GEODYN™ SOLUTIONS

Total Waste Solution

Municipal Solid Waste to Power

Geodyn Pellet Gasification System

Contents

Section 1: Introduction

Municipal Solid Waste Management

Threats & Challenges

Proposed Solution

1. What is Municipal Solid Waste (MSW)?

Municipal Solid Waste (MSW), commonly known as trash or garbage is a waste type consisting of everyday items that are discarded by households, commercial establishments etc. and are collected by the local government or private bodies to be dumped at landfills.

1.1. Sources of Municipal Solid Waste

1.2. Collection & Dumping of MSW

Households, Commercial Complex, Shops, Restaurants, Hotels etc.

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Garbage / Waste from Streets

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Primary Collection: Municipal & Private Collectors - Mini Truck / Cycle Rickshaw

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Primary / Intermediate Collection Site

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Secondary Collection: Municipal & Private Agencies through heavy vehicles

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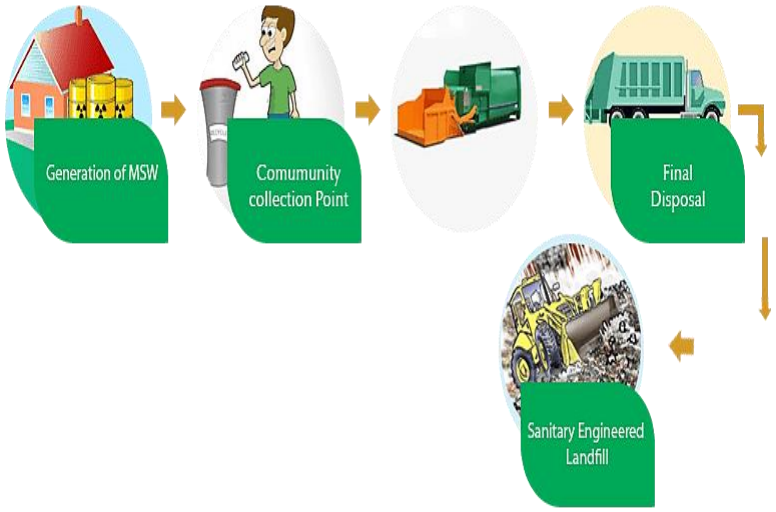
Final dumping at a landfill site.



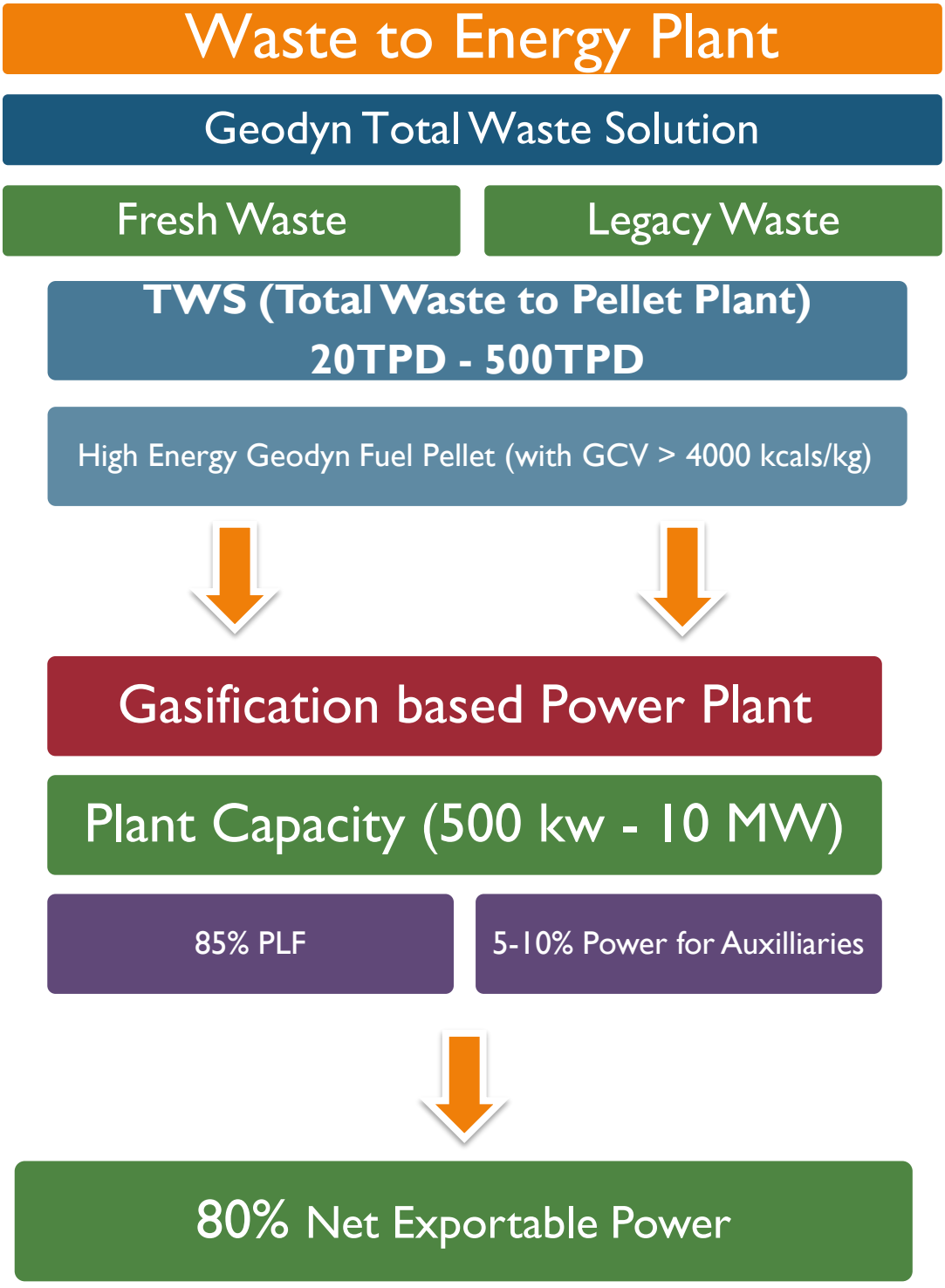
1.3. Threat from Landfills/Dumpsites

- Highly Hazardous to Human Health;
- Ground Water Contamination by leachate generated by waste dump;
- Bad odor, pests, rodents and windblown liter in and around the waste dump;
- Release of toxic gases;
- Risk of Fire within waste dump;
- Increase in waste leading to extension of landfill area;

1.4. Challenges

Problems in Current Method - Major hurdles in managing Legacy & Fresh Waste:	Inadequate Waste Processing Facilities - Very High % of waste collected from various sources such as households etc. is being dumped at a Landfill Site on daily basis.	**Inadequate Waste Processing Facilities**
	Allocated land for most of the landfill sites is over utilized. More land shall be required if waste processing facilities are not introduced to process both fresh and legacy waste.	**Allocated Land is Over Utilized;** **High mountains of garbage across major metropolitan cities.** **More Precious Land will be required at this rate of waste dumping**
	Traditional Methods and Technologies of Processing Waste are no more good.	**Slow Processing Rate** **High Moisture Content does not allow Direct Incineration** **Unsegregated Waste**

1.5. Proposed Solution



Section 2: Waste Processing Solution

Geodyn Total Waste Solution

2. Total Waste to Fuel Pellets

2.1. Geodyn MSW Treatment Technology

- Geodyn's MSW Treatment System is a fully automated technological process that is able to process and convert MSW to either high-energy fuel pellets and/or electricity within 1 hour!

- The technology subjects the MSW to several equipment and processes that effectively treat and process the waste into Refuse Derived Fuel (RDF). This RDF is then converted to the High Energy Fuel Pellets using a Pelletizer;

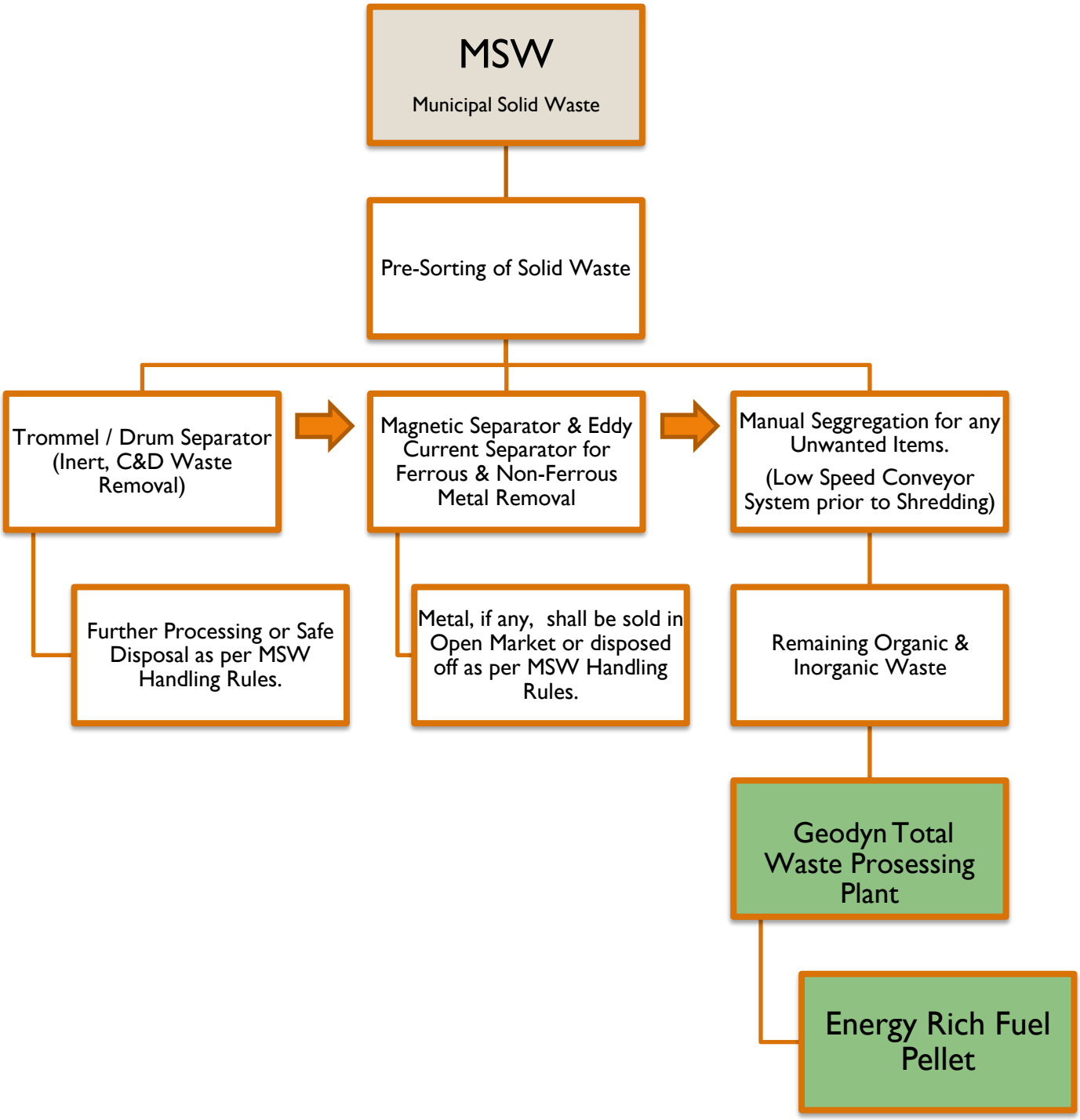
- Invented and Patented by a renowned inventor and design engineer

