

# Handbook on Biogas and Its Applications(from Waste & Renewable Resources with Engineering & Design Concepts)(2nd Revised Edition)

**Author:** NIIR Board of Consultants & Engineers

**Format:** paperback

**Code:** NI114

**Pages:** 384

**Price:** Rs 1175 | US\$ 31.75

**Publisher:** NIIR PROJECT CONSULTANCY SERVICES

**Shipping:** 5 days

## About the Book

Bio Gas typically refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen. Organic waste such as dead plant and animal material, animal dung, and kitchen waste can be converted into a gaseous fuel called Bio Gas. Bio Gas is basically a mixture of methane and carbon dioxide; it originates from biogenic material and is a type of bio fuel. It is a low cost form of energy derived from renewable waste resources: animal manures, agricultural residues, industrial wastewater, human waste and other organic materials. Bio Gas has been used widely as a source of energy and waste treatment, and as liquid fertiliser for soil enhancement, since long time. Digestion the underlying biological process of Bio Gas technology leads to a renewable energy service that ensures a distributed energy production, in which the energy is produced at the point of consumption or demand. A Bio Gas digester, which produces the Bio Gas, also provides an excellent agricultural waste management solution, most notably animal manures. Also, capturing methane generated in a Bio Gas digester has an immensely important role to play with respect to rural energisation, poverty alleviation and development, increased industrial and agricultural efficiency and competitiveness, and improved management of our greenhouse gas emissions. The major applications of Bio Gas are as fertilizer, fuel gas, methane production, mechanical and electrical power production, diesel engine operation, etc. Bio Gas technology is one of the fastest growing renewable energy sectors worldwide, with the annual market growth exceeding 30% each year.

This book majorly deals with Bio Gas plants, raw materials for Bio Gas generation, utilization of Bio Gas and slurry, engineering design of Bio Gas units for developing countries, engineering aspects of small scale Bio Gas plants, a village scale Bio Gas pilot plant study using high rate digester technology, structural behaviour and stress conditions of fixed dome, simplified anaerobic digesters for animal waste, mechanical and electrical power from Bio Gas in developing countries, fuel gas production from organic wastes by low capital cost batch digestion, the toxicity effect of pesticides and herbicides on the anaerobic digestion process, the toxicity effect of pesticides and herbicides on the anaerobic digestion process, Bio Gas manure as a complete fertilizer, feasibility for Egyptian farmers etc.

The book contains technology of Bio Gas generation with its applications. This book will be an invaluable resource for researchers, consultants, entrepreneurs, institutional libraries, students etc.

## Contents

### 1. BIOGAS PLANTS: A BOON FOR RURAL FAMILY

Composition of biogas and slurry

Composition of slurry

Raw materials for biogas generation



Types of biogas plants  
 KVIC floating drum type  
 Janata biogas plant  
 Deenbandhu biogas plant  
 Shramik Bandhu biogas plant  
 Selection of size of biogas plant  
 Selection of type of biogas plant  
 Factors to be considered  
 Technical considerations  
 Consideration of Climatological factors  
 Consideration of Geographical factors  
 Economic considerations  
 Utilization of biogas and slurry  
 (a) Utilization of biogas  
 (b) Biogas burners  
 (c) Chapatti burner  
 (d) Biogas lamps  
 (e) Utilization of slurry as manure  
 Composition of slurry  
 Wet slurry Dried slurry  
 Other uses of slurry In Pisciculture  
 In Mushroom production Advantages  
 Limitations

## 2. ENGINEERING DESIGN OF BIOGAS UNITS FOR DEVELOPING COUNTRIES

Design concepts used for floating cover Indian style digesters Design concepts used for a Chinese digester  
 Design concepts used for a bag digester Items to consider in examining a system Operational factors  
 Composition of the organic feed-stock Retention times  
 Concentrations of the feed-stocks Organic loading rate  
 Degree of mixing  
 Heating and heat balance Location of a digester system Slurry effluents  
 Construction materials Sizing of the digester  
 Size based on health criteria  
 Size based on production of soil conditioner Size based on energy  
 Design example  
 case 1 : fresh manure and urine  
 case 2 : manure and concrete pad not collected daily case 3 : manure on the ground, partially dried  
 case 4 : using destruction of volatile solids case 5 : design using ESCAP (Indian) approach case 5 A : fresh  
 manure and urine  
 case 5 B : manure from a concrete pad case 5 C : manure on dirt Construction costs  
 Conclusions

