Water
05	Output CBG	1000 kg /day	Industry / Vehicle/ Hotels
06	Output Slurry	10000 lit	Garden & Farmers
07	Output Manure	1000 kg /day	Garden & Farmers

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

Benefits of Waste Management

- **Environmental**

Methane Emission
Health and Hygiene
Air and Water Pollution
Saving on Land
Reducing Dependency on Natural Resources
Completing the Cycle of Nature

- **Social**

Employment Generation, Dignity of Work, Image Building of Nation,

- **Economical**

Reducing Import of fuel, Job Opportunities, Good Opportunity for Investment

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

Check List for Prefeasibility

- Quantity Available :
- Space Available:
- Power Supply:
- Water Supply:
- Collection and Transport:
- CBG Utilization:
- Slurry Utilization
- Manure Utilization:
- Implementing Agency:
- Operating Agency:
- Capital Cost
- O & M Cost
- NOC and Permissions

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

Typical Line of Action :

- Preliminary Field visit to collect baseline data.
- Preparation of DPR / feasibility report
- Tender Procedure, WO & Agreement
- Actual Execution Civil work and SITC of Equipment
- Commissioning
- Collection and Transport for Continuous Supply of Waste
- Operation and Maintenance
- Product utilization or sale
- Sustainable Model
- Regular Monitoring

AVNI ENTERPRISES

THE BEST FROM NATURAL WASTE

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2-DAY CONFERENCE

"Waste to Energy for Clean Environment"

@ FEDERATION OF GUJARAT INDUSTRIES (FGI), GOTRI, VADODARA
29-30 July2025 (Tuesday-Wednesday),

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###########

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WhatsApp M – 9328658594 Web: www.spevadodara.in

Atmospower

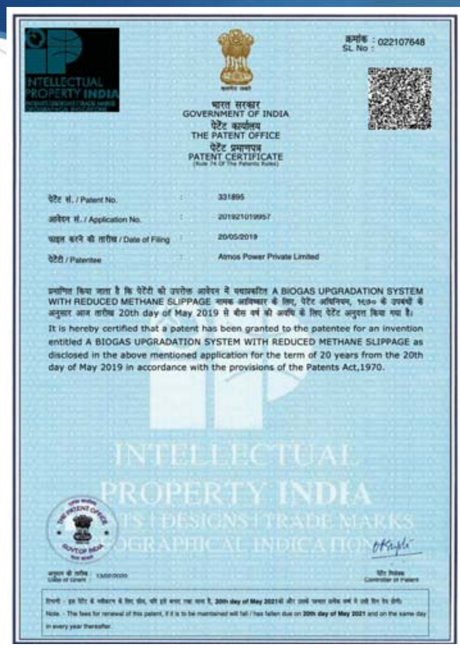
Company Overview

Committed to the Environment

AtmosPower

- AtmosPower Pvt. Ltd. was established in 2010, in the city of Ahmedabad, Gujarat, India.
- It is a part of the Mazda Limited group and has multiple manufacturing facilities in Ahmedabad making products such as Turbine By-Pass valves, crystallizers, surface condensers, evaporators, vacuum systems, and gas separation systems.
- Under the guidance of TUV Rhineland's expert audit and inspection team (Notified body: 0035), AtmosPower can manufacture in compliance with ASME, PED, ATEX, SIL, and any other European & North American manufacturing directive.
- After installing more than **120 BioGas to BioCNG plants**, Atmospower has become the unparalleled leader of the Asian Biogas Upgradation market.
- Based on its Patented Technology, it the only Indian Company that can manufacture upgradation systems capable of offering 98+% methane purity with **methane losses of <1%**

Indian & European Patents



भारत सरकार
GOVERNMENT OF INDIA
पेटेंट कार्यालय
THE PATENT OFFICE
पेटेंट प्रमाणपत्र
PATENT CERTIFICATE

SL No : 022107648

Patent No.	:	331895
Application No.	:	201921019957
Date of Filing	:	20/05/2019
Patentee	:	Atmos Power Private Limited

It is hereby certified that a patent has been granted to the patentee for an invention entitled A BIOGAS UPGRADATION SYSTEM WITH REDUCED METHANE SLIPPAGE as disclosed in the above mentioned application for the term of 20 years from the 20th day of May 2019 in accordance with the provisions of the Patents Act,1970.