2.2. Patent & Trademark Details

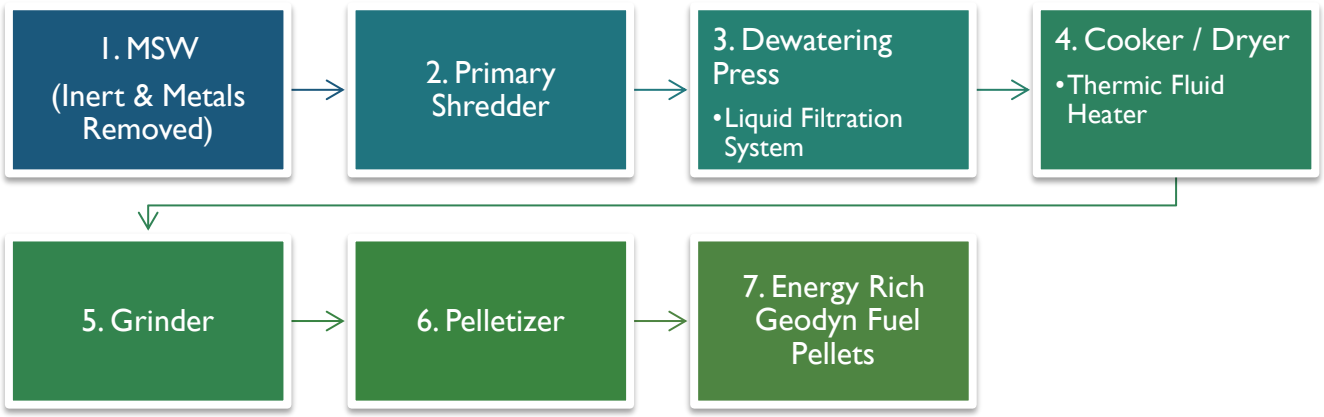
US Patent/TM Application: Processing Food Waste and Organic and Biological Disposal by means of a machine which performs the steps of Dehydration, Pulverization, Drying and Hardening to Produce a Liquid Extract and a Solid Residue for use as a Biofuel.

2.3. Process Layout of Waste Treatment

2.3.1. Pre-Sorting Process Flow Chart



2.3.2. Processing of Total Waste to Energy Rich Fuel Pellets Flow Chart



2.4. 3D Map of Geodyn Solid Waste Treatment Plant

2.5. Brief on Entire Process from MSW to Geodyn Fuel Pellets

The Geodyn MSW Treatment Technology is a unique technology that subjects the solid waste to several processes before converting the waste into high energy fuel pellets;

1. (Optional) The MSW is first subjected to pre-sorting through a Trommel or Drum Separator for removal of Inert, C&D Waste etc. upon which it passes through metal separator for removal of ferrous and non-ferrous metal. Finally, manual screening is done to remove any left-over of Inert or Metal before entering into Primary Shredder.

2. A leading conveyor system immediately takes all incoming solid waste material to GR-S-150 model shredders. These units render incoming material to a small uniform size for effective processing.

3. The shredding process is augmented by our liquid separation press. This process removes liquids from the solid material to be processed into RDF.

4. The separated liquid is pumped to our water treatment and oil separation unit to create irrigation quality water and a petroleum based bio-fuel product for further refining.

5. Solids are moved via an enclosed container (both shredded solids and solids recovered) to "Total Waste System" cooker/dryer units which kill all harmful bacteria and eliminate odors.

6. Directly from the Cooker/Dryer units cooked and dried material is taken by enclosed conveyors to Pelletizers to create 8,000 pound-per-square-inch (psi) Energy Rich Geodyn Fuel Pellets with Calorific Value ranging from (4000-6000kcals/kg) to be sold to energy market.

7. Approximately 10-15 tons of Geodyn fuel pellets per-day, generated from operations, shall be used in a steam/thermic heater to generate the dry steam used to cook/dry the solid material.

8. The Entire Process takes less than 1 Hour!!

2.6. Final Output & By-Products

2.7. General Characteristics of Final output and its Usage

Geodyn Fuel Pellet

- Compressed & Stable;
- High Calorific Value;
- Negligible Hazardous Emissions;
- **Green** Alternative to Fossil Fuel.

Irrigation Quality Water

- Non-Harmful Water which can be used for irrigation purposes or drained into sewage as per MSW Handling Rules & Best Industry Practices.

Oil

- Oil can be used as bio-fuel after further refining or safely disposed off as per MSW Handling Rules & Best Industry Practices.

Inert/C&D Waste/Metals

- Inert Material such as Construction & Demolition (C&D) Waste, Stone, Debris can be further processed to make briquttes etc. or else shall be safely disposed off at the landfill site as per MSW Handling Rules.
- Metals, if any, shall be collected and be sold in open market.

2.8. Key Equipment

2.8.1. Pre-Sorting Equipment

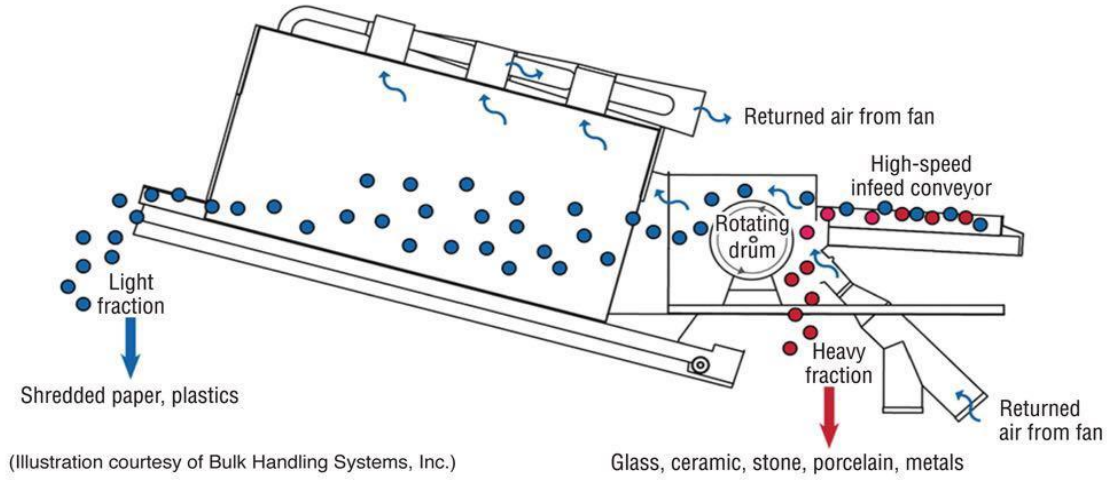
2.8.1.1. Drum Separator (optional)

The Single Drum Separator is a highly versatile separator that processes a large variety of waste streams. The Single Drum Separator easily separates Municipal Solid waste (MSW), Commercial & Demolition waste (C&D), Refuse Derived Fuel (RDF), compost, and more.

The Single Drum Separator (SDS) has one splitter drum, at which the heavy material is separated from the light material. View the picture below for the operating principles.

The heavy fraction falls down in front of the splitter drum and is discharged by means of a conveyor. The light fraction is transported over the splitter drum and will be separated from the air in the expansion room.

Figure 1. Drum separator



2.8.1.2. Metal Separator

1. Ferrous Metal Remover

Over-belt magnetic separator (STM)

The over-belt magnetic separator type STM is intended for removal of tramp iron from bulk materials transported on conveyor belts or vibratory feeders.

The STM magnetic separator is used to protect of process machines against damage caused by an unwanted piece of ferrous metal and also to recover valuable ferrous scrap from waste materials.

Applications of over-belt magnetic separator

- Removal of tramp iron contaminants from coal, granite, limestone, basalt and other aggregates to protect crushing and grinding machines.
- Cleaning of cullet, rubber, plastics and other materials coming from recycling.
- Recovery of ferrous scrap from municipal and industrial waste.
- Cleaning of alternative fuels and compost.

