바이오가스 개론

바이오매스 / 바이오에너지

- **Biomass (organic matters such as wood, plants, residue from agriculture or forestry, and the organic component of municipal and industrial wastes) can be used to provide heat, make fuels, and generate electricity. This is called bioenergy.**

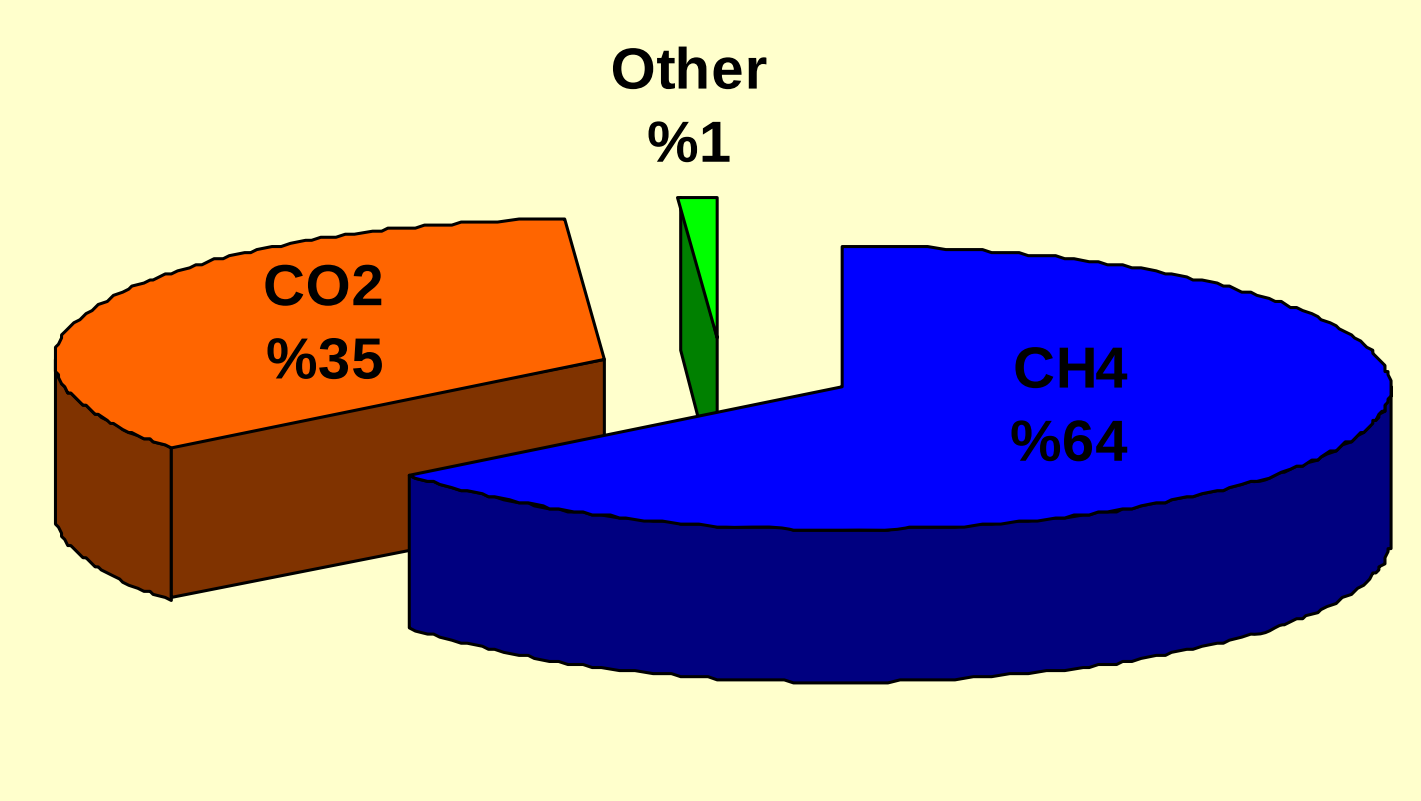
- **Biopower, or biomass power, is the use of biomass to generate electricity.**

- **World-wide, biomass is the fourth most-used fuel after oil, coal and natural gas.**

- **Biomass can be converted directly into liquid fuels (biofuels) like ethanol and biodiesel.**

