FIRST INTERNATIONAL CONFERENCE ON GLOBAL WARMING, CLIMATE CHANGE MITIGATION AND NUCLEAR THREATS

AT

GODFREYOKOYE UNIVERSITY,

THINKER'S CORNER,

ENUGU, NIGERIA

26 FEBRUARY – 1 MARCH,2018

ANAEROBIC DIGESTION (AD) TECHNOLOGY AND CLIMATE CHANGE: MITIGATION & ADAPTATION STRATEGIES

ONYIA CHRISTIE OBY AND IFUNANYA IBEH

Department of Biotechnology and Applied Biology,
Godfrey Okoye University,
Thinker’s Corner, Enugu-Nigeria

Author for Correspondence : onyia01@hotmail.com/c.onyia@gouni.edu.ng

CLIMATE CHANGE AND GLOBAL WARMING

- Can the terms be used interchangeably?
- Yes – Because the main characteristic of climate change are increases in average global temperature (i.e. global warming) – United Nations Framework Convention on Climate Change (UNFCCC), leading to:
  - Changes in cloud cover and precipitation over land;
  - Melting of ice caps, glaciers, and reduced snow cover
  - Increases in ocean temperatures and ocean acidity (caused by seawater absorbing heat and carbon dioxide from the atmosphere

MITIGATION AND ADAPTATION

- Mitigation – reducing climate change – involves reducing the flow of heat-trapping greenhouse gases into the atmosphere
- Adaptation – adapting to life in a changing climate – involves adjusting to actual or expected future climate

STRATEGIES FOR VULNERABILITY REDUCTION

- Climate change, though a global issue that has local implications; countries need to plan strategies for reducing their vulnerability to climate change impact
- Policy issues: to participate in UNFCCC's projects and attract support from common funds, countries must have policies on Climate Change and strategies for vulnerability and adaptation its impact
- **USA:** Biogas production was recognized as a key component of the former US President's Climate Action Plan: The USDA (along with EPA and DOE) was charged with responsibility of developing Strategy to Reduce Methane Emissions
- UK: Prohibition of dumping organic solid waste in landfills
- NIGERIA: Policy on Renewable Energy, including Biomass Energy

ANAEROBIC DISGESTION

- Anaerobic digestion (AD) is a microbial fermentation process that occurs without free oxygen resulting in production of biogas composed mostly of methane and carbon dioxide.
- It occurs naturally in anaerobic environment such as wetlands, peat bogs, marshes, sediments, including the digestive tracts of ruminants and certain insect species.
- AD is also the principal decomposition process occurring in **landfills**
- AD systems are employed in many **wastewater treatment facilities** for sludge degradation and stabilization, and
- in **engineered anaerobic digesters** to treat high-strength industrial and food processing wastewaters prior to discharge.

BENEFITS OF AD TECHNOLOGY

- AD technology is used in different regions of the worldwide to:
  - Reduce the amount of material being landfilled
  - Stabilize organic material before disposal in order to reduce future environmental impacts from air and water emissions
  - Reduce methane emission
  - Provide soil improvement opportunities
  - Provide renewable energy
  - Clean the environment

DIGESTION PROCESE INVOLVED

- HYDROLYSIS of large protein macromolecules, fats and carbohydrate polymers (cellulose and starch) to amino acids, long-chain fatty acids, and sugars.
- ACIDOGENESIS – the formation of soluble organic compounds and short-chain organic acids, such as lactic, butyric, propionic acids etc.
- ACETOGENESIS – The fermentation products are consumed by bacteria to generate acetic acid, carbon dioxide, and hydrogen
- METHANOGENESIS – The bacterial conversion of organic acids into **methane** and **carbon dioxide**

Methane causes global climate change 21 times more than carbon dioxide.