2. **Non-Ferrous Metal Remover (optional)**

The Eddy Current Separator uses a strong magnetic field to efficiently & accurately repel aluminum from incoming materials, recovering your highest value product at high levels of

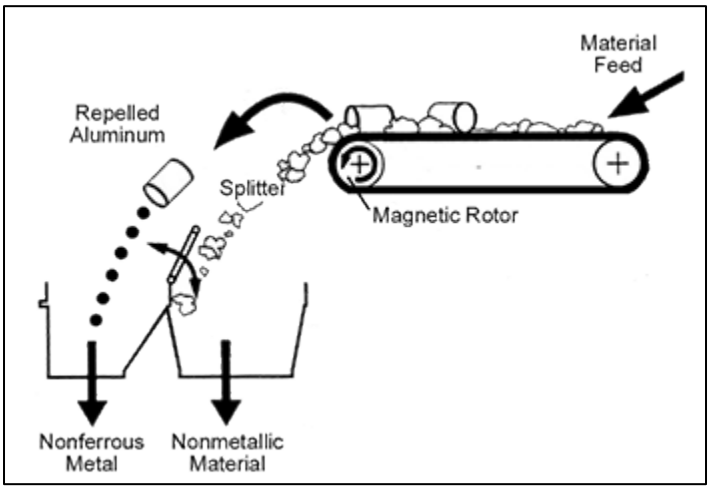
purity. With ECS, removal of aluminum from the waste stream is precise and product loss is minimized. The ECS is rugged, effective and reliable, offering exceptional commodity recovery.

Benefits:

- Effectively separates aluminum from the waste stream
- Increases system recovery rates
- Compact overall dimensions for installation versatility

3. I-Sens Sensor Separator

- TheI-Sens sensor separator perfectly complements the metal separation before or after the eddy current separators.
- With this separator it is possible to separate **stainless steel, lead and copper wire** from a material flow.
- The separation principle is composed of a conveyor belt in which a sensor plate is mounted just before the final roller. This sensor plate detects a metal particle as well as the line along which this metal particle is located on the conveyor belt. The software then calculates the exact location and the metal particle is ejected from the flow with a pulse of air during its free-fall curve, after which it falls behind a partition.



2.8.2. Geodyn Waste to Pellet Equipment

2.8.2.1. Geodyn Shredder

The Geodyn Shredder machines were designed perfectly to shred any type of waste product. The shredding rotors are made from especially hardened steel to withstand anything thrown at it. Our machine uses a water cooling system to help regulate temperature and specially designed weld filler in our knives help to prevent premature wear. Our shredders feature infused water cooled housing which indirectly keep the knives cool. Coupled with our cooling system, our low RPM motor helps to extend the life time of our knives. The knife system features 6 rows of staggered knives, with 18 knives sitting on variable degrees which allow all material and fibers to be shredded without exception.

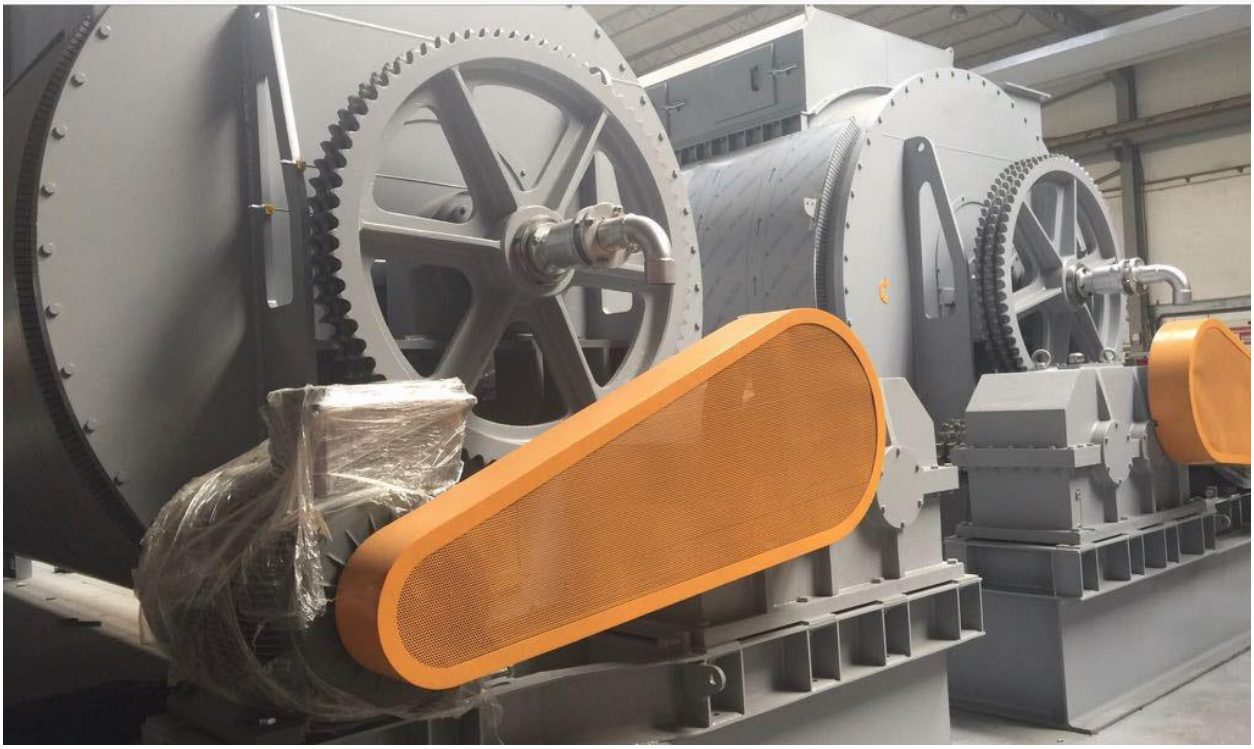
Front View Profile View - Complete System - Sieve - Cooling System - Elec. Panel

2.8.2.2. Geodyn Separation / Dewatering Press

This press is utilized after the shredding process to extract the liquid from the food and green waste. The liquid will be transferred to our filtration system in order to purify the water. The remaining solids will be sent to the cooker via conveyor for further processing

2.8.2.3. Geodyn Liquid Filtration System

2.8.2.4. Geodyn Cooker/Dry

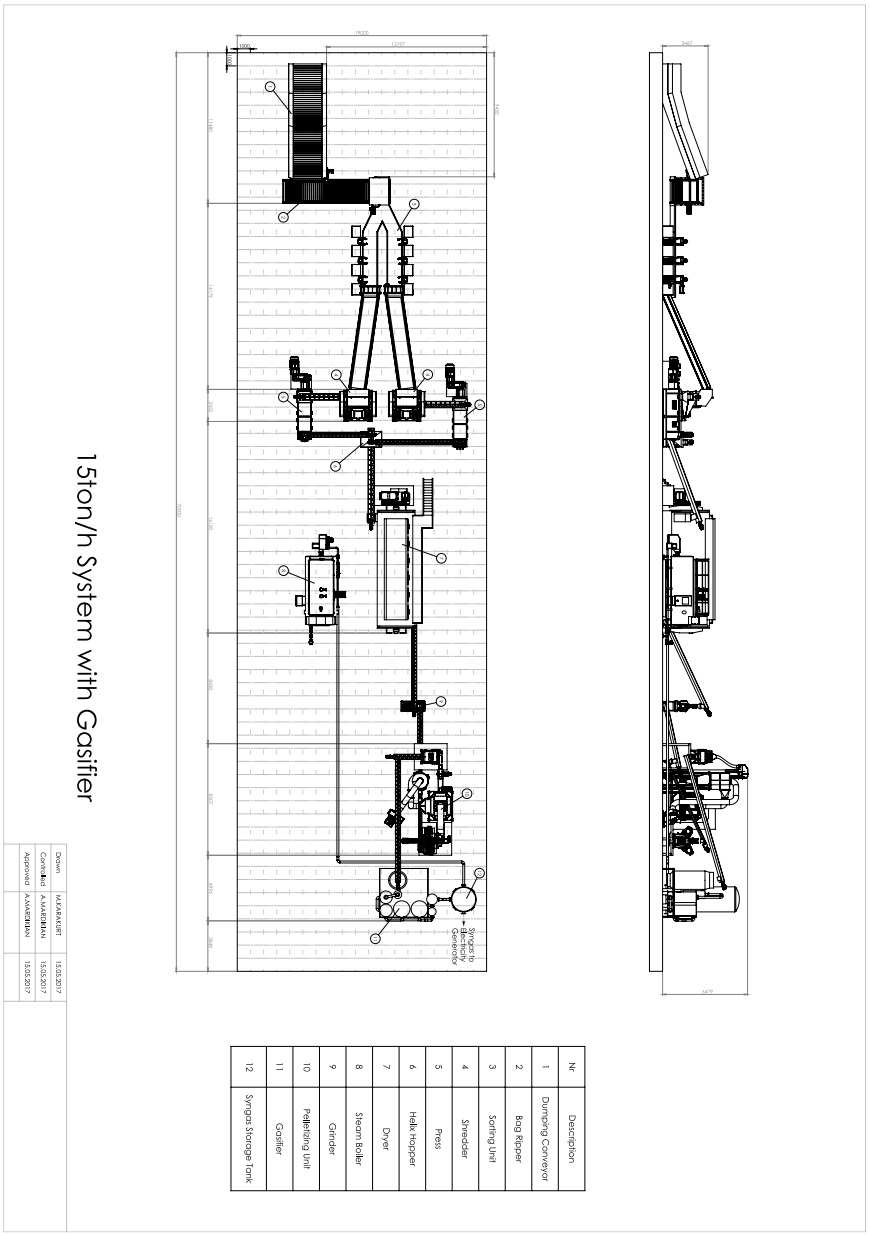


2.8.2.5. *Geodyn Thermic Fluid Heater*

2.8.2.6. *Geodyn Grinder*

2.8.2.7. Geodyn Pelletizer

2.8.3. Layout of MSW Treatment Plant



2.8.4. Advantages of Geodyn's MSW Treatment Technology

Reliability

- Technologically Validated & Tested for Total Waste;
- Single Automated Process;
- Less Complicated & Easy to handle Operate;
- Operational Life of 20-25Yrs.

Affordability

- Relatively Low Capital Cost & Operating Cost;
- Long Economic Life;
- Financially Viable;
- Higher ROI; Low Risk.