- **Even gas can be produced from biomass for generating electricity (biogas).**

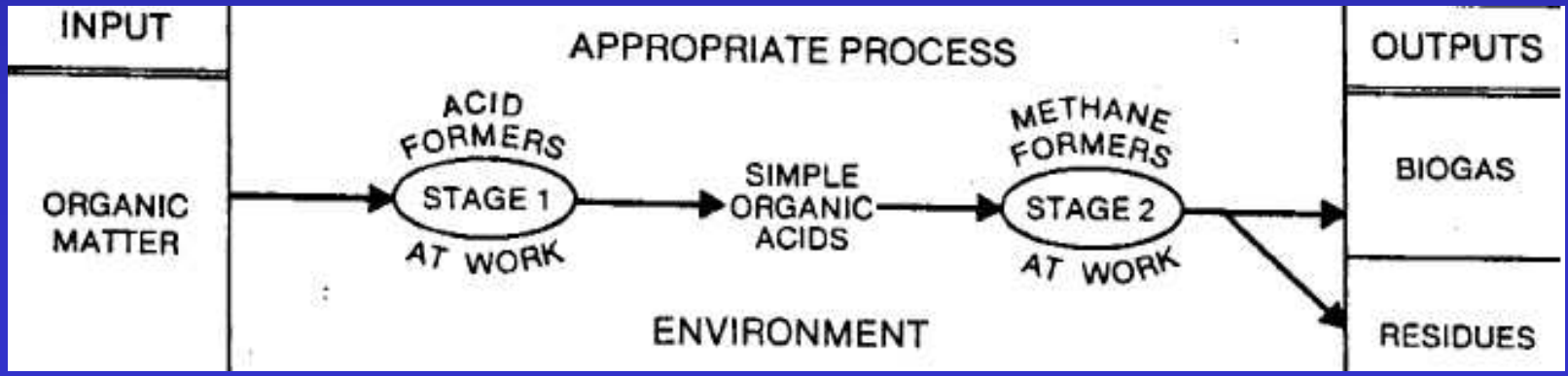
바이오가스 구성성분



바이오가스 생산방법

혐기소화

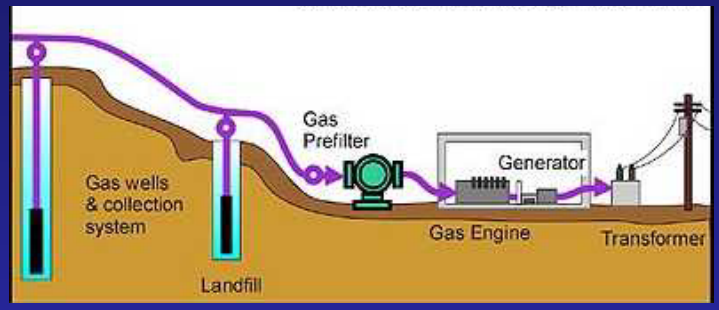
- **Organic Material → Fatty Acids (Acid Formers)**
- **Acids Converted to Methane (NH_4) and Carbon Dioxide (CO_2) by Methanogenic Bacteria (Methane Formers):**
  - **Methanobacterium, Methanobacillus, Methanococcus, Methanosarcina**



바이오가스 생산방법

바이오가스 생산 시스템

Short Mountain Landfill, Eugene, Oregon



- **Over 200 landfill generating stations in operation in US; another 180 landfill projects in planning or construction; total estimated capacity: 650 mWe**
- **Total US landfill potential is estimated as 4000 mWe**

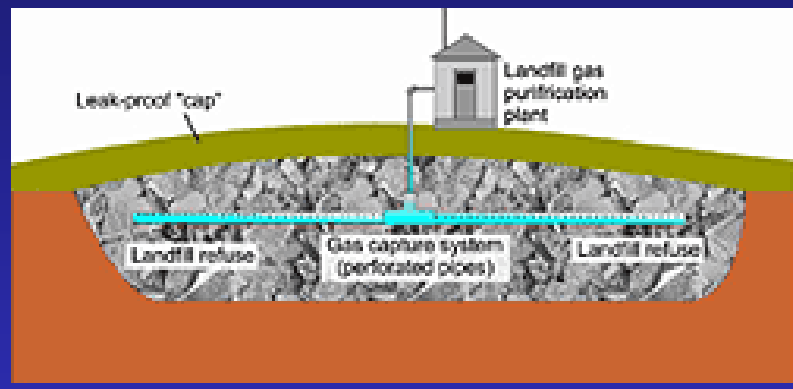
Sewage Treatment Plant, Salem, OR 450 kWe CHP System

Gasification system which uses gas turbines to generate electricity Renugas,Hawaii

바이오가스 생산방법

바이오가스 생산 시스템

매립가스



• Wells are drilled to release the methane from the decaying organic matter.