EUROPÄISCHES PATENT | EUROPEAN PATENT
BREVET EUROPÉEN

EP3972720 01.05.2024

A BIOGAS UPGRADATION SYSTEM WITH REDUCED METHANE SLIPPAGE

Patentinhaber | Proprietor(s) of the patent | Titulaire(s) du brevet

Atmos Power Pvt. Ltd.
C/1, 39/3, Phase III, GIDC, Naroda
Ahmedabad Gujarat 382330
IN

António Campinos

URKUNDE | CERTIFICATE | CERTIFICAT

Biogas Upgradation Systems

- AtmosPower's Biogas Upgradation systems can offer methane purity of up to 99.5% with a methane recovery of >99%
- Flow Rates: 50 Nm^3/Hour to 10,000 Nm^3/Hour
- 120+ installations in compliance with BIS 16087

Founders

Navroz H. Tarapore

Brij Raj Singh

Brij Raj Singh

- **Mr. Brij Raj Singh** is a chemical Engineer with more than 35 years of experience in Designing, Engineering, Manufacturing & Commissioning of gas generation systems throughout Asia & Africa.
- With a vast experience in producing Hydrogen, Nitrogen, Oxygen & Bio-Methane, Mr. Singh co-founded AtmosPower with the aim to manufacture the most cost efficient gas generation systems in the market today.
- He has set up more than 120 Biogas to Bio-CNG plants in Asia and is a renowned authority in the field of Biogas, Natural Gas & Syngas Upgradation.

Navroz H. Tarapore

- **Mr. Navroz H. Tarapore** has been in the Engineering field for the past 45 years. He owns multiple factories manufacturing a vast array of engineering equipment based on international standards.
- In 1992, Mr. Tarapore started H.T. Engineering, a company with expertise in high precision fabrication, including equipment such as detonators for Rockets & Missiles for the Indian Ministry of Defence.
- In 2010 he cofounded AtmosPower, which is renowned as one of the top Green Energy companies in India.
- In 2015, he cofounded Mecaster Flow Solutions, which manufactures Turbine Bypass Valves, Pressure Reducing Stations, Desuperheaters, etc.
- Mr. Tarapore has also served as the Chairman for the Gujarat Chamber of Commerce's MSME Committee.

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Product List

- PSA & VPSA Oxygen Generation Plants
- Turnkey Bio-Gas to Bio-CNG Plants
- VPSA Biogas Purification/Upgradation Plants
- Natural Gas Dehydration & Upgradation Plants
- Syngas & Producer Gas Upgradation Plants
- PSA Nitrogen Generation Plants.
- Air, Gas & Solvent Dryers
- Hydrogen Gas Generation plants through steam reforming of natural gas & Bio-CNG
- Hydrogen Gas Generation plants using water electrolysis

All products can be manufactured under PED/ASME Directives.

TÜVRheinland®
Precisely Right.

Committed to the Environment

More than 350 Installations Across India

AtmosPower's Biogas to Bio-CNG Plant at Amul Dairy

Amul
The Taste of India

AtmosPower's Biogas to Bio-CNG Plant at Banas Dairy

Committed to the Environment

AtmosPower's Biogas to Bio-CNG Plant at Indore Smart City

Mahindra

India's First Landfill Gas Upgradation Plant in Hyderabad Supplied by AtmosPower

ATMOS POWER
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AtmosPower's 10.5 TPD Biogas Upgradation System for IndianOil Adani Ventures

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AtmosPower's 15 TPD Biogas Upgradation System for Ever Enviro at Punjab