Availability

- Configured & Tested for long continnous operating hours;
- Available in multiple configurations with various customization for handling every kind of waste;
- Easy to Operate & maintain.

Sustainability

- Clean Source of Energy, virtually carbon neutral with less than 2% smoke generated on burning;
- Pellets are a Green substitute to Coal, reduces dependence on other sources of power
- Higher Social & Economic Impact.

2.8.5. Comparison with Other Technologies

Technology	By Product	Capacity	Processing Time	Pathogen Free End Product	Odor Free End Product	Humidity Control	Indirect Heat Controlled Cooker & Drying	Liquid Separation / Pelletizing Option	High Kcal Output
Geodyn Organic Waste Recycling	Fertilizer/ Feed/ Fuel/ Pellets & water recovery	Up to 42 TPH	Less than 1 Hour	✓	✓	✓	✓	✓	✓
In Vessel Composting System	Compost	75 Tons	4-7 days	✗	✓	✗	✗	✗	✗
Tunnel Composting	Compost	Various	7-30 days	✗	✗	✗	✗	✗	✗
Dry Fermentation Digester	Bio-Gas	Various	21 to 28 days	✗	✗	✗	✗	✗	✗
Tunnel Composting	Compost	Various	7-30 days	✗	✗	✗	✗	✗	✗
In Vessel Composting System	Compost	40-50Yds	14-21 Days	✗	✗	✗	✗	✗	✗
Biomass Pyrolysis	BioChar/ Syngas	2-4 TPH	2-4 TPH	✓	✓	✗	✗	✗	✓
Plasma Waste Disposal	SynGas	10-5000 TPD	NA	✓	✓	✗	✗	✗	✓
Dehydration System	Dehydrated Food Waste	110-2000 lbs/D	12-18 Hours	✗	✓	✓	✗	✗	✗

2.8.6. Market Place for Geodyn Fuel Pellets & other By-Products

High Energy Fuel Pellets produced by treating solid waste using Geodyn's waste treatment technology has an extremely high calorific value as compared to its peers. The estimated gross calorific value ranges anywhere from 4000kcals/Kg to 6000kcals/kg depending upon the composition of waste. Upon burning, these fuel pellets has virtually zero hazardous emissions and are a green alternate to fossil fuels such as Coal, Fire Wood etc. The pellets has a ready market for its mass consumption, some of the most common users are:

Geodyn has overcome the most common difficulties faced in marketing of RDF which is bad or not stable quality of the product (limitations are due to odor/foul smell and variation in GCV of the RDF). Geodyn has established plants that follow a stringent process to establish Fuel Pellet as a Green Alternative Fuel to Coal especially in emerging markets due to its stable quality and price advantages.

Efficient	• Uniform shape and size for remarkable consistency & Burning efficiency. • Fuel Pellets have low moisture and ash content, which further adds to their performance.
Safe	• Safe to use and store • No risk of fire hazards
Smokeless Operations	• Smokeless operations • Clean and hygienic working environment
Cost Effective	• Significantly lower their energy costs through use of eco pellets
Sustainable & Eco Friendly	• Use of Fuel Pellets reduces emissions through utilization of MSW • Biomass residue an replacement to conventional fossil fuels
Easily Available	• Fuel Pellets will be manufacture locally, within the country, using the abundant MSW and biomass resources. • No fear of shortages, stock-outs or undue price fluctuations unlike conventional fossil and imported fuels such as LPG and Diesel

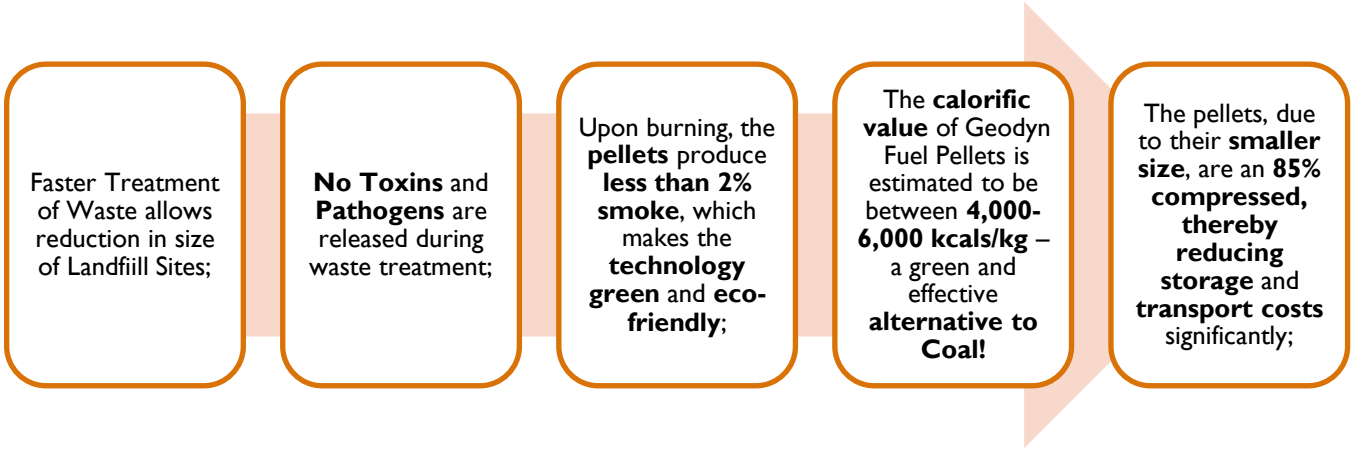
2.8.7. Lab Report of Fuel Pellet

No.	Test Parameters	Observed Results	Test Method
1	Moisture, % by mass	4.19	IS: 1350 (P-1)
2	Ash, % by mass	21.94	IS:1350 (P-1)
3	Volatile matter, % by mass	65.15	IS: 1350 (P-1)
4	Fixed carbon, % by mass	8.72	IS:1350 (P-1)
5	Gross calorific value, k.cals/kg	4302	IS: 1350 (P-1)
6	Bulk density, kg/m^3	719.5	IS: 33-1992 guidelines

2.8.8. Comparison of Fuel Pellet with different fuels

ITEM	COAL	DIESEL D2	NG	Geodyn Fuel Pellets
HEAT VALUE	5000 (kcal/kg)	10200 (kcal/kg)	8700 (kcal/m3)	**4300 (kcal/kg)**
BOILER EFFICIENCY	74%	88%	88%	**80%**
DENSITY (kg/m³)	1100-1400 (kg/m³)	830-860 (kg/m³)	0.74 (kg/m³)	**980 (kg/m³)**
CO2 (g/kg)	1.78%	3.06%	1.96%	**< 1.00%**
SO2 (g/kg)	0.5%	3.25%	/	**0.07%**
NOx (g/kg)	2.94%	3.67%	1.87(g/m³)	**1.02%**

2.8.9. Environmental Impact



2.8.10. Key Factors Responsible for Economic & Commercial Viability of Geodyn MSW Treatment Technology

Faster Processing of Solid Waste in less than 1 Hour!

Technology suited to handle any Composition of Waste effectively & efficiently.

Technology is Less Complex. Easy Operation & Maintenance.

Fewer Space Requirement to setup MSW Plant.

High Availability of MSW Plant; Very low downtime.

Fuel Pellets High on Calorific Value with negligible emission levels.

Low & Easy Storage Requirements for Geodyn Fuel Pellets.

Ready Domestic & International Market Place for Geodyn Fuel Pellets.

Easy Handling & Low Transporartion Cost as compared to other Fossil Fuels, RDF or Biomass etc.

Section 3: Geodyn Pellets to Power

Gasification & Syngas Overview

Became easily available. The interest in the gasification technology has undergone many ups and downs in running century. Today, because of increased fuel prices and environmental concern, there is renewed interest in this century old technology. Gasification has become more modern and quite sophisticated technology.

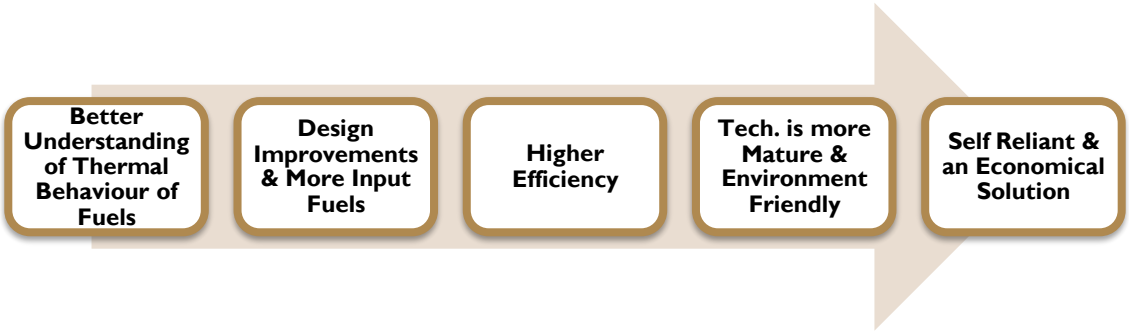
The advantage of this technology is decentralized energy conversion system which operates economically even for small scale. A gas producer is a simple device consisting of usually cylindrical container with space for fuel, air inlet, gas exit and grate. It can be made of fire bricks, steel or concrete and oil barrels. The design of gasifier depends upon type of fuel used and whether gasifier is portable or stationary. Gasifier alone itself is of little use. The complete gasification system consists of gasification unit (gasifier), gas purification unit and energy converter - burners or internal combustion engine/gas generator set.

Gasification is basically a thermochemical process which converts biomass materials or into gaseous component. The result of gasification is the producer gas aka syngas, containing carbon monoxide, hydrogen, methane and some other inert gases. Mixed with air, the producer gas can be used in gasoline or diesel engine with little modifications.

Based on the design of gasifiers and type of fuels used, there exists different kinds of gasifiers. Portable gasifiers are mostly used for running vehicles. Stationary gasifiers combined with engines are widely used in rural areas of developing countries for many purposes including generation of electricity and running irrigation pumps.