• Pipes carry the gas to a central point where it is filtered and cleaned before burning.

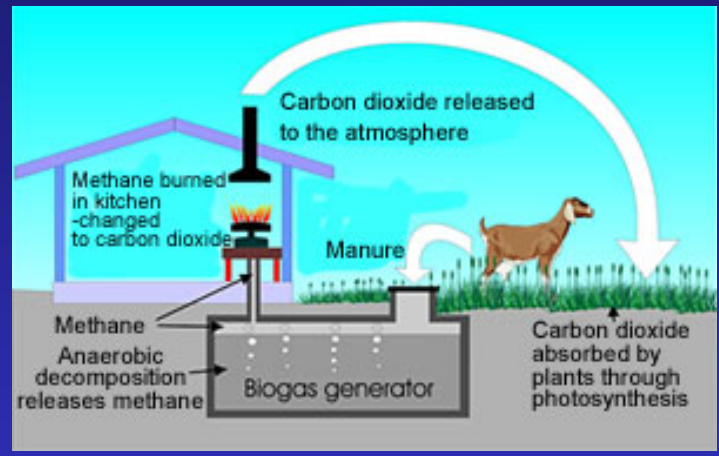
•Approximately 50 to 200 m3 of landfill gas, containing 50 to 60% of methane, is produced per tonne of municipal solid waste collected and dumped in the landfill.

• The amount of gas produced varies with the proportion of biological material contained in the domestic refuse.