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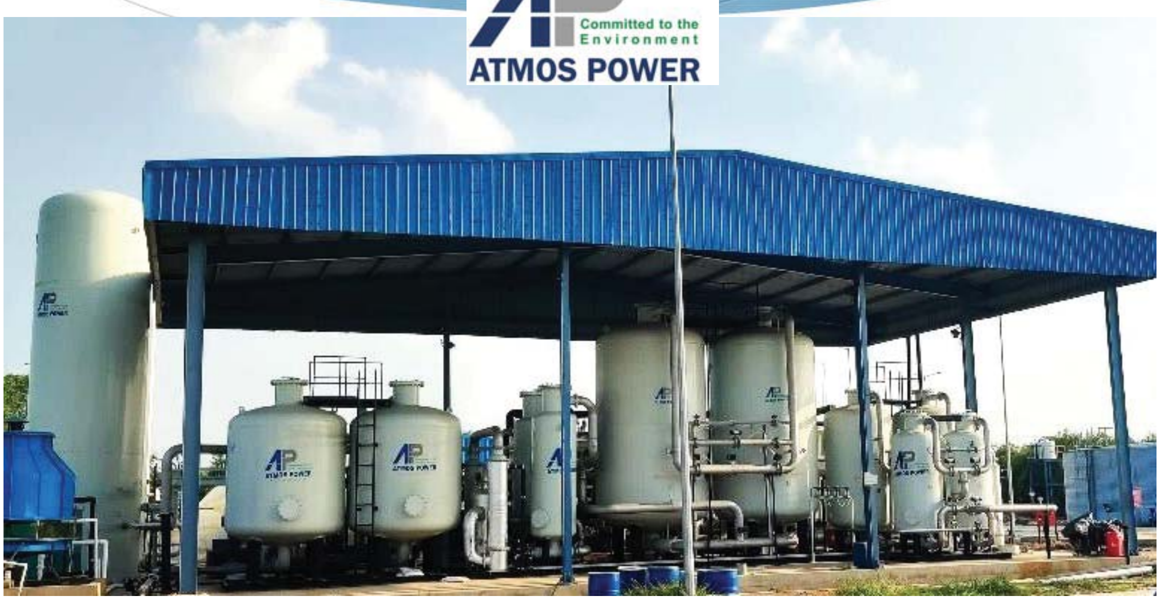

AtmosPower's 20 TPD Biogas Upgradation System for Reliance at Nagpur

PSA Nitrogen

- AtmosPower's Nitrogen Gas Generation plants can offer purity levels up to 99.9999%
- Flow rates: 5m^3/Hour - 10,000m^3/Hour
- 20+ Installations

PSA & VPSA Oxygen

- AtmosPower's Oxygen gas generation plants can offer purity levels up to 95%
- Flow rates: 3 m³/Hour to 10,000 m³/Hour
- 175+ Installations

A Quick Glance

Manufacturing Capability

- AtmosPower's team consists of industry veterans with expertise in Designing, Manufacturing & Commissioning of gas plants & gas separation systems throughout Asia.
- Under the guidance of TUV Rhineland's audit and inspection team (Notified body: 0035) based in Ahmedabad, AtmosPower can manufacture in compliance with PED, ATEX, SIL, and any other European & North American manufacturing directive.
- With 5 manufacturing facilities, AtmosPower can Manufacture more than 300 systems a year. **During the Covid Pandemic AtmosPower Manufactured a record 160 PSA Medical Oxygen plants in 120 Days.**
- In order to offer the best performance and ease to clients, AtmosPower also offers operation and maintenance contracts for all its plants.
- Atmos also owns and operates a Compressed Biogas Plant in India.

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Contact Information

- Biogas Division Website www.biogaspurifier.com
- Company Website www.atmospower.in
- Email mkt@atmospower.net, sales@atmospower.net

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Transforming E-Waste into Energy: A Sustainable Path to a Cleaner Environment

Dr Ruchi Shrivastava,Principal ,
PIET DS, Parul University
Email id - ruchi.shrivastava@paruluniversity.ac.in

Abstract

The rapid rise in electronic waste (e-waste) due to global digitalization poses severe environmental and health challenges. Conventional disposal methods like landfilling and incineration contribute to pollution and squander valuable resources. This paper examines waste-to-energy (WTE) technologies as a sustainable solution for e-waste management, exploring innovative processes, environmental benefits, policy frameworks, and their role in a circular economy. By recovering energy and materials while minimizing emissions, WTE offers a pathway to sustainable development and a cleaner environment.