Gasification allows utilization of msw/biomass as fuel with moisture content of 5-30% can be gasified; however, not every msw/biomass fuel can lead to the successful gasification. It was recognized that fuel properties such as surface, size, shape as well as moisture content, volatile matter and carbon content influence gasification. The key to a successful design of gasifier is to understand the properties and thermal behavior of the fuel as fed to the gasifier. Compared to conventional system such as liquid fuel run engines, msw/biomass gasification technology is inconvenient. But it is economical at many places and may lead to self-reliance in the crucial time of fuel crisis.

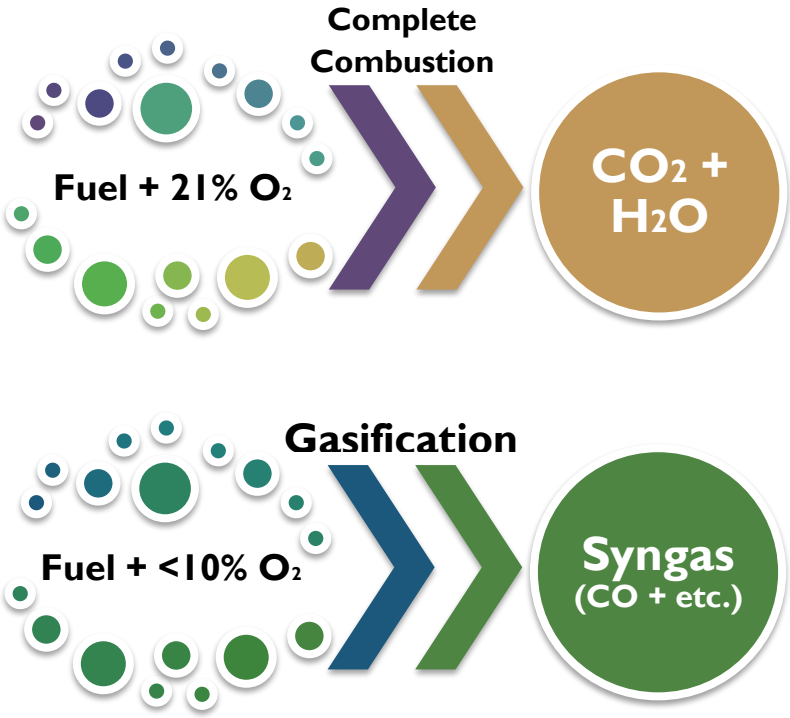
Evolution of Gasification Technology



3.1.1. Gasification Products and Application

The product from the gasification process is a product gas mainly includes carbon monoxide (CO) and hydrogen (H2) and less percentage of methane (except for nitrogen, water and CO2).

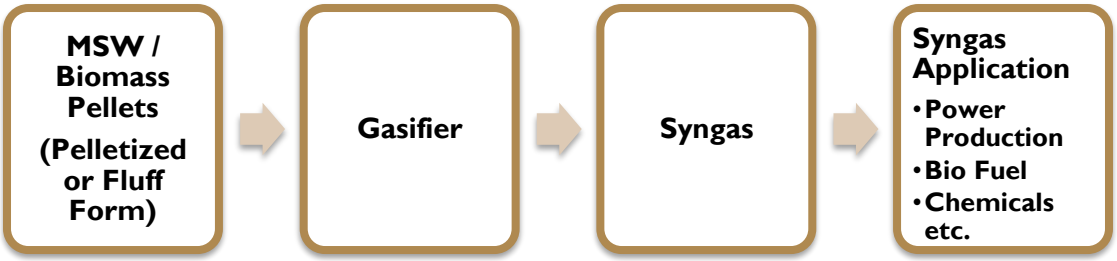
When the concentration of CO and H2 is high, the product is named **Syngas**. Syngas is colorless, odorless and very flammable. Syngas through gasification is considered to be as sustainable alternative fossil fuel which has multiple applications such as Electricity Prodn., Automotive Fuel, and Chemicals etc.



In the gasification process, the energy content in the waste materials is converted into a gas phase fuel. The conversion is affected by several parameters where one of the important is the preparation of the feedstock to achieve increased conversion efficiency. Pellet production as an option for pretreatment of waste, has highly influence on waste gasification.

3.1.2. Electricity Production

Syngas and product gas can be fired in gas turbines and gas engines to generate electric power. Use of Gas Turbines & Engines is dependent on the required capacity of the plant. Gas Engines are recommended for small & moderate sized projects whereas Gas Turbines are preferred for large scale power production.

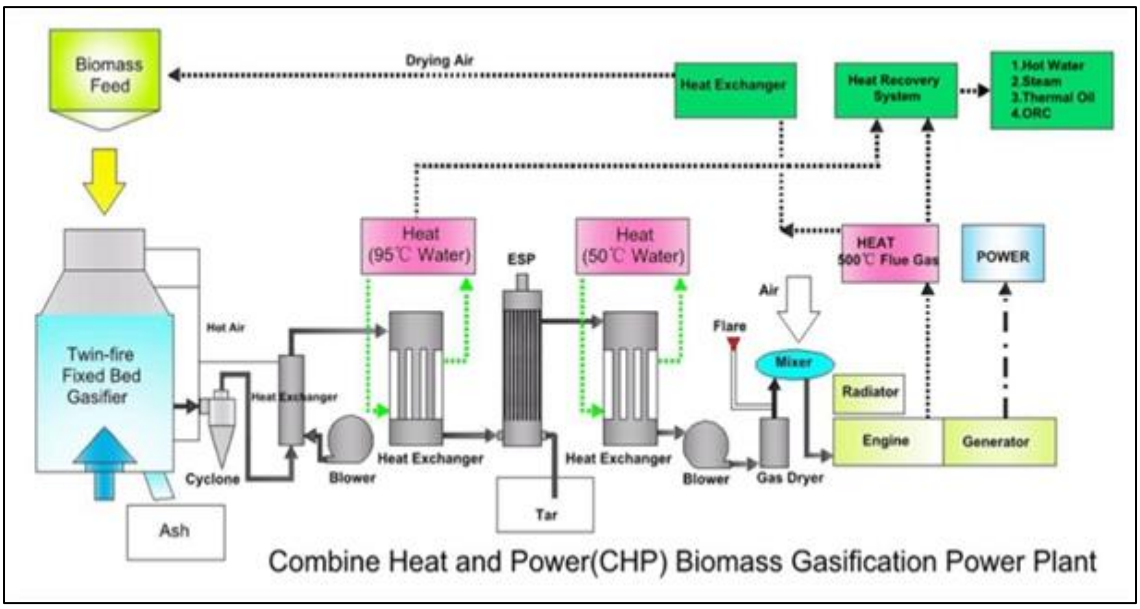


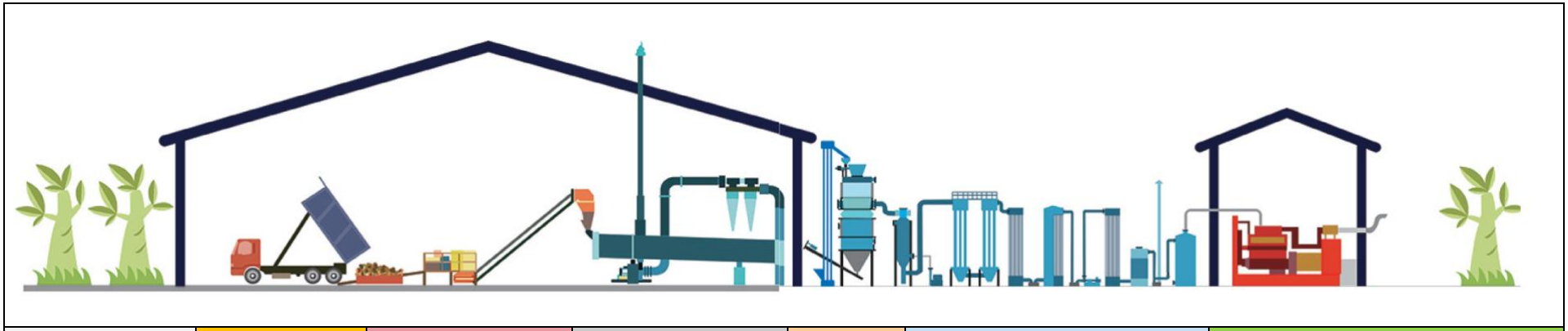
3.2. Geodyn Pellets based Gasification Power Generation System General Flow Chart

1. Geodyn Pellets gasification process includes three steps. The First step is Pellet Gasification, which convert pellets into Syngas.

2. The Second step is Syngas Purification. The producer gas coming from gasifier usually contains contaminates including dust, coke, tar and etc. The contaminants will be removed by the purification system to ensure normal operation of gas engine.

3. The Third step is power generating in gas engine. The high temperature exhaust gas may be reused by waste heat boiler to generate steam or hot water for civil or industrial use. Steam turbine may also be considered to make a gas-steam combined cycle power plant, which will increase the total efficiency.





Geodyn Pellet	Delivery	Preparation	Drying	Gasifier	Gas Cleaning	Power Gen.

MSW/Biomass	MSW/Biomass Preparation	Gasification System	Power System
1. **Municipal Solid Waste** - Geodyn Pellets / Fluff Form	- Weighbridge - Storage - Briquettes for fine material, if needed - Transport Conveyor - Dryer, if needed - Dust Collector - Biochar Recycle System - Crusher, if needed	- Bucket Elevator / Skip Charger / Belt Conveyor - Gasifier (TFBG) - Biochar Discharge Screw - Dust Collector - ESP (Electrostatic Precipitator) - Air Blower / Roots Blower / Suction Blower - Air Cooler - Heat Exchanger - Butter Tank - Gas Dryer - Flare - Process water treatment system / evaporator - Cooling Tower	- Gas Generators **Other Application** - Dryers - Boilers - Thermic Fluid Heaters - Ovens - Furnaces - Micro Turbines - Gas Turbines

3.3. Gasification Process

Gasification is quite a complex thermochemical process. Splitting of the gasifier into strictly separate zones is not realistic, but nevertheless conceptually essential. Gasification stages occur at the same time in different parts of gasifier.

