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OPTIMIZED DESIGN OF FIXED-DOME TYPE BIOGAS PLANT

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OPTIMIZATION:

Optimization is the mathematical discipline which is concerned with finding the maxima and minima of functions, possibly subject to constraints. And it is the act of obtaining the best result under givencircumstances.The optimum seeking methods are also known as mathematical programming techniques and are generally studied as a part of operations research.Operations research is a branch of mathematics concerned with the application of scientific methods and techniques to decision making problems and with establishing the best or optimal solutions. An optimization algorithm is a procedure which is executed iteratively by comparing various solutions till an optimum solution is found. With the advent of computers, optimization has become a part of computer-aided design activities.

OPTIMAL PROBLEM FORMULATION:

An optimal design is achieved by comparing a few alternative solutions created by using a priori problem knowledge. In this method feasibility of each design solution is first investigated. It is impossible to apply single formulation procedure for all engineering design problem, since the objective in a design problem and associated therefore, design parameters vary product to product different techniques are used in different problems. Purpose of formulation is to create a mathematical model of the optimal design problem, which then can be solved using an optimization algorithm.

LINEAR PROGRAMMING:

Linear programming is the process of taking various linear inequalities relating to some situation, and finding the "best" value obtainable under those conditions. A typical example would be taking the limitations of materials and labor, and then determining the "best" production levels for maximal profits under those conditions.

In "real life", linear programming is part of a very important area of mathematics called "optimization techniques". This field of study (or at least the applied results of it) is used every day in the organization and allocation of resources. These "real life" systems can have dozens or hundreds of variables, or more. In algebra, though, you'll only work with the simple (and graphable) two-variable linear case.

The general process for solving linear-programming exercises is to graph the inequalities (called the "constraints") to form a walled-off area on the *x,y*-plane (called the "feasibility region"). Then you

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figure out the coordinates of the corners of this feasibility region (that is, you find the intersection points of the various pairs of lines), and test these corner points in the formula (called the "optimization equation") for which you're trying to find the highest or lowest value.

Linear programming (LP; also called linear optimization) is a method to achieve the best outcome (such as maximum profit or lowest cost) in a mathematical model whose requirements are represented by linear relationships. Linear programming is a special case of mathematical programming (mathematical optimization).

More formally, linear programming is a technique for the optimization of a linear objective function, subject to linear equality and linear inequality constraints. Its feasible region is a convex polytope, which is a set defined as the intersection of finitely many half spaces, each of which is defined by a linear inequality. Its objective function is a real-valued affine (linear) function defined on this polyhedron. A linear programming algorithm finds a point in the polyhedron where this function has the smallest (or largest) value if such a point exists.

Linear programs are problems that can be expressed in canonical form as

$$\begin{aligned} &\text{maximize} && \mathbf{c}^{\mathrm{T}}\mathbf{x} \\ &\text{subject to} && A\mathbf{x} \leq \mathbf{b} \\ &\text{and} && \mathbf{x} \geq \mathbf{0} \end{aligned}$$

where $\mathbf{x}$ represents the vector of variables (to be determined), $\mathbf{c}$ and $\mathbf{b}$ are vectors of (known) coefficients, A is a (known) matrix of coefficients, and $(\cdot)^{\mathrm{T}}$ is the matrix transpose. The expression to be maximized or minimized is called the objective function ($\mathbf{c}^{\mathrm{T}}\mathbf{x}$ in this case). The inequalities $A\mathbf{x} \leq \mathbf{b}$ and $\mathbf{x} \geq \mathbf{0}$ are the constraints which specify a convex polytope over which the objective function is to be optimized. In this context, two vectors are comparable when they have the same dimensions. If every entry in the first is less-than or equal-to the corresponding entry in the second then we can say the first vector is less-than or equal-to the second vector.

Linear programming can be applied to various fields of study. It is widely used in business and economics, and is also utilized for some engineering problems. Industries that use linear programming models include transportation, energy, telecommunications, and manufacturing. It has proved useful in modeling diverse types of problems in planning, routing, scheduling, assignme nt, and design.

ADVANTAGES OF LINEAR PROGRAMMING:

- The main advantage of linear programming is its simplicity and easy way of understanding.
- Linear programming makes use of available resources
- To solve many diverse combination problems
- Helps in Re-evaluation process-linear programming helps in changing condition of the process or system.