## 3. ENGINEERING ASPECTS OF SMALL SCALE BIOGAS PLANTS

Structural demands  
 Relation between the length and height of the bearing structure Size of the Digester  
 Size of gasholder Gasholder-digester ratio 30 days retention time (RT) 60 days RT  
 90 days RT  
 120 days RT  
 Engineering for extension programs Concluding remarks

## 4. AN IMPROVED PLUG-FLOW DESIGN FOR THE ANAEROBIC DIGESTION OF DAIRY CATTLE WASTE

Introduction Methodology Description of the plant Mixing and feeding tank Anaerobic digester

Biogas piping and storage

Digester heating station

Capital costs

Results and discussion

Conclusions

#### 5. A VILLAGE SCALE BIOGAS PILOT PLANT STUDY USING HIGH RATE DIGESTER TECHNOLOGY

Digester

Insulation of digester and gas-holder

Slurry heating system

Operation of plant and presentation of data

Discussions of results

Conclusions

#### 6. COMPOST-HEATED SMALL SCALE FARM DIGESTER APPROPRIATE FOR KOREAN CONDITIONS

System design and construction

Biogas generation from pig manure

Results and discussion

Organic material loading conditions

Maintaining high temperature by compost heat

Heat loss comparison

Economic feasibility

#### 7. STRUCTURAL BEHAVIOUR AND STRESS CONDITIONS OF FIXED DOME TYPE OF BIOGAS UNITS

Base of fermentation tank

Wall of fermentation tank

Dome of gas-holder

Construction technique

Analytical considerations

Structural testing of biogas unit

Concluding remarks

#### 8. FERROCEMENT GASHOLDER FOR TWO 60M<sup>3</sup> DIGESTER

Procedures for construction of a 20 M<sup>3</sup> gasholder

(1) Construction of the mould

(2) Reinforcement

(3) Plastering

(4) Gas-tightness

(5) Inner-steel structure Conclusions

#### 9. SIMPLIFIED ANAEROBIC DIGESTERS FOR ANIMAL WASTE

Batch digester plant

Results

Plug flow digester plant

Results

Covered lagoon biogas system

Results

Continuous expansion digester

Tests on a small electric generator set fuelled by biogas

Results

An economic evaluation of the plants

## Conclusions

### 10. COLD CONDITION BIOGAS

Methodology

Results and discussion

### 11. MECHANICAL AND ELECTRICAL POWER FROM BIOGAS IN DEVELOPING COUNTRIES

Engines modification for bio-gas use

Performance of biogas fuelled engines

Main factors limiting use of bio-gas fuelled engines and -  
prospective solutions

### 12. PERFORMANCE OF A SMALL DIESEL ENGINE IN OPERATING IN A DUAL FUEL MODE WITH BIOGAS

Objectives of the research

The test unit

Fuels used

Test procedure

Evaluation of the test results

Discussion of the test results

Power out-put

Exhaust gas temperature and combustion

Specific fuel consumption and fuel savings

Efficiency

Comparison of mixing chamber types

Conclusions and recommendations

### 13. METHANE PRODUCTION FROM FARM WASTES

History of application of farm digesters

Post World War II developments

Post 1970 developments

American farm digesters

Technical problem

Economic feasibility of farm waste digestion

Barriers to application of anaerobic digestion to farm wastes Technical approaches to system improvements

Research needs

### 14. OPTIMIZATION OF BIO-CONVERSION OF SOLID AND LIQUID RESIDUES

Technological aspects

1. Parallel operation

2. Series (stages) operation

3. Phased operation Advantages of phased operation

Fixed film and suspended growth reactors

1. Fixed bed

2. Expanded bed

3. Fluidized bed

4. Anaerobic rotating discs

5. Recycled bed

A. Contact or recycled flocs

B.Fluidized flocs or sludge blanket

C.The digester

Choice of process and reactor type Micro-organisms

Bio-chemical study of the process

1. Screening of the Electron Transfer proteins and Enzymes 2.Purification Processes.

Bacterial control of the digester through co-factor analysis.