바이오가스 생산방법

바이오가스 생산 시스템

Animal Manure as a Biogas Feedstock

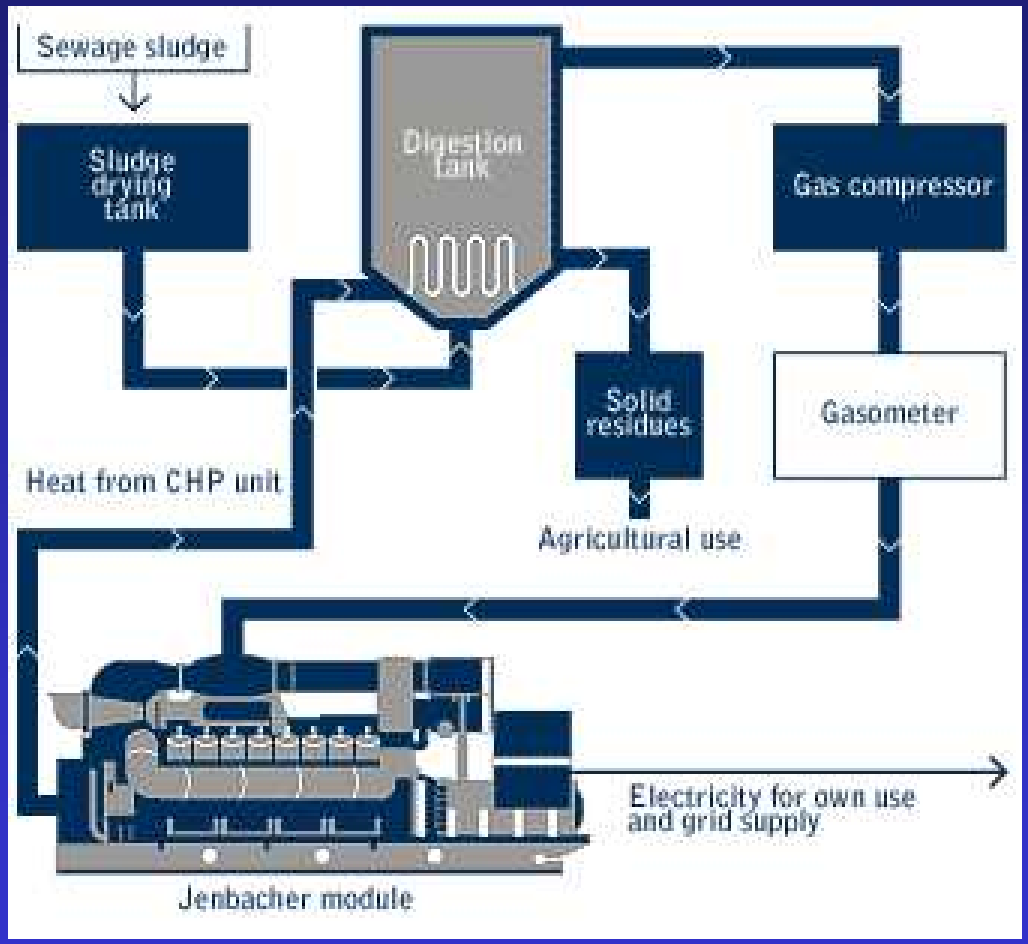


- **Food is only partially digested in animal's digestive tract.**
- **The remaining food (manure) still has plenty of organic fats, proteins, carbohydrates and other nutrients to feed gas-producing bacteria.**
- **If manure is routinely left on the floor or ground, aerobic bacteria decay it, producing a small amount of heat and ammonia, but no biogas.**
- **In an artificial environment (anaerobic digester), bacteria can work on the remaining organic particles in manure long enough to achieve more complete digestion and biogas production**
- **It is calculated that the annual amount of energy that can be obtained from one cow is equivalent to the energy in about 50 gallons of gasoline.**

바이오가스 생산방법

바이오가스 생산 시스템

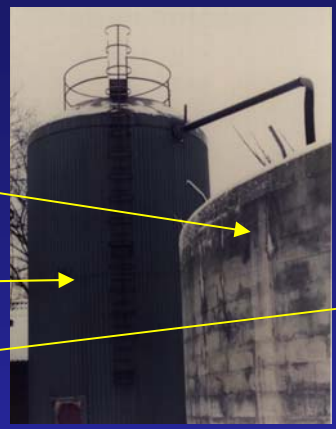
하폐수 슬러지



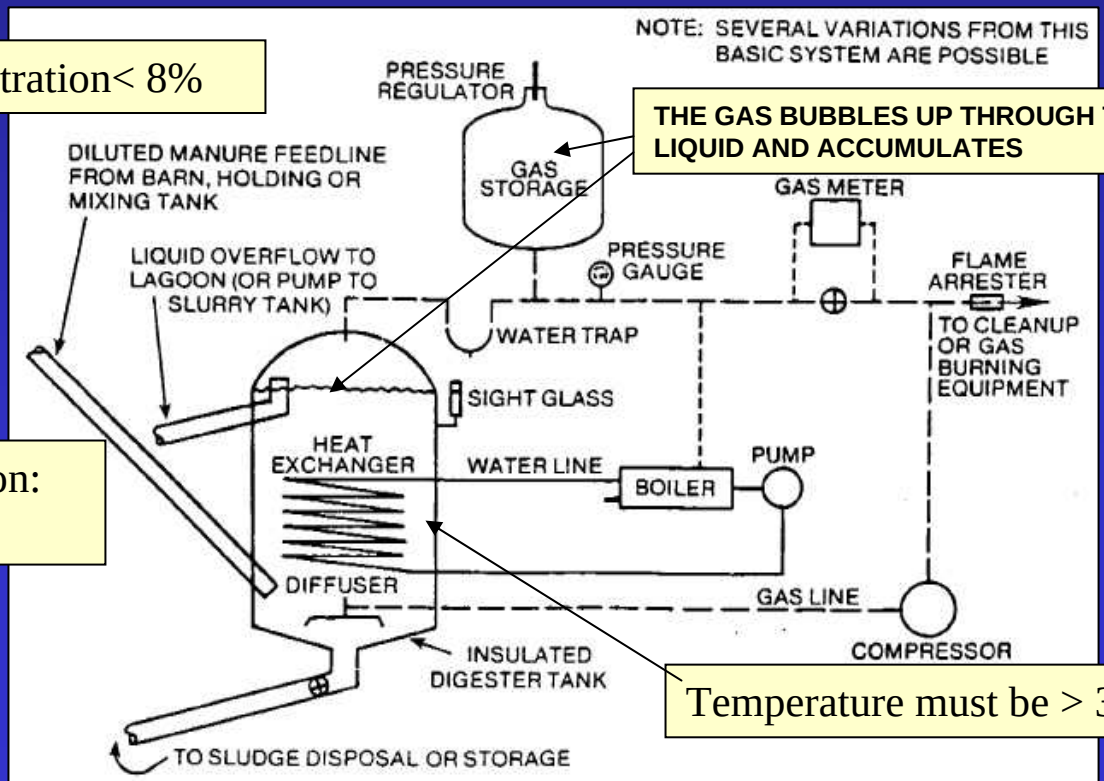
바이오가스 생산방법

바이오가스 시스템의 기본 성분:

- **A manure handling system**
- **A digester, with provisions for mixing and heating**
- **A gas handling and storage system**



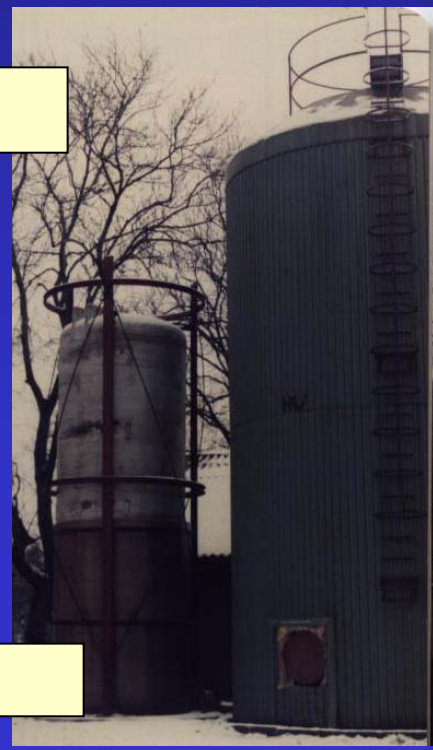
Manure Concentration< 8%



THE GAS BUBBLES UP THROUGH THE LIQUID AND ACCUMULATES

Digestion duration:
15-20 days

Temperature must be > 36C



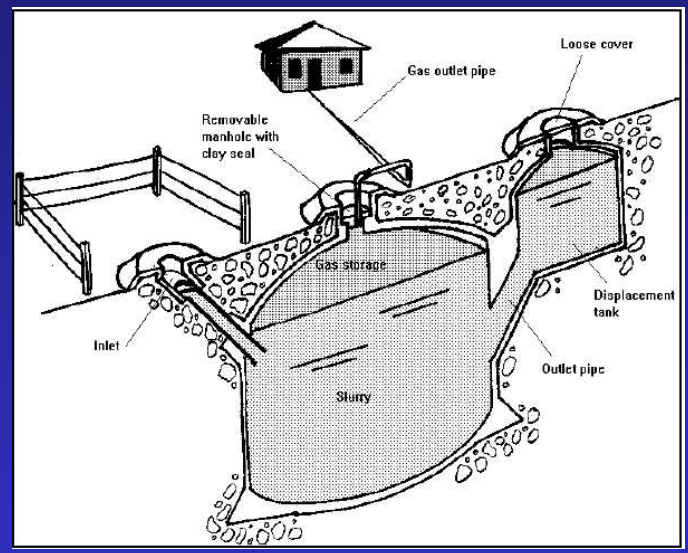
바이오가스 생산방법

바이오가스 생산 시스템

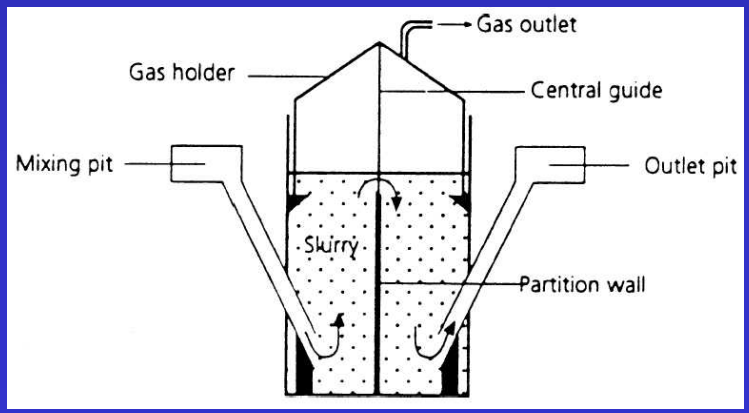
소화조

- **Two popular simple designs of digester have been developed;**
  - **Chinese fixed dome digester**
  - **Indian floating cover biogas digester**
- **The digestion process is the same in both digesters but the gas collection method is different in each.**

Water sealed cover of the digester is capable of rising as gas is produced and acting as a storage chamber, whereas the fixed dome type has a lower gas storage capacity and requires good sealing if gas leakage is to be prevented.