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- Linear programming is adaptive and more flexibility to analyze the problems.
- The better quality of decision is provided.

DISADVANTAGE OF LINEAR PROGRAMMING:

- Linear programming works only with the variables that are linear.
- The idea is static,it does not consider change and evolution of variables.
- Non linear function cannot be solved over here.
- Impossibility of solving some problem which has more than two variables in graphical method.

LIMITATIONS OR PROBLEMS OF LINEAR PROGRAMMING MODEL:

- Limitations and constraints are not given to a large problem.
- Linear programming yield fractional valued answers for the decision variables.
- In some cases both the objective function and constraints in linear form cannot be expressed.
- Is a mathematical technique used in solving single objective problem
- Long term objective of the management cannot be resolved with a single goal.
- The problem can be solved only when there is a clear representation of linear relationship between different variables.

OBJECTIVES:

- With the growing demand of power we have to think about new alternative source of energy and utilize them to their best. Waste to energy is the one of the new source of energy for meeting the growing demand of power. But at the same time we have to optimize the fuel value and reduce cost from the source.
- The main objective of this project is toPlan the biogas plant layout and designing the digesters finding an alternative with the most cost effective or highest achievable performance under the givenconstraints, by maximizing desired factors and minimizing undesired ones hence reduced cost.
- To formulate linear programming model.
- To obtain the required result, an optimization technique has been used in this thesis.

BIOGAS PLANT

WHAT IS BIOGAS?

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste.

Biogas is a clean and efficient fuel. It is a mixture of methane (CH4), carbon dioxide (CO2),hydrogen (H2) and hydrogen sulphide (H2S).

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The chief constituent of biogas is methane (65%).

Biogas technology has been promoted worldwide over the past decades and its use has led to the recognition of the many benefits of domestic biogas digesters.

A bio digester is a structure constructed under the ground, made with cement, brick/stone, sand and pipes & appliances to decompose organic material and produce biogas- to supplement conventional fuel sources.

The aim of optimization is to adjust the actual state of a process with regard to a certain property through selective variation of influencing factors in such a way as to achieve a defined target state (the optimum).

In general terms, operation of a biogas plant can be optimized in three areas: technical, economic and environmental (see picture). These areas cannot be optimized independently of each other.

In this project we are going to optimize the biogas plant economically.

TYPES OF BIOGAS PLANTS:

There are two types of biogas plants in usage for the production of biogas. These are:

- The fixed- dome type of biogas plant
- The floating gas holder type of biogas plant

In this project we are going to discuss about Fixed dome type biogas plant.

FIXED DOME TYPE OF BIOGAS PLANT:

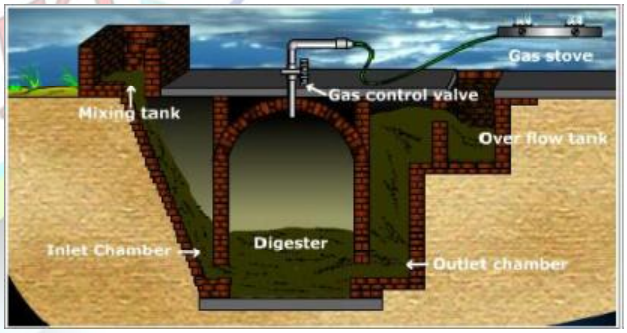
PRINCIPLE:

Biogas is produced as a result of anaerobic fermentation of biomass in the presence of water.

CONSTRUCTION:

The biogas plant is a brick and cement structure having the following five sections:

- **Mixing tank:** present above the ground level.
- **Inlet chamber:** The mixing tank opens underground into a sloping inlet chamber.
- **Digester:** The inlet chamber opens from below into the digester which is a huge tank with a dome like ceiling. The ceiling of the digester has an outlet with a valve for the supply of biogas.
- **Outlet chamber:** The digester opens from below into an outlet chamber.
- **Overflow tank**: The outlet chamber opens from the top into a small over flow tank.



2.1 Fixed Dome type Biogas Plant

WORKING OF BIOGAS PLANT:

- The various forms of biomass are mixed with an equal quantity of water in the mixing tank. This forms the slurry.
- The slurry is fed into the digester through the inlet chamber.
- When the digester is partially filled with the slurry, the introduction of

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slurry is stopped and the plant is left unused for about two months.