AD TECH AND GREENHOUSE GAS EMISSION

- AD projects can minimize the threats posed by climate change in a number of significant ways:
- AD projects reduce greenhouse gas emissions by capturing and combusting methane
- Generating renewable energy (thereby reducing dependence on fossil fuels)
- Sequestering carbon by land applying nutrient rich digestate
- Diverting organics from landfills (thereby decreasing methane production and release)
- AD projects help communities become more sustainable by producing renewable energy thereby off-setting the need for purchased energy

ANAEROBIC DIGESTER SYSTEMS

- Digesters come in different styles/shapes, sizes, styles, and uses
- AD systems can be household-sized or community-sized.
- They can be used primarily for waste processing or energy generation
- They can be designed to optimize mixing, volume reduction, biogas production, pathogen destruction, vector attraction reduction, and odor control.
- Systems can be designed as batch or continuous flow systems, within a sealed vessel or holding tank, or with a series of vessels
- Anaerobic digestion processes come in different configurations:
  - Low rate anaerobic digesters are usually used for small systems (less than a million gallons per day), usually contain no auxiliary mixing, and are operated at long sludge retention times (SRTs) in the 30-60 day range.

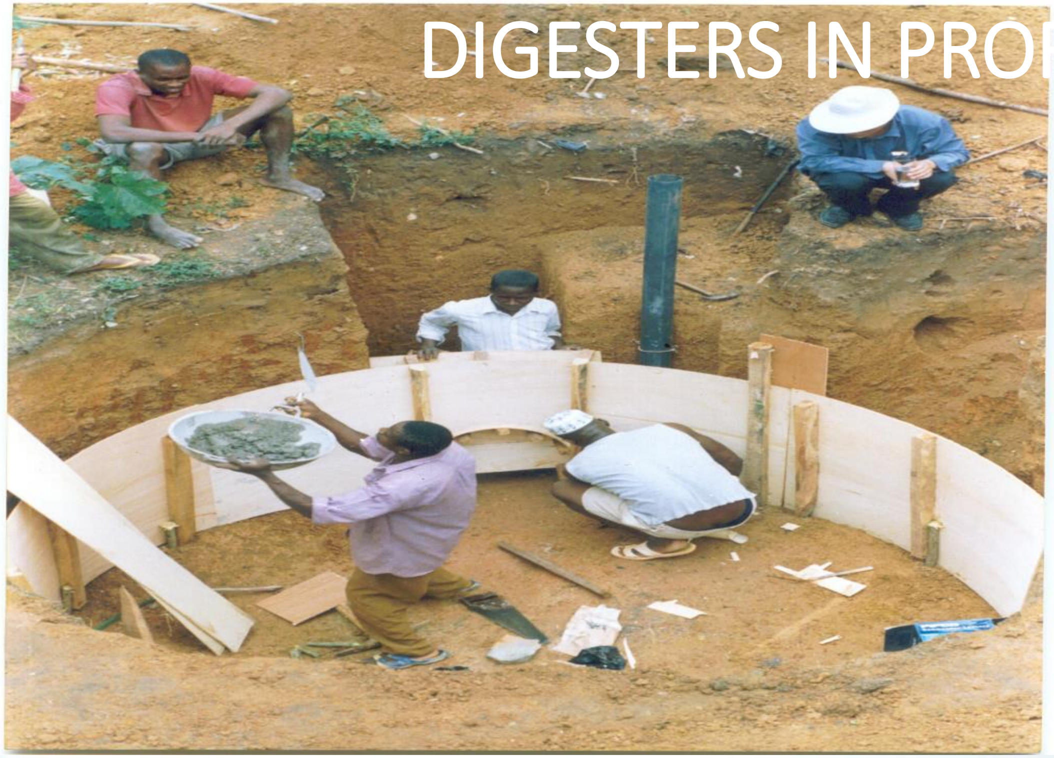
ANAEROBIC DIGESTERS

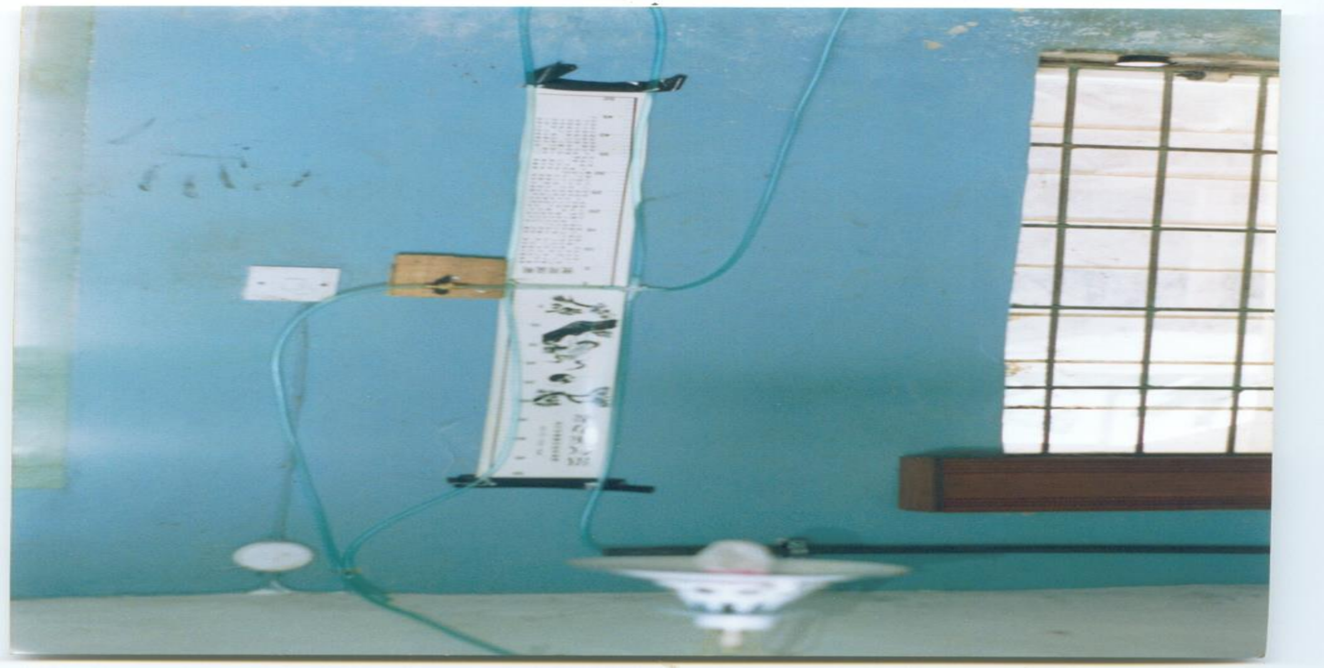
- High rate systems are characterized by supplemental heating, auxiliary mixing, uniform feeding rates, and sludge thickening before digestion
- They are designed for mesophilic temperatures (30^{o}C-38^{o}C), the most common configuration at short retention times (SRTs) in the 12-25 day range; or thermophilic temperatures (50^{o}C- 60^{o}C) at SRTs in the 10-12 day range.
- Two-stage anaerobic digester systems include a first stage (mesophilic or thermophilic), where most of the gas is produced, and a second stage used for solid-liquid separation or as a holding tank before dewatering
- Temperature-Phased anaerobic digestion configurations combine in one system both mesophilic and thermophilic digestion stages connected in series
- Two-phase AD systems are also available with the first stage being an acid phase reactor and the second phase being a methanogenic reactor.
- Three and multi-stage configurations are also available.
- Each AD alternative has advantages and disadvantages