Fixed Dome Digester



Indian Floating Cover Digester

The waste is fed into the digester via the inlet pipe and undergoes digestion in the digestion chamber. The residual slurry is removed at the outlet and can be used as a fertiliser.

바이오가스 생산방법

가스화 시스템:

The conversion of biomass to a low- or medium-heating-value gaseous fuel generally involves two processes:

1. 열분해:

- **Releases the volatile components of the fuel at temperatures below 600˚C via a set of complex reactions. (hydrocarbon gases, hydrogen, carbon monoxide, carbon dioxide, tars, and water vapor)**
- **The by-products of pyrolysis that are not vaporized are referred to as char and consist mainly of fixed carbon and ash.**

2. 촤 전환:

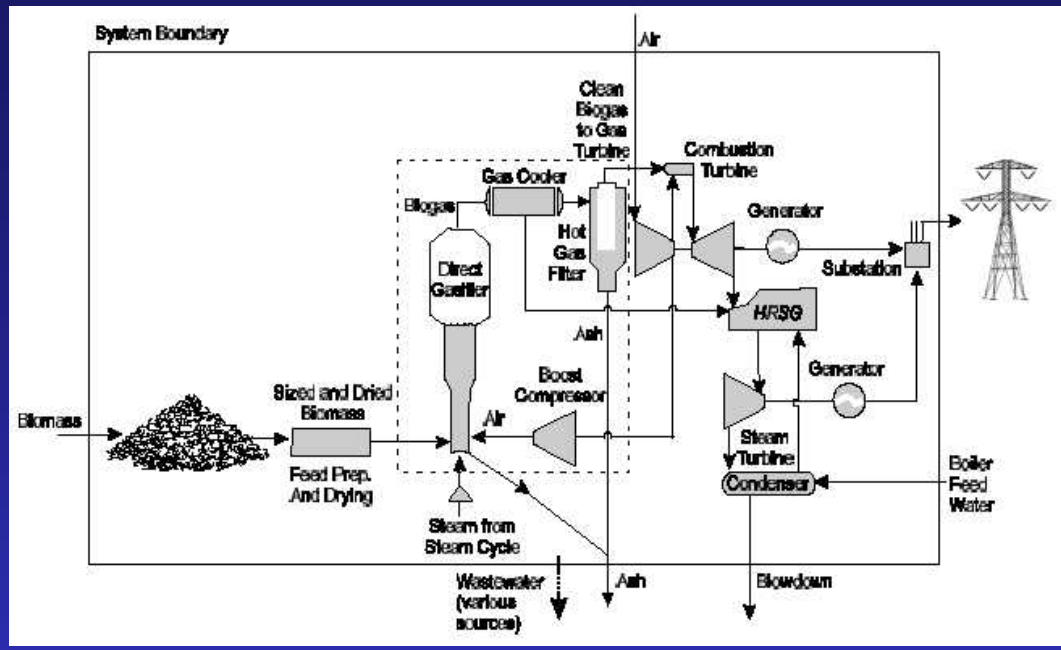
- **Carbon remaining after pyrolysis undergoes the classic gasification reaction (i.e. steam + carbon) and/or combustion (carbon + oxygen).**
- **It is this latter combustion reaction that provides the heat energy required to drive the pyrolysis and char gasification reactions.**

바이오가스 생산방법

가스화 시스템 :

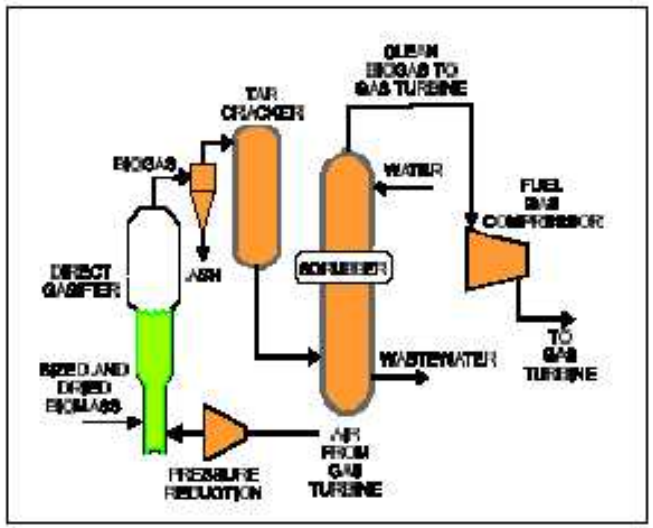
Gasifier options:

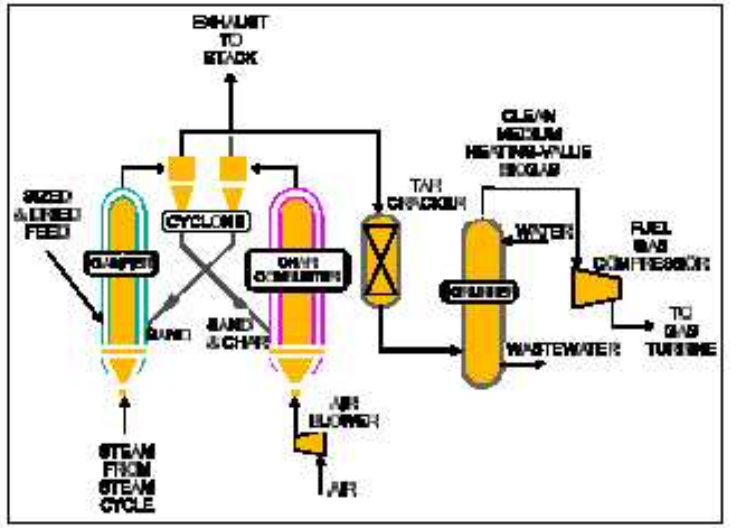
- 직접 가스화기:
  - **pyrolysis, gasification, and combustion take place in one vessel,**
- 간접 가스화기 :
  - **pyrolysis and gasification occur in one vessel, and combustion in a separate vessel.**



High pressure direct gasifier

Low pressure direct gasifier





Indirect gasifier

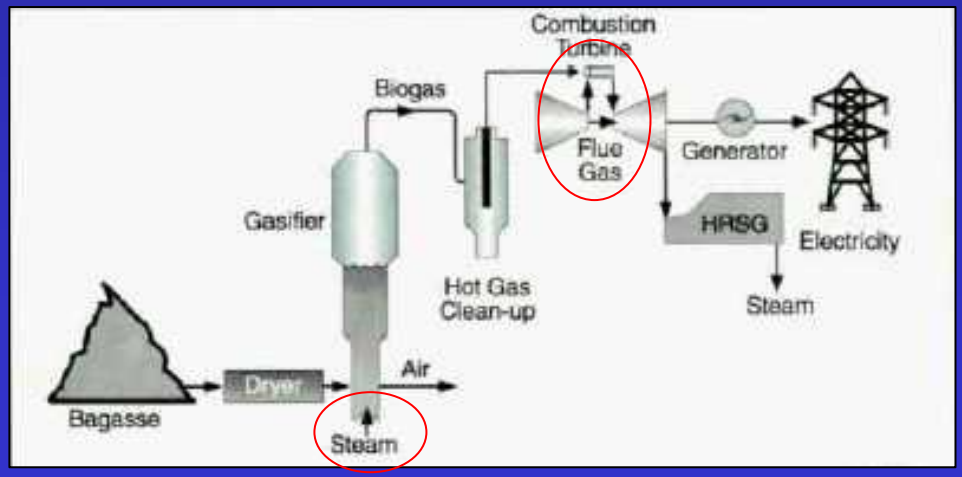
바이오가스 생산방법

가스화 시스템 / 가스화기 선정 :