- During these two months, an anaerobic bacterium present in the slurry decomposes or ferments the biomass in the presence of water.
- As a result of anaerobic fermentation, biogas is formed, which starts collecting in the dome of the digester.
- As more and more biogas starts collecting, the pressure exerted by the biogas forces the spent slurry into the outlet chamber.
- From the outlet chamber, the spent slurry overflows into the overflow tank.
- The spent slurry is manually removed from the overflow tank and used as manure for plants.
- The gas valve connected to a system of pipelines is opened when a supply of biogas is required.
- To obtain a continuous supply of biogas, a functioning plant can be fed continuously with the prepared slurry.

ADVANTAGES OF BIOGAS PLANT:

- Requires only locally and easily available materials for construction.
- Inexpensive.
- Easy to construct.

Renewable Source of Energy: To begin with, biogas is considered to be a renewable source of energy. Since it often produced from materials that form sewage and waste products, the only time it will be depleted is when we stop producing any waste.

Unlike non-renewable energy sources, such as oil, coal and natural gas, renewable energy sources are considered "sustainable" as they will not run out. In addition to this, renewable energy sources have a less damaging effect on the environment.

APPLICATION AREAS:

Biogas can be used to run any type of heat engine in order to generate electrical or mechanical power. It can be compressed, like a natural gas, to control motor vehicles.

Generally, biogas is a renewable fuel. In any country, for cooking or heating purposes biogas can be used as a low-cost fuel.

It can produce one hundred billion kilowatt hours of electricity, enough to power millions of homes by converting cows manure into methane biogas through anaerobic digestion. Moreover, to generate 3 Kw hours of electricity, one cow can produce enough manure in one day.

In china, 30 million rural households have biogas digesters and they have 12 enjoyable benefits.

- Saving cooking time
- Saving money
- Saving fossil fuels
- Saving time for collecting firewood
- Using crops residues for animals fodder instead of fuel
- Improving hygienic conditions
- Producing high-quality fertilizer
- Enabling local mechanization
- Electricity production
- Improving the rural standard of living
- Reducing water and air pollution

CONCLUSION:

- It has been shown that minimization of the cost of the gas holder alone leads to the narrow and deep digester is

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minimized,the optimization leads to wide and shallow digesters,which are less expensive.

- To test this alternative ,two prototype plants have been designed constructed and operated.
- These plants are not only 25-40%cheaper ,but their performance is actually slightly better than the conventional plants.

REFERENCES:

1. Bhumesh Singh Bhadouria,Sai.V.S,"**Utilization And Treatment Of Dairy Effluent Through Biogas Generation-A Case Study",** INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES Volume 1, No 7, 2011, ISSN 0976 – 4402.

2. Christian Wolf, Sean McLoone, Michael Bongards,**"Biogas Plant Control And Optimization Using Computational Intelligence Methods".**
3. D K Subramanian.PRajabapaiah,Amulya Kumar N Reddy, **"Optimisation Of Plant Dimensions",** Proc,Indian Acad.Sci.,Vol C2,Part 3,September 1979,pp 365-375.
4. Govt. of India's report(2002),**"Evaluation Study On National Project On Biogas Development".**
5. Hanssmann , F. and Hess,S.W 'A,**"Linear Programming Approach To Production And Employment Scheduling" Vol. 1, No. 1 (Jan., 1960), pp. 46-51**.
6. Leo Liberti, Maurizio Bruglieri,"**Optimal Design Of A Biomass-Based Energy Production Process".**
7. K.Karthick, K.S.Prabhakaran, K.Visagavel,**"Effective Use Of Bio Waste In Institutions**", IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.
8. N. Stalin, et al(2007), **"Effect Of Microbial Growth On Biogas Generation Using Carrier Material In The Self Circulating Biogas Plant"**.
9. NavjotRiar, Dr.R.K.Khitoliya,Dr.Shakti Kumar, **"A Study Of Treatability Of Kitchen Wet Waste And Biogas Production"**, International Journal of Computational Engineering Research||Vol, 03||Issue, 6||.
10. Patrick Mukumba, Golden Makaka, Sampson Mamphweli, SherpherdMisi, **"A Possible Design And Justification For A Biogas Plant At Nyazura Adventist High School", Rusape, Zimbabwe.**