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## Book Review

# BIOGAS FROM WASTE AND RENEWABLE RESOURCES

## An introduction

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The book “Biogas from Waste and Renewable Resources” edited by Dieter Deublein and Angelika Steinhauser, is written as a practical introduction to biogas plant design and operation. The author covers both the biological and technical aspects of biogas generation, illustrated by numerous examples from real-life plants.

The book includes detailed of all the process steps to be followed during the production of biogas, from the preparation of the suitable substrate to the use of biogas, the end product. Biological, chemical and engineering processes are detailed in the same way as apparatus, automatic control, and energy or safety engineering.

The first part of the book, *General thoughts about energy supply* has an introductory role and includes five chapters.

Chapter 1, *Energy supply – today and in the future*, describes primary energy sources: fossil energy sources, renewable energy sources and nuclear fuels, and secondary energy sources can be converted until the end – point energy. This chapter describes a case study from Germany. The total consumption of primary energy in Germany is ca. 4100 TWh<sup>-1</sup>, which has been provided by the use of different primary energy sources. This is explained by the current trend toward a society with a high number of cars per family leading to a high demand of petrol, a secondary energy source of petroleum.

Chapter 2, *Energy supply in the future – scenarios* presents the scenarios for different energy sources for the years 1990 up to 2100 and stipulate that by 2020 the technologies around renewable resources are expected to have reached the potential for full economic use.

In this chapter is including the potential yield from biomass, technical, economical and the realizable potential. The authors present the perspectives for energy sources as a percentage of the total energy consumption in Germany until year 2080.

Chapter 3, *History and status to date in Europe* describes the case study from Germany about the first attempts at using biogas still 1897, when Pasteur produced energy from horse dung, and finish by actually period and perspective in Europe.

Chapter 4, *History and status to date in other countries*, illustrates the importance of biomass in developing countries and makes considerations about the utilization of biogas in SUA, China, India, Latin America and the CIS states. In the rich industrialized countries, biomass represents an average of about 3% of the total amount of primary energy carriers. In the emerging markets, it accounts for 38%, while in some particularly poor countries it reaches even more than 90%.

Chapter 5, *General aspects of the recovery of biomass in the future*, depicts the importance of biomass energy products.

The second part of the book, *Substrate and biogas* comprises four chapters.

Chapter 1, *Biogas*, describes the characteristics and qualities of methane. This chapter is a detailed overview on biogas components and their impacts on the gas quality.

Chapter 2, *Substrates*, explains in details all types of biomass that can be used as substrates, as long as they contain carbohydrates, proteins, fats, cellulose, and hemicelluloses as main components.

Chapter 3 presents *Evaluation of substrates for biogas production*. The practically attainable methane yield depends on many factors like

composition, grain size, and proportions of the assigned, on the microbial degradability of the biomass, the content of dry matter and organic dry matter, and the relationship of the nutrients to each other.

Chapter 4, *Benefits of a biogas plant* related the benefits, which derived from the process of converting substrates in a biogas plant. Like natural gas, biogas has a wide variety of uses, but, as it is derived from biomass, it is a renewable energy source.

The third part of the book, *Formation of biogas*, includes three chapters.

Chapter 1 presents the *Biochemical reaction* and the formation of methane from biomass. The energy, which is set free when burning biomass, corresponds theoretically overall to the energy set free in the biogas production plus the energy set free burning methane. This sum is equal to the energy which was needed for photosynthesis.

Chapter 2, *Biology*, described the complex process of fermentation producing methane, divided into four phases of degradation, named hydrolyses, acidogenesis, acetogenesis, and methanation, inclusive the process parameters.

Chapter 3, *Bacteria participating in the process of degradation*, illustrates the genus and the species of bacteria which contribute in the fermentation process in all four phases.