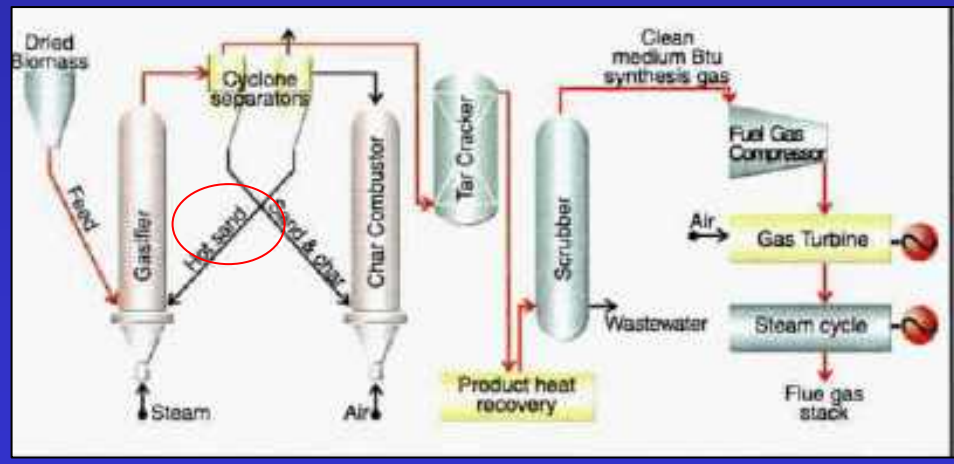
• In direct gasification, **air and sometimes steam** are introduced directly to the single gasifier vessel. In indirect gasification, an inert heat transfer medium such as **sand** carries heat generated in the combustor to the gasifier to drive the pyrolysis and char gasification reactions.

• Heating values (due to the diluent effect of nitrogen):

- Fuel gas from a direct gasifier is of low heating value (5.6-7.5 MJ/Nm3). This requires an increased fuel flow to the gas turbine. In order to maintain the total (fuel + air) mass flow through the turbine, an **air bleed** is usually taken from the gas turbine compressor and used in the gasifier.
- Since the fuel-producing reactions in an indirect gasifier take place in a separate vessel, the resulting fuel gas is free of nitrogen diluent and is of medium heating value (13-18.7 MJ/Nm3). Fuel gas from an indirect gasifier can be used in an **unmodified** gas turbine without air bleed.



Direct Gasifier



Indirect Gasifier

바이오가스의 특성

- **Biogas equivalents:**

Application	1m^3 biogas equivalent
Lighting	equal to 60 -100 watt bulb for 6 hours
Cooking	can cook 3 meals for a family of 5 - 6
Fuel replacement	0.7 kg of petrol
Shaft power	can run a one horse power motor for 2 hours
Electricity generation	can generate 1.25 kilowatt hours of electricity

1000 ft³ of biogas	=	600 ft³ of natural gas
	=	6.6 gal of propane
	=	5.9 gal of butane
	=	4.7 gal of gasoline
	=	4.3 gal of #2 fuel oil
	=	44 lb of bituminous coal
	=	100 lb of medium-dry wood

Fuel Equivalents of Biogas

- **Biogas systems requires time, along with specialized training and skills.**

- **Biogas is explosive, requiring special handling using proper safety procedures and equipment**

- **The same safety precuations taken for natural gas applications should be applied to the biogas delivery system.**

  (Methane component of biogas can be explosive when mixed with air in concentrations of 5%-15% methane)

바이오가스의 특성

- **Nuisance in storage (Huge storage volume requirement)**
  - **–Relatively low energy value to the volume**
  - **–Impossiblity of liquefaction at reasonable temperatures and pressures**
    - **One day's net production will fill a space up to double the size of the digester itself**

- **Biogas is one of the 'greenhouse effect' producing agents, hence its use helps to reduce the amount released in the atmosphere. On burning biogas, the carbon dioxide released is not considered as net contributor to the global carbon dioxide level since it originated from plants which have absorbed it from the atmosphere.**

- **During the digestion process bacteria in the manure are killed, which is a great benefit to environmental health.**

- **Combined-cycle system: Biogas can be burned in a boiler to produce steam for electricity generation and can also fuel gas turbines or combined-cycle generation systems.**
  - **– Pressurized gas first turns a gas turbine to generate electricity. Then, the waste gas from the gas turbine is burned to make steam for additional power production**

- **Biogas plants together with the electricity generation plants which have to be situated close by, require a large area of land.**

결론

- **Because it is a clean technology that uses renewable agricultural crops or manufacturing waste products as an energy source, it is ideal for community.**

- **Civilization must make careful use of a wide variety of energy sources, applying each where it is most appropriate in terms of local climate, population density, land availability, soil and atmospheric conditions, and other factors.**

- **Biomass-derived renewable fuels do have a place in the energy source mix that has been only partially realized. Many opportunities exist, and many projects are in progress or planned to make appropriate use of these fuels.**