3.3.1. Drying

Geodyn Pellets consist of moisture ranging from 5 to 12%. At the temperature above 100°C, the water is removed and converted into steam. In the drying, fuels do not experience any kind of decomposition.

3.3.2. Pyrolysis

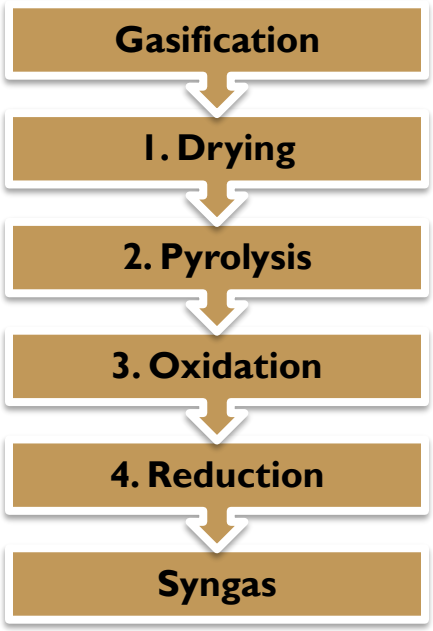
Pyrolysis is the thermal decomposition of Geodyn Pellets in the absence of oxygen. Pyrolysis involves release of three kinds of products: solid, liquid and gases. The ratio of products is influenced by the chemical composition of biomass fuels and the operating conditions. The heating value of gas produced during the pyrolysis process is low (3.5 - 8.9 MJ/m3).

It is noted that no matter how gasifier is built, there will always be a low temperature zone, where pyrolysis takes place, generating condensable hydrocarbon.

3.3.3. Oxidation

Introduced air in the oxidation zone contains, besides oxygen and water vapors, inert gases such as nitrogen and argon. These inert gases are considered to be non-reactive with fuel constituents. The oxidation takes place at the temperature of 700-2000o c.

Heterogeneous reaction takes place between oxygen in the air and solid carbonized fuel, producing carbon monoxide. Plus and minus sign indicate the release and supply of heat energy during the process respectively



- C + O2 = CO2 + 406 [MJ/kmol]

In reaction 12.01 kg of carbon is completely combusted with 22.39 m3 of oxygen supplied by air blast to yield 22.26 m 3 of carbon dioxide and 393.8 MJ of heat. Hydrogen in fuel reacts with oxygen in the air blast, producing steam.

- H 2 + ½ O 2 = H2O + 242 [MJ/kmol]

3.3.4. Reduction

In reduction zone, a number of high temperature chemical reactions take place in the absence of oxygen. The principal reactions that take place in reduction are mentioned below.

- **Boudouard Reaction**

CO 2 + C = 2CO - 172.6 [MJ/kmol]

- **Water-gas reaction**

  C + H2 O = CO + H 2 - 131.4 [MJ/kmol]

- **Water shift reaction**

  CO 2 + H 2 = CO + H 2 O + 41.2 [MJ/kmol]

- **Methane production reaction**

  C + 2H 2 = CH 4 + 75 [MJ/kmol]

Main reactions show that heat is required during the reduction process. Hence, the temperature of gas goes down during this stage. If complete gasification takes place, all the carbon is burned or reduced to carbon monoxide, a combustible gas and some other mineral matter is vaporized. The remains are ash and some char (unburned carbon).

3.4. Syngas and its Constituents

Syngas, Producer gas from Geodyn Pellet gasification system is the mixture of combustible and non-combustible gases. The quantity of gases constituents of gas depends upon the type of fuel and operating condition.

The heating value of producer gas varies from 4.5 to 6 MJ/m 3 depending upon the quantity of its constituents. Carbon monoxide is produced from the reduction of carbon dioxide and its quantity varies from 15 to 30% by volume basis. Although carbon monoxide possesses higher octane number of 106, it´s ignition speed is low. This gas is toxic in nature. Hence, human operator needs to be careful while handling the gas.

Hydrogen is also a product of reduction process in the gasifier. Hydrogen possesses the octane number of 60-66 and it increases the ignition ability of producer gas. Methane and hydrogen are responsible for higher heating value of producer gas. Amount of methane present in producer gas is very less (up to 4%). Carbon dioxide and nitrogen are non-combustible gases present in the producer gas. Compared to other gas constituents, producer gas contains highest amount (45-60%) of nitrogen. The amount of carbon dioxide varies from 5 to 15%. Higher percentage of carbon dioxide indicates incomplete reduction. Water vapors in the producer gas occur due to moisture content of air introduced during oxidation process, injection of steam in gasifier or moisture content of biomass fuels.

4. Geodyn Pellets as Input Fuel for Syngas & Power Prodn.

Producing energy from trash is known as a "waste-to-energy" option. Several such options have existed for many years and are in extensive use throughout Europe and limited use in the United States. One of the more exciting options that has been proposed within the last decade is to convert waste into engineered Fuel Pellets or Briquettes to extract the valuable energy in the most efficient ways. The technology is an agglomeration process that can be categorized as densification technology which makes the bulk density of rubbish to be compact and dense. Physical and chemical behavior of raw material has significant influence of the briquette quality as a fuel.

Geodyn Fuel Pellets

4.1.1. Important Properties of Geodyn Fuel Pellets

- *Higher Calorific Value*

Geodyn Fuel Pellets have a gross calorific in the range of 4000-6000 kcals/kg which is much higher than other pellets available in the market and comparable to fossil fuels such as Coal.

- *Low Moisture Content*

Geodyn Fuel Pellets have less than 12% moisture content, and highly suited as input fuel for any kind of boiler etc.

- *Less Emissions*

Geodyn Fuel Pellets have less carbon and other hazardous emissions than coal, diesel etc.

- *Strength*

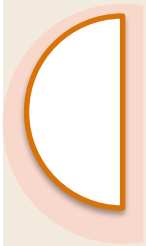
Material composition has great influence on the final quality of the produced fuel (the density and strength of the briquettes or pellets). In case of Geodyn Fuel Pellets, the strength is much higher than other similar pellets due to the unique binding and pelletization process.

- *Density*

Geodyn Fuel Pellets have high density ratio and thus a higher energy ratio. High-density products are desirable in terms of transportation, storage and handling. The calorific value of raw MSW is around 1500 kcal/kg while that of fuel pellets is +4000kcal/kg. On an average, about 45-65 tons of fuel pellets can be produced after treatment of 100 tons of raw garbage

4.1.2. Advantages of Geodyn Fuel Pellet in Power Prodn.

Results shows that the Geodyn fuel pellets have a predictable energy content in the range of 4000-6000 kcals/kg with less than 12% moisture content and higher density. When the whole production, transportation and combustion life cycle of the Geodyn fuel pellets is considered, large fossil fuel energy savings can be realized. An approximate of 1-1.25kg of Geodyn fuel pellets are capable of producing 1kwh of energy.



Geodyn Fuel Pellets Properties

Composition: Mixture of organic, plastic material and other combustible material;

Organic Content: App. 45.85% depending on plastic content, lower CO2 emission as compared to coal

Calorific Value: App. 4000-6000 kcals/kg depending on the plastic and biomass contents

Ash Content: App. 15%, depending on the paper contents in CCF Fuel

Carbon Content: App. 20% less Carbon compared to coal, giving a direct lower CO2 emission reduction next to the reduction gained by avoiding coal

Moisture Content: <12%

Chlorine Content: Compared to other biomass fuels the CCF Fuel contains low chlorine contents

Sulphur Content: Compared to high volatile bituminous coal, the sulphur content is very low

Nitrogen Content: CCF Fuel is NOx reducing, the N content is lower than that of coal and it has a higher burning reactivity

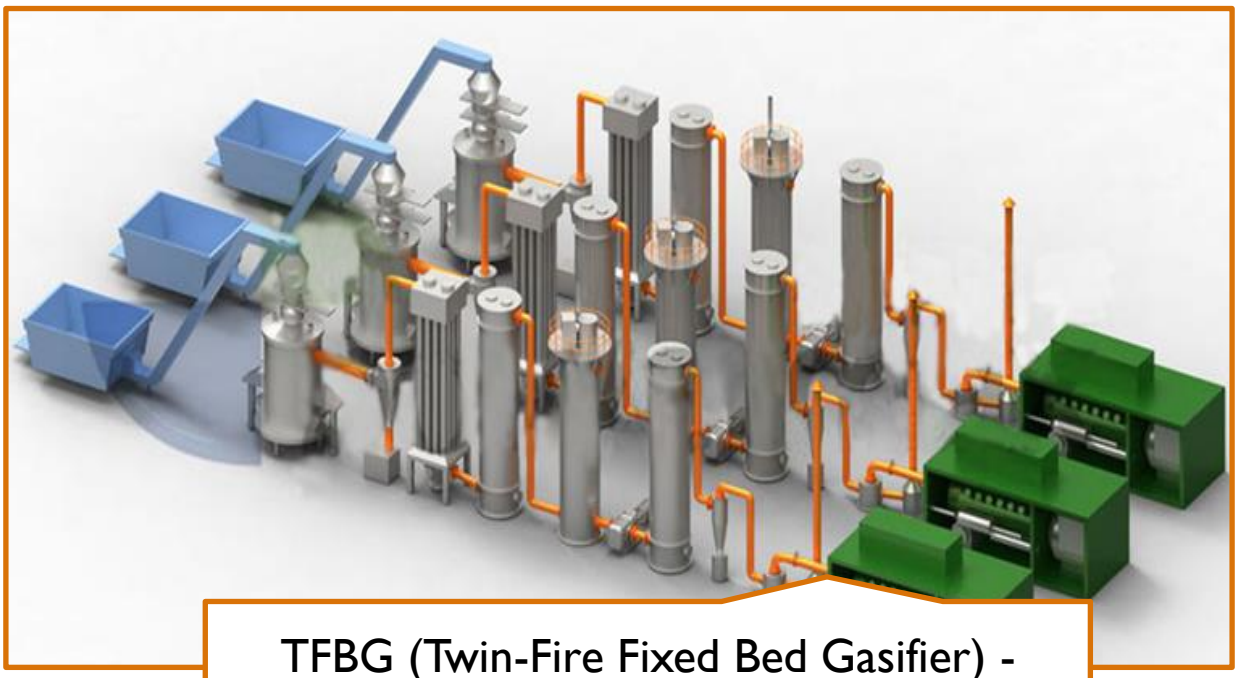
Copper content: Copper (Cu) will be separated by using a so called Eddy Current machine.