#### 15. NOVEL PROCESS FOR HIGH-EFFICIENCY

##### BIO-DIGESTION OF PARTICULATE FEEDS

Limitations of conventional anaerobic digestion Novel process concepts

Phase separation High-SRT Digesters

Two-phase digestion of semi solid feeds Studies with CSTR Digesters

Studies with upflow digesters

Dominant reactions in first and second stage digesters Advantages of two-phase fermentation mode and the up flow...

digester

Energetic and economic advantages of two-phase digestion Two-phase digestion of solid feeds

Summary and conclusions

#### 16.BIOGAS FROM ORGANIC WASTE DILUTED WITH SEA WATER

Materials and methods

The organic waste

The synthetic seawater

The Inoculum

The digestion apparatus

Experimental procedure

Analytical procedures

Methane content

Results and discussion

Conclusion

#### 17.FUE LGAS PRODUCTION FROM ORGANIC WASTES BY LOW CAPITAL COST BATCH DIGESTION

Background on "controlled" landfilling

Process description

Conventional landfill gas recovery

Application of enhancement to agricultural residues

Status of landfills as fuel gas sources in the United States

#### 18. BIOGAS PRODUCTION FROM WATER HYACINTH (EICHHORNIA CRASSIPES) : INFLUENCE OF TEMPERATURE

Materials and methods

Fermenter

Substrate

Inoculum

Analytical Methods

Experimental procedure

Results and discussion

#### 19. THE TOXICITY EFFECT OF PESTICIDES AND HERBICIDES ON THE ANAEROBIC DIGESTION PROCESS

Materials and methods Results and discussions

Effects of Lindane and DDT on anaerobic digestion of mixtures of cotton stalks and cow-dung.

Effect of Gesapax and Gesaprime on the anaerobic digestion of mixture of water Hyacinth and fresh cow-dung.

Effect of Gesapax and Gesaprime on the anaerobic digestion of mixture of weeds and fresh cow-dung.

Conclusion

## 20. BIOGAS PRODUCTION FROM SOME ORGANIC WASTES

Materials and methods

Organic wastes

Geranium flour

Akalona

Watermelon residues Citrullus Vulgaris

Starter

Digestion apparatus

Analytical procedures

Gas volume

Methane content of the biogas

Determinations of total solids

Experimental

Results and discussion

Biogas from geranium flour (gf)

Biogas production from Akalona (Ak)

Biogas production from Watermelon residue (WR)

## 21. THE ASSESSMENT OF CELLULYTIC ACTIVITIES IN ANAEROBIC DIGESTERS BY THE "TEXTILCOUPONnTECHNIQUE"

Experimental

The use of the screw-capped tubes

The crimped-caped-serum tubes

Results and discussion

Discussion

## 22. BIOGAS PRODUCTION FROM ANTIBIOTIC- CONTAMINATED

COW MANURE

Materials and methods

Experimental procedure

Results

Discussion

## 23. BIOGAS FROM LIQUID AGRO-INDUSTRIAL WASTES

DERIVED FROM BANANA AND COFFEE PROCESSING

## 24. A SIMPLE, RAPID AND ACCURATE METHOD FOR DETERMINATION OF CARBON-DI-OXIDE IN BIOGAS

Background Theory Material Procedure

Estimation of Methane content Validation

## 25. ASSESSMENT OF ANAEROBICALLY DIGESTED SLURRY AS A FERTILIZER AND SOIL CONDITIONER

Fertilization effect on effluents on field-grown wheat in clay soil Microbiological and chemical analysis



## Result

Composition of effluents from bio-gas plants Introduction

Methodology Effluents sources

Detection of phytotoxicity Methods of handling effluents

Fertilization effect of effluents on corn (pot experiment) Fertilization effect of effluents on wheat (pot experiment) Effect of continuous feeding on effluent composition Phytotoxic effect of digester effluent

Changes in fertilizer value of digester effluents during handling and storage.

Effluents as soil conditioner

Fertilizer value of the digester effluents Effect on nutrient uptake

Yield response to fertilizer application Discussion

## 26. REPEATED APPLICATION OF ANAEROBICALLY DIGESTED SLURRY AND ITS EFFECT ON THE YIELD AND NPK UPTAKE OF WHEAT, TURNIPS AND ONION PLANTS