BIODISTERS AND BIOGAS PRODUCTION IN EUROPE

BIODIGESTERS AT THE ENERGY CENTRE IN UNN

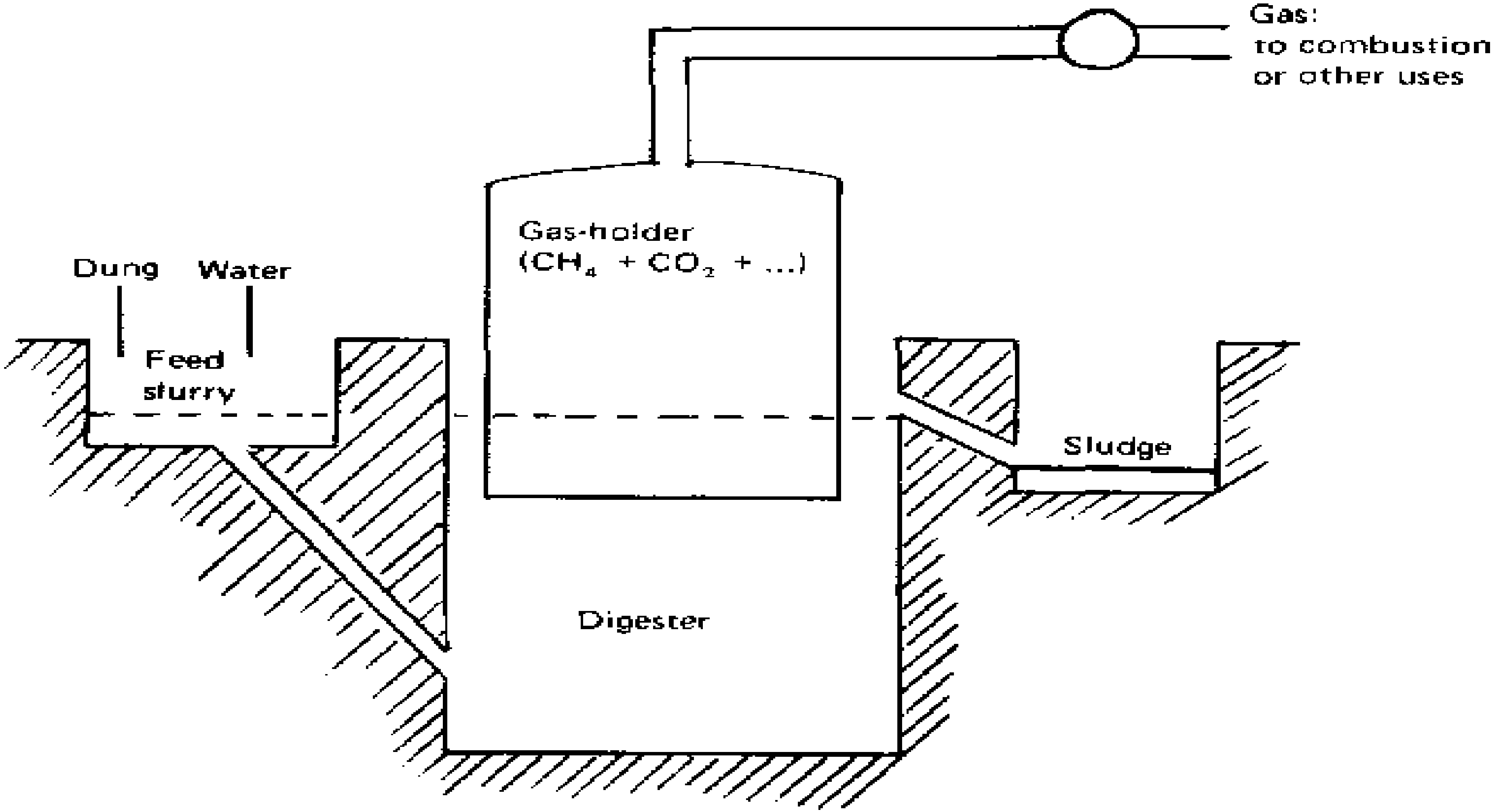
DIGESTERS IN PROF. ODEYEMI'S FARM IN ILE-IFE