Handling: Open air storable and transportable, just like coal

5. Gasification & Power Generation Solution

The gasification power generation systems are based on a modular concept and are recommended for **50-10000KW** power station. There are four series of biomass gasification systems offered by Geodyn which range from **50-2000KW** of power generation: CBFG (Circulating Fluidized Bed Gasifier) Series, UFBG (Updraft Fixed Bed Gasifier) Series, OFBG (Downdraft Fixed Bed Gasifier) series, TFBG (Twin-fire Fixed Bed Gasifier) Series. A series generator sets from 50KW to 1200KW are offered by Geodyn with combination of advanced gasification technology.

These gas generator sets uses the high efficiency Siemens Alternators, and top brand speed gas engine (500-1500rpm) with advanced European engine control systems. The high performance of the MSW/Biomass gasification plants and the later production of electricity with the gensets represent a competitive solution when compared with conventional boiler-fired system



TFBG (Twin-Fire Fixed Bed Gasifier) -
Range from **50-2000KW** * Multiple Sets
Best Suited for Power Gen. upto 10 MW

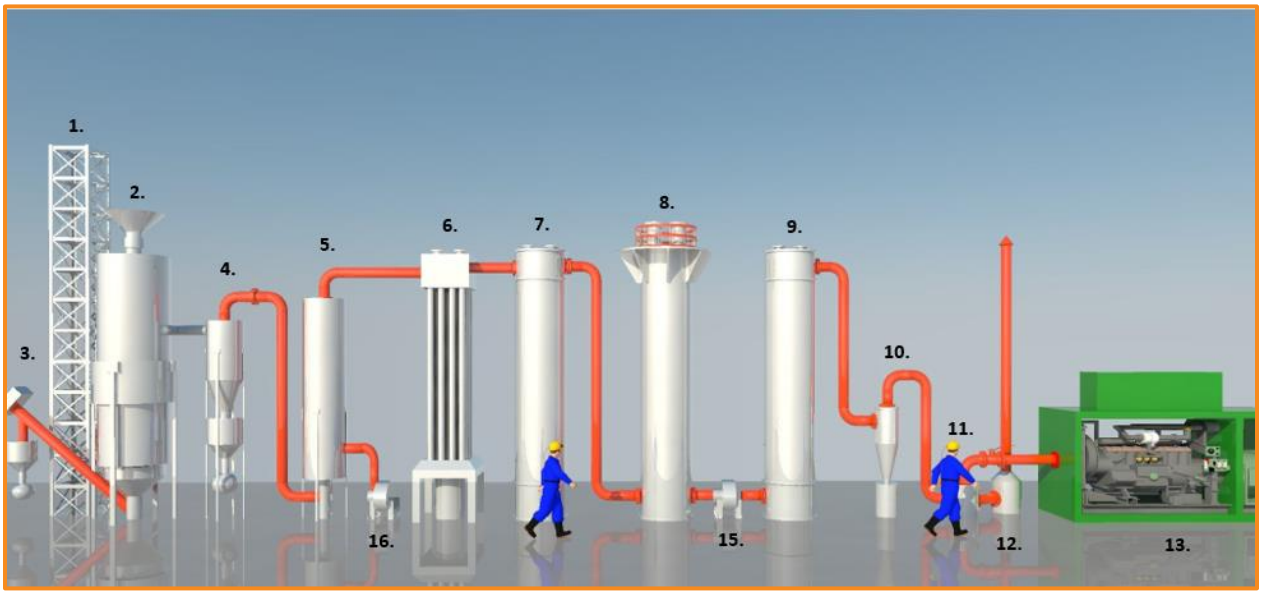
5.1. Twin Fired Fixed Bed Gasifier

The fuel in the form of Geodyn Pellets is fed through the skip charger into feed shell having pneumatic double door assembly and is stored in the upper part of gasifier.

The twin-fire fixed bed gasifier has got two locations for the air introduction: one in the oxidation area of upper part of the gasifier and another from the bottom part of gasifier via the ash grate.

The dry ash discharge that falls out of reactor gets collected in the slanted table of reactor and from there it is taken out with the help of a screw conveyor. The screw conveyor outlet has a two valve Dry Ash Collection Box which holds the dry ash/discharge for a particular duration of time. The dry ash amount is 5-6% of material feeding in.

Extraction of the producer gas from the reactor is via the collecting duct located in the area of the reduction zone. The gas outlet is connected with Dry Type Gas Cleaning and Cooling System. It includes cyclone dust collector, hot air heat exchanger, air cooler, first indirect cooler, dry type ESP, second indirect cooler, gas compressor, gas dryer, buffer tank.



1. Skip Charger | 2. Gasifier | 3. Dry Ash Discharger | 4. Cyclone Dust Collector | 5. Hot Air Heat Exchanger | 6. Air Cooler | 7. Gas Cooler | 8. ESP | 9. Gas Cooler | 10. Gas Dryer | 11. Buffer Tank | 12 . Gas Flare | 13. Gas Generator Sets | 14. Blower 115. Gas Compressor

5.1.1. Feeding System/Feed shell:

The feed shell stores Geodyn Pellets in air tight compartment before discharging it into the upper part of gasifier. The feed shell has two pneumatically operated doors, one on top and other at the bottom.

This is to prevent ingress of excess air into the gasifier. When Geodyn Pellets is fed into the feed shell, the bottom door is closed and the top door is open. When Geodyn Pellets is fed into the gasifier, the top door is closed and the bottom door is opened. There's a vibrator motor fitted on the feed shell which operates only when the bottom feed door is in open condition & assists in discharge of biomass into the upper part of gasifier.

5.1.2. Twin-Fire Fixed Bed Gasifier:

Twin-fire Fixed Bed Gasification is a combination of downdraft and updraft gasification. In the upper part of the gasifier the fuel is converted by means of a downdraft. It performs four functions of gasification viz, drying, pyrolysis, oxidation, reduction. It has air nozzles for induction of hot air into oxidation zone. The air nozzles are connected by ring canal outside the gasifier body. Inside of gasifier, it also has a tube for induction of hot air into the central of oxidation zone. The hot air flow can be controlled due to the different operation load of gasifier.

In the bottom part of the gasifier it works like updraft. In the upper part of gasifier still has a certain amount of unreacted charcoal accumulates in the reduction zone. The purpose of two-zone gasification is to use updraft gasification to convert this residual fuel in the grate area completely into producer gas. Our design of the reaction areas in the upper section corresponds to downdraft gasification; in the area of the ash grate there is an additional second oxidation zone.

5.1.3. Gas Cleaning and Cooling System:

The hot gas cleaning and cooling system could consist of Cyclone Dust Collector, Hot Air Heat Exchanger, Air Cooler, First Indirect Cooler, Dry Type ESP, Second Indirect Cooler, Gas Compressor, Gas Dryer, and Buffer Tank.

5.1.4. Cyclone Dust Collector

The carbon particulates from the hot gas settle down on passing through the cyclone dust Collector and are collected in the ash collection box. There are two pneumatic/manual valves and an ash collection box at the bottom of the cyclone. A temperature sensor to measure hot gas temperature is fitted on the hot gas line from cyclone dust collector to hot air heat exchanger.

5.1.5. Hot Air Heat Exchanger

In Order to increase the efficiency of gasification, the hot air heat exchanger is used to make the normal gasify agent (normal temp. air) to warm air. A temperature sensor to measure hot gas temperature is fitted on the hot gas line from hot air heat exchanger to Air Cooler.

5.1.6. Air Cooler

The Air Cooler is used to cool the gas inside of air cooler's tube by the normal air outside of air cooler's tube.

5.1.7. First Indirect Cooler

A flow of clean water is circulated in the first indirect cooler and producer gas passes through the tubes in the first indirect cooler. The temperature of the clean water should be maintained maximum 35°C when feeding to first indirect cooler. The clean water enters from the bottom part of the first indirect cooler, circulates across the tubes and comes out from the top part of first indirect cooler. In order to keep the best efficiency of dry type ESP which is fall behind of first indirect cooler, the producer gas after first indirect cooler must be maintained 100°C. Normally the flow of clean water is 25m3/hr ,the outlet water temp. is 70°C.

5.1.8. Dry ESP (ELECTROSTATIC PRECIPITATORS)

Dry type electrostatic precipitator (ESP) is a particle and tar control device that uses electrical forces to move the particles and tar out of the producer gas stream and onto the wall of pipe-shaped ESP filter. The working principle is characterized by three basic processes, firstly when the raw gas go through the Dry ESP, the tar and particle will be electrical charged, secondly tar and particle will be separated by electrical forces of attraction in an electrostatic field. Thirdly the tar and particle will settle down along the inner wall of pipe-shape ESP filter. The important operation is keeping the temp. of Dry type ESP 80-100°C in order to let the particles and tar fall down from the wall of pipe shaped ESP filter easily, In the Dry Type ESP, the raw gas enters from the bottom part of dry type ESP, and the clean gas after purification from the top part of dry type ESP. The amount Tar and Particle collected by Dry ESP is about 2kg per hr. They can be sent back to gasifier.

5.1.9. Second Indirect Cooler

A flow of clean water is circulated in the second indirect cooler and producer gas passes through the tubes in the second indirect cooler. The temperature of the clean water should be maintained 30°C when feeding to second indirect cooler. The clean water enters from the bottom part of the second indirect cooler, circulates across the tubes and comes out from the top part of second indirect cooler. In order to keep the best efficiency of gas generator set which is fall behind of second indirect cooler, the producer gas after second indirect cooler must be maintained less than 35°C. Normally the flow of clean water is 25m3/hr ,the outlet water temp. is 45°C.