Methodology Materials Experimental Chemical analysis

Results and discussion Effect on the dry matter yield Wheat plant

Turnip plant Onion plant

Effect on Nitrogen, Phosphorus and Potassium uptake

## 27. BIOGAS MANURE AS A COMPLETE FERTILIZER, FEASIBILITY FOR EGYPTIAN FARMERS

Composition of bio-gas manure and treatments Aim and scope of work

Results and discussion

Short term effect of bio-gas manure

Maize

Wheat

Rice

Broad bean

Cotton

Spinach

Carrots

The residual effect of bio-gas manure

Residual effect of bio-gas manure on Wheat

Residual effect of bio-gas manure on Broad bean

## 28. HEALTH RISKS ASSOCIATED WITH THE USE OF BIOGAS SLURRY: AN INTRODUCTORY NOTE

## 29. INCIDENCE, PERSISTENCE AND CONTROL OF PARASITIC EGGS AND CYSTS IN ANAEROBICALLY DIGESTED WASTES

Methodology

1. Incidence of Ascaris eggs and Eimeria Oocysts in different village digester.

2. Laboratory-controlled experiments Aeration of the sludge after 45 days Results and discussion

1. Incidence of Ascaris eggs and Eimeria Oocysts in different village digester

2. Laboratory-controlled experiments

Conclusion

Incidence, persistence and control of some pathogens during anaerobic digestion of organic wastes

Methodology

Isolation and identification of the pathogens Results

Isolation of pathogens in samples obtained from different operating village digester.

Persistence and control of pathogens during anaerobic digestion of sludge under laboratory conditions

Discussion



### 30. SURVIVAL OF PATHOGENS AND PARASITES DURING THE ANAEROBIC DIGESTION OF ORGANIC WASTES

Methodology  
 Laboratory digester  
 Organic wastes  
 Fermentation experiments  
 Biogas Analysis  
 Chemical Analysis  
 Microbiological determinations  
 Results and discussion

### 31. DEVELOPMENT AND APPLICATION OF BIOGAS TECHNOLOGY FOR RURAL AREAS OF EGYPT

Background and objective  
 The preliminary fact-finding phase  
 Outline of the R & D activities  
 The demonstration phase  
 Future plans  
 Conclusions

### 32. BIOGAS PRODUCTION FROM KITCHEN REFUSES OF ARMY CAMPS OF EGYPT USING A TWO STAGE BIOGAS DIGESTER

Materials and methods Materials fed to the digester Plant description  
 Inlet tank Main digester Gas-holder  
 Operation of the system Experimental  
 Methods of analysis  
 Methane content in the biogas CO<sub>2</sub> content  
 Results and discussion  
 1. Heating  
 2. Mixing

### 33. AN INTEGRATED RENEWABLE ENERGY SYSTEM PROJECT OVERVIEW

Project objectives  
 Design considerations  
 System components  
 Operation concept  
 Technical Data

### 34. PHOTOGRAPHS OF PLANT & MACHINERY WITH SUPPLIERS'S CONTACT DETAILS

---

**NIIR PROJECT CONSULTANCY SERVICES (NPCS)** is a reliable name in the industrial world for offering integrated technical consultancy services. NPCS is manned by engineers, planners, specialists, financial experts, economic analysts and design specialists with extensive experience in the related industries.

Our various services are: Detailed Project Report, Business Plan for Manufacturing Plant, Start-up Ideas, Business Ideas for Entrepreneurs, Start up Business Opportunities, entrepreneurship projects, Successful Business Plan, Industry Trends, Market Research, Manufacturing Process, Machinery, Raw Materials, project report, Cost and Revenue, Pre-feasibility study for Profitable Manufacturing Business, Project Identification, Project Feasibility and Market Study, Identification of Profitable Industrial Project Opportunities, Business

Opportunities, Investment Opportunities for Most Profitable Business in India, Manufacturing Business Ideas, Preparation of Project Profile, Pre-Investment and Pre-Feasibility Study, Market Research Study, Preparation of Techno-Economic Feasibility Report, Identification and Section of Plant, Process, Equipment, General Guidance, Startup Help, Technical and Commercial Counseling for setting up new industrial project and Most Profitable Small Scale Business.

NPCS also publishes varies process technology, technical, reference, self employment and startup books, directory, business and industry database, bankable detailed project report, market research report on various industries, small scale industry and profit making business. Besides being used by manufacturers, industrialists and entrepreneurs, our publications are also used by professionals including project engineers, information services bureau, consultants and project consultancy firms as one of the input in their research.

Our Detailed Project report aims at providing all the critical data required by any entrepreneur vying to venture into Project. While expanding a current business or while venturing into new business, entrepreneurs are often faced with the dilemma of zeroing in on a suitable product/line.

---

**NIIR PROJECT CONSULTANCY SERVICES**, 106-E, Kamla Nagar, New Delhi-110007, India. **Email:** [npcs.india@gmail.com](mailto:npcs.india@gmail.com) **Website:** [NIIR.org](http://NIIR.org)