1. Introduction

The global surge in electronic device consumption has driven e-waste production to critical levels, with 62 million metric tons generated in 2022 and projections estimating 75 million by 2030 (Forti et al., 2020). Improper disposal releases toxic substances, pollutes ecosystems, and wastes recoverable materials. Waste-to-energy (WTE) technologies, traditionally applied to municipal solid waste (MSW), present a promising approach for e-waste by converting it into energy and recoverable metals. This paper investigates WTE's potential to address e-waste challenges, emphasizing sustainable energy recovery and environmental protection within a circular economy framework.

2. E-Waste: Composition and Impacts

2.1 Definition and Composition

E-waste encompasses discarded electronic devices, including smartphones, computers, televisions, and batteries. These items contain:

- Valuable metals: Gold, silver, copper, palladium.
- Hazardous materials: Lead, mercury, cadmium, brominated flame-retardants.
- Other components: Plastics and ceramics.

2.2 Environmental and Health Risks

Improper e-waste management causes:

- Soil and water contamination from leaching heavy metals.
- Air pollution from open burning.
- Health issues, including neurological, respiratory, and developmental disorders (Robinson, 2009).

3. Waste-to-Energy Technologies for E-Waste

WTE technologies convert e-waste into energy and recoverable materials, reducing landfill dependency. Key methods include:

3.1 Pyrolysis

This oxygen-free thermal decomposition process transforms e-waste plastics into energy-rich oils and gases, leaving metallic residues for recycling (Kumar et al., 2017).

3.2 Gasification

High-temperature partial oxidation converts organic components into syngas (CO and H_2), suitable for power generation or synthetic fuel production (Arena, 2012).

3.3 Plasma Arc Gasification

Using plasma torches, this method breaks down e-waste at extremely high temperatures, producing clean syngas and inert vitrified slag (Moustakas et al., 2005).

3.4 Incineration with Energy Recovery

Controlled combustion with advanced air pollution controls recovers heat from non-recyclable e-waste fractions, generating energy for electricity or heating (UNEP, 2013).

4. Environmental Benefits of WTE for E-Waste

WTE technologies offer multiple advantages:

Reduced Landfill Use: Diverts e-waste from disposal sites.

Energy Recovery: Yields thousands of kWh per ton of plastic e-waste (Zhang et al., 2019).

Metal Recovery: Retrieves up to 90% of metals post-thermal treatment (UNEP, 2013).

Emission Control: Modern WTE facilities meet stringent EU standards, minimizing pollutants (European Commission, 2020).

5. Challenges and Limitations

Despite its potential, WTE for e-waste faces obstacles:

High Costs: Advanced technologies like plasma gasification require significant investment.

Toxic Emissions: Poorly managed processes risk releasing dioxins and furans (Robinson, 2009).

Complex Feedstock: E-waste's heterogeneous composition complicates processing.

Regulatory Gaps: Many developing nations lack policies for e-waste WTE (Balde et al., 2017).

6. Policy Frameworks and Global Practices

Effective policies are critical for WTE adoption:

EU WEEE Directive (2012) : Enforces producer responsibility and structured recycling (European Union, 2012).

Japan's 3R Approach: Promotes reduce, reuse, and recycle, integrating WTE into waste management.

India's E-Waste Rules (2022) : Implements Extended Producer Responsibility (EPR) to encourage recycling and energy recovery (MoEFCC, 2022).

7. WTE in a Circular Economy

Integrating WTE with circular economy principles enhances sustainability:

Design for Environment (DfE): Encourages products designed for easier recycling.

Urban Mining: Recovers rare metals from WTE residues.

Hybrid Systems: Combines mechanical sorting, recycling, and thermal recovery for optimal resource use.

