

# Generation of Biogas using Fixed-Dome Anaerobic Digester for Small-Scale Industrial Applications in New Zealand

Author: Jai Khanna

Co-Authors: Mohammad Al-Rawi & Ninad Dabholkar  
Centre of Engineering and Industrial design



## Abstract

In this research project, detailed understanding towards the generation process of Biogas in a Biogas digester was established by the researcher. Detailed information around the temperature bands and the temperature chosen for the research was provided with a scientific explanation. This research will also help the readers to understand various formulae which are being used or could be used in designing a Biogas digester. These formulae have been extracted from various reputable sources. These will then give the readers a deep understanding towards how the existing Farm Dairy Effluents can be used to generate Biogas which can be used to provide for heating, cooking and electricity generation.

## Methodology

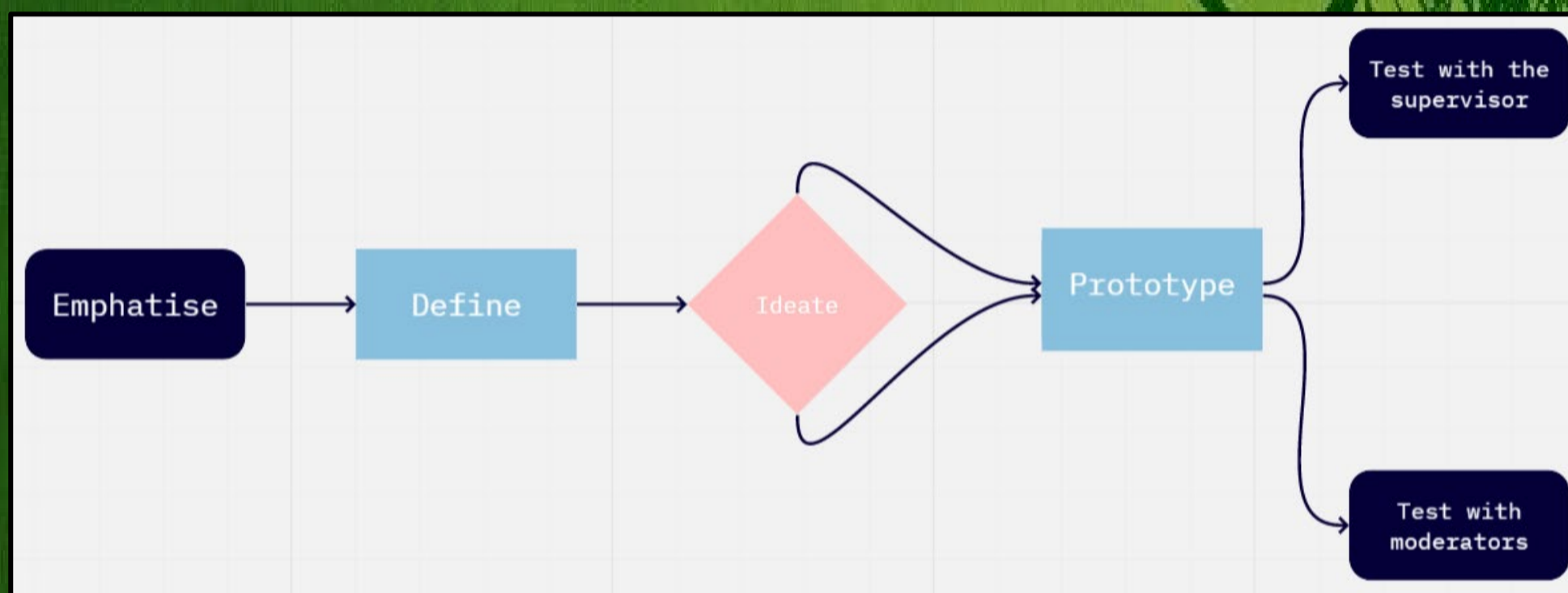


Figure 1: 5 Distinct Stages of Design Thinking Process to Define and Produce Biogas Efficiently