Thermophilic Anaerobic Digesters for Biogas Production

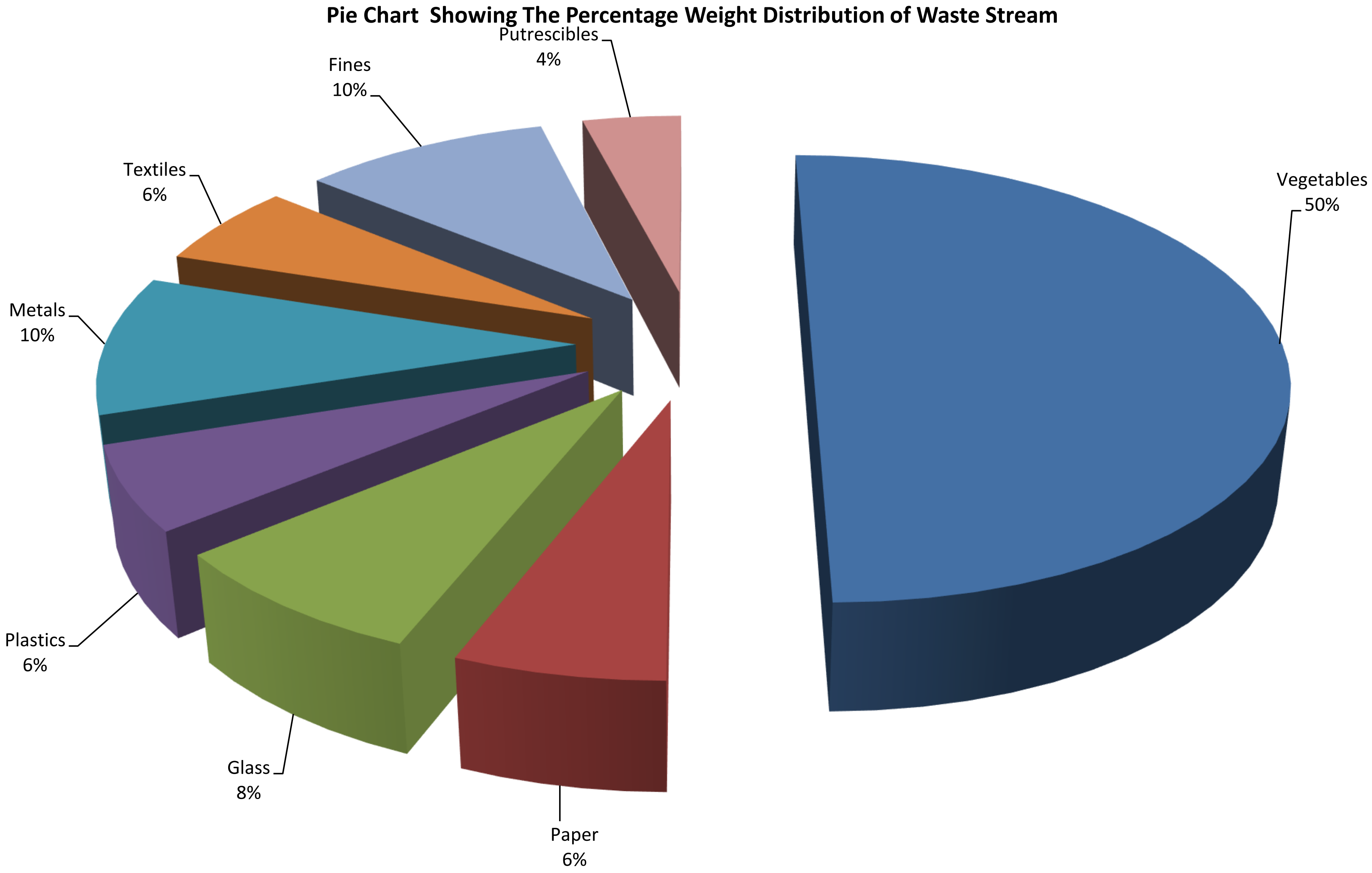
Schematic Representation of a typical Biogas Plant



STEPS INVOLVED IN THE OPERATION OF BIODISTER

- Collection and Pretreatment of substrate/raw material
- Production of slurry with balance composition (water, total organic solids, Carbon : Nitrogen ratio)
- Feeding of reactor at constant rate and interval
- Operating the system at the required constant temperature
- Mixing of substrate during fermentation
- Gas purification, collection and utilization (e.g. heat – cooking gas, electricity
- Collection and utilization of the digestate (e.g. soil conditioner, organic fertilizer etc)

Pie Chart Showing The Percentage Weight Distribution of Waste Stream



COMMON SITE IN THE STREETS OF SOME DEVELOPING COUNTRIES

ORGANIC FERTILIZER FROM WASTE

Fig 1: 150 litre Biodigester with scrubbers, connected to a fabricated cooking stove

THE SCRUBBERS

The gas concentration system has a dual system of scrubbers, designed to:

- remove hydrogen sulphide and some form of CO_2 with the help of high affinity carbon material
- for extraction of CO and NH_3.

CHALLENGES

- Lack of efficient working tools and seals.
- Pre-treatment challenges
- Lack of efficient gas storage reservoir. It is important to note that the gas storage reservoir should have plastic properties as to withstand the natural pressure from the reactor.
- Rapid fluctuating temperature destabilizes the thermal stability of the reactor

BENEFITS

- Introduction of a sustainable method of handling municipal organic waste for cleaner environment.
- Curbing the practice of deforestation, thereby reducing greenhouse gas emission and mitigating the effect of Climate Change and Global Warming.
- Use the bio-fertilizer produced as soil fertility enhancer aimed at improving food security in the country.
- To use the biogas produced for cooking.
- Protect our women and Children from abuse when fetching wood fuels.
- To generate electricity from the methane produced and capture methane instead of releasing it into the atmosphere

We can all do something to save the environment and life on earth!

THANK YOU