8. Case Study: E-Waste to Energy in Sweden

Background

Sweden, a leader in sustainable waste management, recycles or recovers energy from over 99% of household waste. E-waste is increasingly integrated into its WTE infrastructure (Avfall Sverige, 2020).

Process

E-waste is collected via drop-off centres and retail take-back systems under EPR. After manual dismantling for reuse or metal recovery, non-recyclable plastics and residuals are processed in WTE facilities like Fortum Värme and Sysav.

Technologies

- Advanced incineration with flue gas cleaning.
- Metal separation from bottom ash.
- Energy recovery for district heating and electricity.

Outcomes

- Over 50% of Stockholm's heating needs are met through WTE, including e-waste contributions.
- Metals (e.g., aluminum, copper, iron) are recovered from ash.
- Emissions remain well below EU thresholds due to high-efficiency scrubbers.

Key Takeaways

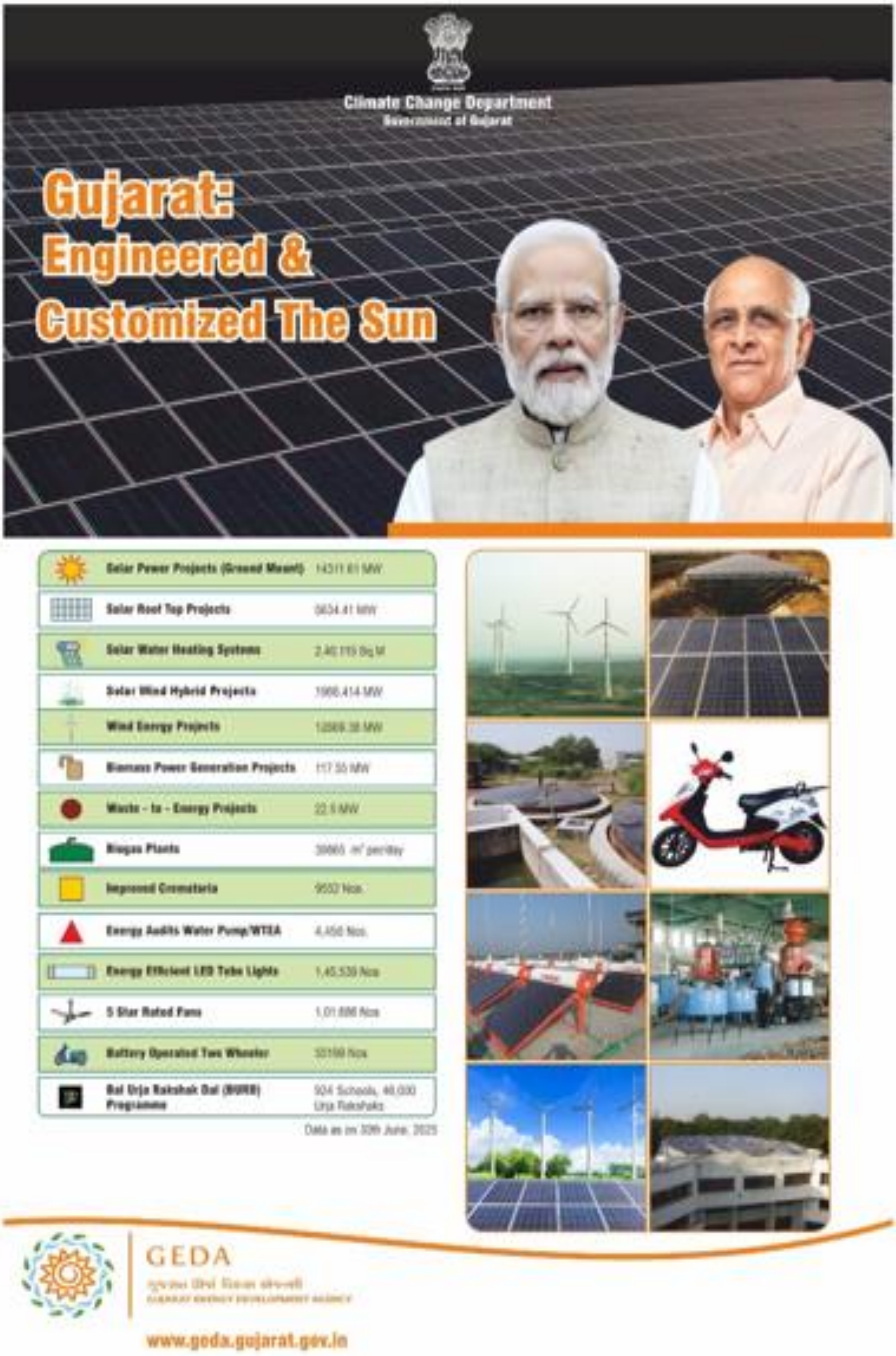
- Integrated systems enable efficient e-waste utilization with minimal environmental impact.
- EPR and public participation are critical to success.
- District heating showcases WTE's societal and environmental benefits.