<p><b>Empathise:</b> Why, Who, What and How style questions were asked to establish a strong foundation towards the research.</p>	<p><b>Define:</b> Fair amount of research was done and it was decided to research about a fixed dome, single stage, medium scale production type Biogas digester. It also became clear that the researcher has to put efforts in researching various formulae which will help in the design of a Digester.</p>
<p><b>Ideate:</b> Creation of questionnaire for farmers to obtain some real-life data. Contact people from the big-scale farming industry and seek for their help.</p>	<p><b>Prototype:</b> If possible this research can turn into a product. Therefore efforts were put in scripting some MATLAB programs to turn it into a calculator. QR codes were used to obtain additional supporting information.</p>

Figure 2: Detailed overview of the steps undertaken in each stage of design thinking

## Conclusion

Anaerobic digestion along with Mesophilic bacteria are ideal choice for an Economical Biogas system with a moderate production rate.

An alternate source of energy can be established by using Farm Dairy Effluents and other organic matters. This reduces the waste in landfills and water bodies and convert them into Biogas energy.

Biogas can be used for heating, cooking and electricity generation and can thus provide an alternative to natural gas and coal-fired steam turbines.

Integration of Biogas technology with modern technology such as an Android powered calculator app can help in boosting it's popularity among younger population.

## Acknowledgements

- Tony Hogg (Student)
- Glenn Sullivan (Wintec Tutor/ Fonterra team member)
- Antony Hill (Farm operations manager - Upper North island, Fonterra)
- Trudy Harris (Team Manager - Centre for Engineering & Industrial Design)

## References

Bioenergy Association. (n.d.). *Www.Biogas.Org.Nz*. Retrieved May 11, 2020, from <https://www.biogas.org.nz/nz-biogas-opportunities>  
Luque, Campelo, Clark. (2011). *Handbook of Biofuels production: Process and Technologies*. Cambridge, UK: Woodhead Publishing Limited  
Wellinger, Murphy, Baxter. (2013). *The biogas handbook: Science, production, and applications*. UK. Woodhead Publishing Limited.

## Introduction

Just as fossil fuels from conventional sources are finite and are becoming depleted, those from difficult sources will also run out. If we put all our energy and resources into continued fossil fuel extraction, we will have lost an opportunity to have invested in renewable energy". This wonderful quote above by David Suzuki truly explains why there is a need for the general population to invest in renewable source of energy. With that said, Biogas being an excellent source of renewable energy is being researched by the researcher. The main aim of this research project is to study the basic principle of anaerobic digestion and the basic functionality of a Biogas digester. With various researched formulae, a prototype digester which would be compatible with NZ's climatic conditions will be designed on paper. The Methane gas generated in the Biogas plant can then be used for various purposes. However, the primary focus of this research project is to design a Biogas digester which would generate methane for small-scale industrial applications.

## Discussion

**Anaerobic Digestion:** consists of a series of processes in which micro-organisms degrade the organic matter into simple substances which leads to the production of gaseous substances like methane and carbon dioxide. All of this takes place in the absence of oxygen. (Luque, Campelo, Clark, 2011)