5.1.10. Gas Compressor

The gas compressor is used to increase the pressure of the producer gas in order to meet the gas intake pressure of producer gas generator set.

5.1.11. Gas Dryer

The gas dryer is used to separate the water in the gas in order to decrease the humidity in the gas. The working principle is similar like cyclone dust collector.

5.1.12. Buffer Tank

The buffer tank is used to balance the pressure of producer gas after gas purification system and equally distributed the producer gas to each producer gas generator sets (if the quantity of producer gas gensets are more than one set).

5.2. Dry Type Gas Purification System

Dry Type Gas Purification Systems make Gasification System More Environmental Friendly.

Traditionally msw/biomass gasification utilizes a Wet Type Gas Purification System which normally contains scrubber or spray tower use water to direct washing the producer gas of particulates, tar and at same time cooling the gas. Wet Gas Purification System requires a large quantity of water that will need treatment for longer reuse and eliminates the opportunity for heat recovery. Dry Type Gas Purification System has been used with DFBGPP, CFBGPP, UFBGPP and the new TFBGPP all over the world.

Dry Type Gas Purification Delivers Installation Opportunities

With Dry Type Gas Purification System there is no direct contact with the producer gas, therefore no dirty washing water generation. It eliminates challenges of a foul smell as there is no process water pond and evaporation cooling requirements and offers a substantial savings in water otherwise needed for gas cooling. There is no slug produced with Type Gas Purification System, eliminated cumbersome sludge handling requirements. Best of all heat is recovered from hot gas which can be used for drying applications, heating purpose, or by thermal oil heat exchanger for ORC to make free electricity.

5.3. Producer Gas (Syngas) Quality & Dry Type Gas Purification System Benefits

The Dry Type Gas Purification System is consistent which allows for a smooth operation of the gas engine without fluctuations of power.

- Average CV of the Gas is >1100-2200 kcal/Nm3.
- Tar content in gas after cleaning is <5-10 mg/Nm3.
- Particulates after filtering is <5-10mg/Nm3.

Both particulates and tar are removed in a dry form in dry type ESP which makes handling easier. Ammonia is also removed through dissolution in condensate and only a small quantity (condensate) needs to be treated. There is also a possibility of recovering ammonium salts, which is a useful fertilizer, from condensate. And hot air is generated in the Gas Temperature

Control Subsystem during the cooling of the gas which can also be used for drying of the biomass or send back to gasifier for increasing the efficiency of gasifier.

Dry Type Gas Purification System totally eliminates any adverse environmental impact as no harmful vapors or particulates are released into the environment. The systems are extremely user-friendly and have no adverse health impact of operators or other associated people.

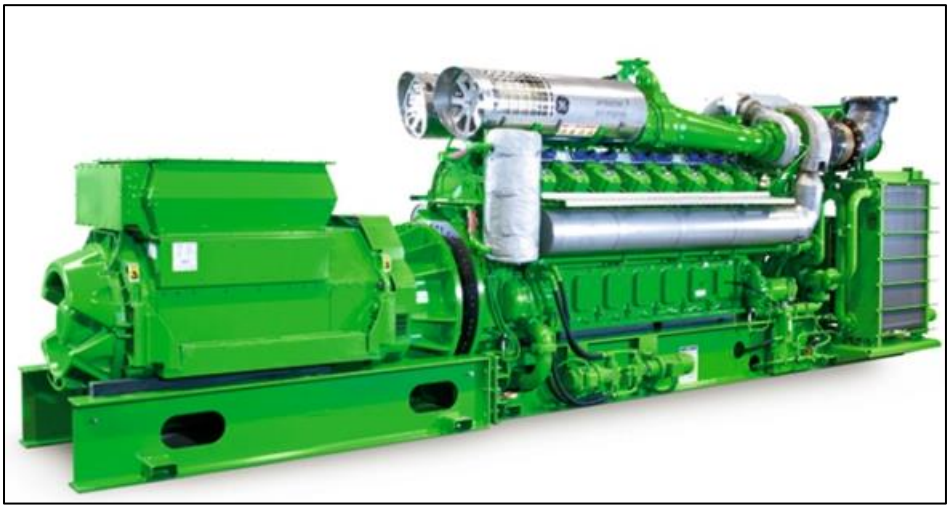
Gas Composition:

- CO 16~20%
- CO2 6~14%
- H2 13~15%
- CH4 2.5~3%
- O2 ~0.6%
- N2 47~51%
- Tar Content ~10mg/Nm3
- Particle~10mg/Nm3

5.4. Gas Generator Sets

Geodyn offers gas generator sets of high efficiency, low exhaust temperature, simple operation, easy maintenance and stable running, With the function of automatic/manual control, electronic speed control, automatic fault monitoring, automatic shut-down and etc. Gas generator may even be operated efficiently in long time under poor working conditions. Power range from 50-1200KW. High power output, lower emissions, lower life cycle cost (LCC), flexible gas application.

Our Partners: Siemens, Bosch, Heinzmann, Woodward, Deutz, Stamford, Smartgen and many more



5.5. Technical Specifications of TFBG Series Gasification Power Generation System

Model	TFBG	TFBG100	TFBG200	TFBG300	TFBG400	TFBG500	TFBG600	TFBG800	TFBG1000	TFBG1200	TFBG1500	TFBG2000
Rated Power (kw)	50	100	200	300	400	500	600	800	1000	1200	1500	2000
Rated Frequency	50 / 60 Hz											
Rated Voltage (V)	220 / 400 / 440 / 6300 / 6600 / 11000 / 13800											
Model of Gasifier	TFBG	TFBG100	TFBG200	TFBG300	TFBG400	TFBG500	TFBG600	TFBG800	TFBG1000	TFBG1200	TFBG1500	TFBG2000
Gasifier Type	Twin Fired Fixed Bed Gasifier											
Moisture Requirement	< 20% (Wet Basis)											
Size Requirement	Diameter 20mm-80mm; Length 10mm-80mm											
Consumption (Kg/Hr)	50-10	100-200	200-400	300-600	400-800	500-1000	600-1200	800-1600	1000-2000	1200-2400	1500-3000	2000-4000
Gas Production (Nm3/H)	125-150	250-300	500-600	750-900	1000-1200	1250-1500	1500-1800	2000-2400	2500-3000	3000-3600	3750-4500	5000-6000
Ash Discharge Type	Dry Ash Type / Wet Ash Type											
Type of Gas Purification	Dry Type Gas Purification System											
Heat Value of Gas	>1200Kcals/Nm3											
Gas Composition	CO15-20% | CO2 8-12% | Ch4 – Up to 3% | H2 15-20% | N2 45-50%											
Model of Genset	50GFLS	100 GFLS	100 GFLS	300 GFLS	400G FLS	500G FLS	300G FLS	400G FLS	1000 GFLS	400G FLS	500G FLS	1000 GFLS
Qty. of Genset	1	1	2	1	1	1	2	2	1	3	3	2

5.6. Advantages of Geodyn Pellet Gasification & Power Generation System

1. **Flexibility:** Gas engine, gas turbine and even waste heat recovery boiler may be used considering various power plant capacity requirements. It ensures high power generating efficiency. Different capacities of biomass power generation plant can be designed with various types of BOP system.

2. **Clean technology:** MSW/Biomass as one kind of renewable energy, may reduce the emission of carbon dioxide, Sulfur dioxide causing from fossil fuel. Nitrogen oxides emission is very limited in our biomass gasification power generating system because of low temperature (700t-1200t).

3. **Economical:** BOP is capacity flexible. Even small size biomass power plant is also profitable process and less land requirements make biomass gasification per plant more economical comparing with other renewable energy. Generally speaking, biomass gasification power generating is the most economical technology in renewable power generating plant, the cost of which is nearly the same as small-size conventional power plant

1 MW Gasification Power Plant Covers approx. 600m2 of area.

Section 5: Scope of Supply, Works & Services

Waste to Energy Plant

5.1. Scope of Supply & Works

5.1.1. Total Waste to Pellet Plant

S. No.	Description
1.	Material Intake System
2.	Weighing Bridge
3.	Pre-Sorting & Screening Equipment
4.	Complete Conveyor & Hopper System
5.	Shredder
6.	Separation Press
7.	Water Filtration System
8.	Total Waste System Cooker & Dryer
9.	Thermic Fluid Heater
10.	Pelletizer

5.1.2. Gasification System

S. No.	Description
1.	Raw Material Feeding System
2.	Twin Fire Fixed Bed Gasifier System
3.	Dry-Type Gas Purification System
4.	Flew Gas System
5.	Water Cooling System
6.	Electrical Control System
7.	Mechanical And Electrical Installing Materials
8.	Gas Generator/Turbine Set

5.1.3. Services

S. No.	Description
1.	Complete Design & Engineering
2.	Procurement, Packing, Co-ordination & Project management,
3.	Quality Assurance & Performance Test
4.	Transportation, Receiving & Unloading
5.	Erection and Commissioning
6.	Training of customer personnel at site
7.	Operation & Maintenance
8.	Disposal of Inert/Rejects/Ash

About Geodyn International Solutions Inc., USA

The Geodyn Philosophy

Geodyn aims to create from discarded and otherwise unusable items a new, environmentally efficient commodity that will improve overall quality of life.

Geodyn Technologies strives to become a global leader in innovation, efficiency, and recycling by creating technological solutions and bringing them to the world market. These innovations encompass the 'Geodyn philosophy' and harbor the improvement of our world and the life of its inhabitants.

The Geodyn philosophy is our guiding beacon in all we create. We identify the inefficiencies in our global industries and utilize technology to eliminate it. And we compound the advantages of that technology by making it environmentally beneficial as well as taking what was once green in this world, and forgotten, and bringing it back to life so it is green once more.