9. Conclusion

Waste-to-energy technologies transform e-waste from an environmental liability into a resource, recovering energy and valuable metals while reducing pollution. Sweden's model exemplifies how robust infrastructure, supportive policies, and public engagement can maximize WTE's potential. As e-waste, volumes grow and energy demands rise, scaling WTE globally within a circular economy framework is essential for sustainable development.

References:

1. Arena, U. (2012). Process and technological aspects of municipal solid waste gasification. *Waste Management*, 32(4), 625–639.
2. Balde, C.P., Forti, V., Gray, V., Kuehr, R., & Stegmann, P. (2017). *The Global E-Waste Monitor 2017*. United Nations University (UNU).
3. European Commission. (2020). *Directive 2010/75/EU on industrial emissions*.
4. European Union. (2012). *Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE)*.
5. Forti, V., Baldé, C.P., Kuehr, R., & Bel, G. (2020). *The Global E-Waste Monitor 2020: Quantities, flows and the circular economy potential*. United Nations University.
6. Kumar, A., Holuszko, M., & Espinosa, D.C.R. (2017). E-waste: An overview on generation, collection, legislation and recycling practices. *Resources, Conservation and Recycling*, 122, 32–42.
7. Ministry of Environment, Forest and Climate Change (MoEFCC), India. (2022). *E-Waste (Management) Rules, 2022*.
8. Moustakas, K., Fatta, D., Malamis, S., Haralambous, K., & Loizidou, M. (2005). Demonstration plasma gasification/vitrification system for wastes. *Journal of Hazardous Materials*, 123(1-3), 120–126.
9. Robinson, B.H. (2009). E-waste: An assessment of global production and environmental impacts. *Science of the Total Environment*, 408(2), 183–191.
10. UNEP. (2013). *Guidelines for Environmentally Sound Management of E-Waste*. United Nations Environment Programme.
11. Zhang, S., Ding, Y., Liu, B., & Zheng, H. (2019). Recycling of WEEE plastics: A review. *Journal of Cleaner Production*, 235, 331–350.
12. Avfall Sverige. (2020). *Swedish Waste Management 2020*. https://www.avfallsverige.se



Climate Change Department
Government of Gujarat
Gujarat:
Engineered &
Customized The Sun
Solar Power Projects (Ground Mount) 14311.61 MW
Solar Roof Top Projects 5634.41 MW
Solar Water Heating Systems 2,40,115 Sq.M
Solar Wind Hybrid Projects 1966.414 MW
Wind Energy Projects 12869.38 MW
Biomass Power Generation Projects 117.55 MW
Waste - to - Energy Projects 22.5 MW
Biogas Plants 39665 m³ per day
Improved Crematoria 9552 Nos.
Energy Audits Water Pump/WTEA 4,456 Nos.
Energy Efficient LED Tube Lights 1,45,539 Nos.
5 Star Rated Fans 1,01,898 Nos.
Battery Operated Two Wheeler 33199 Nos.
Bal Urja Rakshak Dal (BURD) Programme 504 Schools, 40,000 Urja Rakshaks
Data as on 30th June, 2025
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