The Part IV of the book, *Laws and guidelines concerning biogas plants* includes the regulations and laws aimed at the elimination or minimization of all safety hazards affecting both people and the environment, especially those due to biogas plant. In this chapter, regulations relating to the operation of biogas plants are described, likely to be issued in Germany and in many other countries. The German law on biowaste regulates the circulation of biowastes in agriculture, forestry, and horticulture. It is described the restrictions when biowastes are to be fermented in biogas plants. Likewise the authors discuss by risk of explosion, risk of fire, noise protection, prevention of injuries and about protection from water.

In Chapter 2 the authors discuss about *Building a biogas plant* and presents the process of planning and setting up a biogas plant. Biogas plants are financed from own resources, credit and public promotion.

The Part V of the book, *Process engineering*, contains five chapters and is dedicated to various industrial – standard procedures and equipment.

Chapter 1 present the *Parts of biogas plants* and preprocessing of raw materials, while Chapter 2 describes *Area for the delivery and equipment for storage of the delivered biomass*.

In Chapter 3 it is described the *Process technology for the upstream processing*. The author describes the front-end treatment of the organic residues before the processing in the bioreactor (adjustment of the water content, removal of

disturbing material, comminution, hygienization, desintegration, and feeding).

Chapter 4 describes *Fermentation technology* and diverse types of reactors and equipment: reactor designs, bioreactors, agitators and heating. The efficiency of agricultural biogas factories depends on the installation performance: the capacity or size of the plant, fraction of autonomously generated power, installation standard and automatization level. The author described the installations by different suppliers from Finland and Germany, which are manufactured based on the same processing principle. In this chapter, the author describes an installation with substrate dilution and subsequent water separation, as well as an installation with biomass accumulation. The accumulation of biomass during the fermentation process is useful in the suspension fed in is a thin fluid. These installations are most commonly used for the anaerobic purification of industrial sewage and for the fermentation of sewage sludge.

Chapter 5, *Special plant installation* presents the combined fermentation of sewage sludge and bio waste.

In the Part VI, *Biogas to energy*, the authors describe the importance of biogas. Biogas can be directly converted into electrical power, e.g. in a fuel cell. The biogas has to be transported over long distances and has to be purified before it can be further utilized. Part VI includes 7 chapters.

Chapter 1, *Gas pipeline*, presents a description of biogas pipelines and presents an example from Germany.

Chapter 3, *Gas preparation*, details biogas qualities required for different application in Europe and described technologies for the decontamination of biogas.

Chapter 4, *Liquefaction or compression of the biogas* detailed liquefaction and compression processes.

*Utilization of biogas for the generation of electric power and heat* is including in Chapter 5. Biogas can be used either for the production of heat only, or for the generation of electric power. The power can be fed into the public electricity network, and the heat into network for long – distance heat supply, and the vehicles can sometimes be driven by power or the heat. This chapter details characteristic values of power generators.

Chapter 6, *Biogas for feeding into the natural gas network*, illustrates the features that have to be adjusted: pressure, density, total sulfur, oxygen and humidity content. Furthermore, the author describes a case study about biogas for feeding into the natural gas network from Switzerland, Sweden and Germany.

Chapter 7 is dedicating to *Biogas as for vehicles*, where the authors present economical, technological and environmental aspects. The authors describe an example of project from Sweden about the utilization of renewable fuels, especially of biogas.

The last part of book is dedicated to *Residues and waste water*. In the chapter about the residues, the author presents the aspects of residues conversion in biogas and some components of the residue of biowastes.

Chapter 2, *Waste water*, discusses about wastewater from the plant that varies greatly in quality according to whether the plant is operated under mesophilic or thermophilic conditions.

Written as a practical introduction to biogas plant design and operation, this book fills a huge gap by presenting a systematic guide to this emerging technology - information otherwise only available in poorly intelligible reports by US governmental and other official agencies. The authors draw on teaching material from a university course as well as a wide

variety of industrial biogas projects, thus combining teaching skills with real-life examples. Alongside biological and technical aspects of biogas generation, this timely work also looks at safety and legal aspects as well as environmental considerations.

The book can also be used for reference, and includes many tables and large index. It is strongly recommended to planners and operators of biogas plants, as it gives good advice on how to maximize the potential of the plant.

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