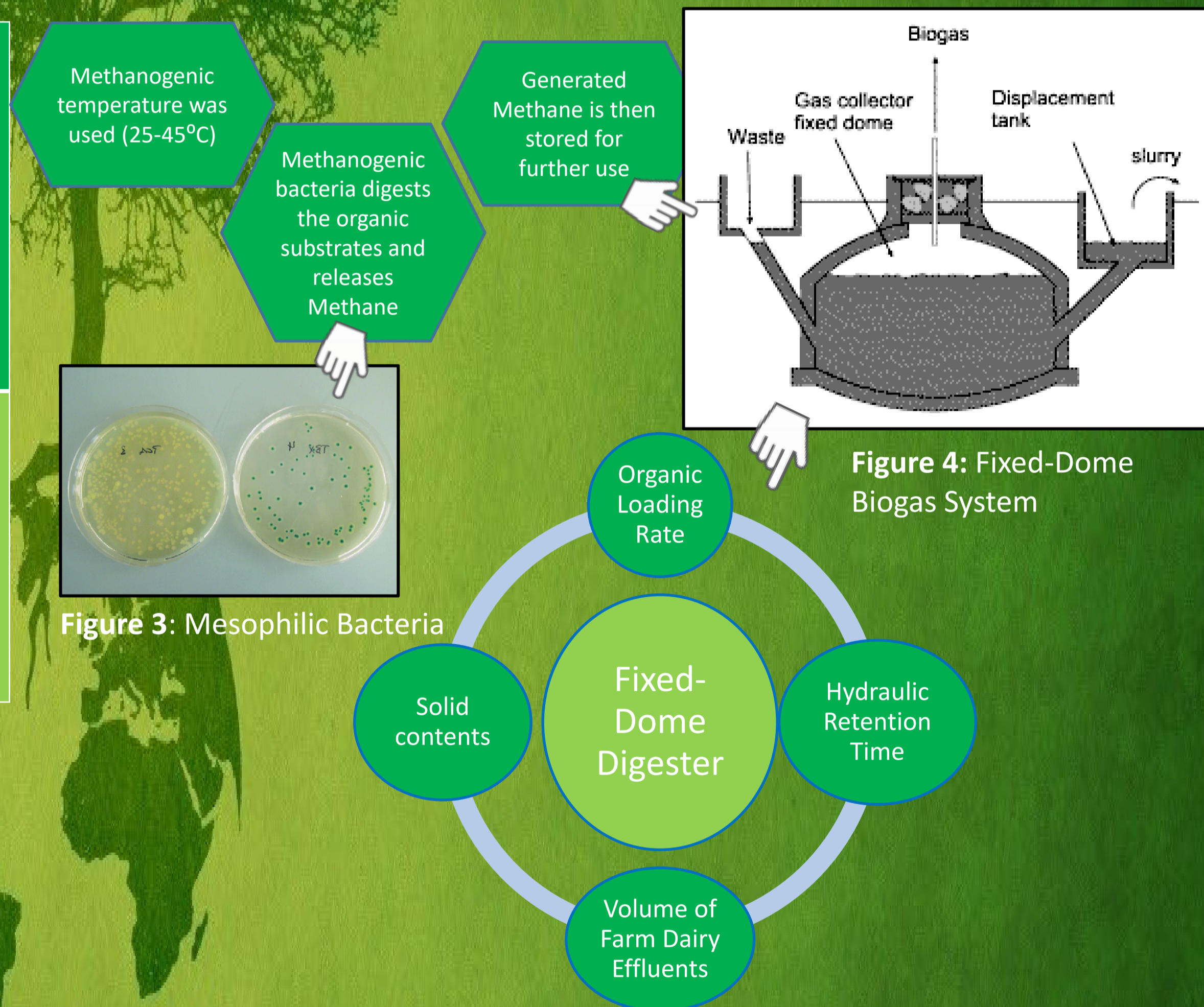
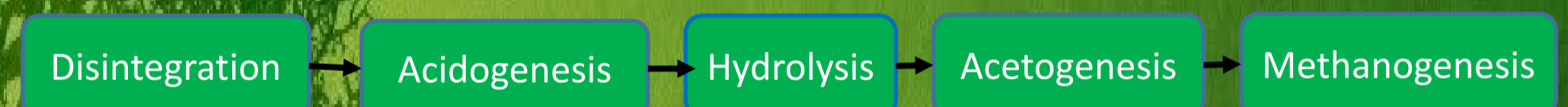


Figure 3: Mesophilic Bacteria

Figure 4: Fixed-Dome Biogas System

## Future Scope

- I. A Calculator app can be created which runs on Android, Windows, Mac, Linux OS. This app will then be able to calculate the Digester's volume, Hydraulic Retention Time and Organic loading rate.
- II. Generated Biogas can be used to fire the boilers which will be used to generate electricity for smaller towns or blocks.
- III. Biogas powered water-heating.
- IV. Increases New Zealand's self-reliance on energy production.
- V. Making younger generation more aware of Biofuels and their easy process of generation by integrating modern Android powered app technology to make learning easier and interesting.
- VI. Encourages small-businesses to manufacture Biogas systems which in return boosts the economy.
- VII. Farmers can obtain an organic source of excellent quality manure from the Biogas residue.

