YASHWANT GROUP
FOR A BRIGHTER TOMORROW

Household Bio-Gas Project for
Replacement of Cooking Fuel

To be Implemented By-

YASHWANT
ENERGY PRIVATE LIMITED
RESPECT NATURE. PROTECT NATURE.

Background for household Gobar-Gas project

Although blessed with the rivers like Krishna and Warna, the western part of Sangli district is still known as the industrially least developed area. Marginal land holding and non-availability of employment have forced the youth of this area to migrate to Mumbai and Pune. To change this social scenario an impulse was required for the social and financial development.

Consequently 'YASHWANT SAHAKARI GLUCOSE KARKHANA LTD.' was established in Shirala in 2001. This 150 TPD maize crushing plant provided direct and indirect employment to 800 people and has introduced maize as a cash crop amongst the farmers. More than 12,000 farmers are the producer members of the unit. At the current scenario of increasing farmers' suicides, today farmers in Western Sangli District are receiving Rs. 9,500 / Mt of maize compared to Rs. 3,500 / Mt in 2005. The high yielding maize varieties have increased their production from 1.2 Mt/acre to 2.5 Mt/acre. This acceptance of maize as cash crop is reflected from the 8000 Acres of area under cultivation compared to just 300 Acres in 2002.

Maize processed in Yashwant Glucose yields Starch and Liquid Glucose as the main products along with by-products like Gluten, Fiber, De-oiled Cake and Husk. All these By-products are blended together and highly nutritional Cattle feed is produced at Yashwant Glucose. This 40 Mt/day cattle feed along with Maize Stalks have provided the farmers continuous and stable supply of Nutritional cattle feed. Hence Milk production in the area has surpassed 70,000 Lit/day within the last five years. This Milk has been a major source of revenue for the marginal land holding farmers and field-workers.

To provide the better infrastructure of procurement and processing of the available Milk, the 50000 lit/day capacity milk processing plant 'YASHWANT DUGDH PRAKRIYA LTD.' was started in 2008. More than 6000 farmers have already registered themselves as the producer members of the unit.

Basic concept behind the project

In order to continue overall development of the area we plan to introduce the third dimension in this Backward Integration with farmers by providing them Gobar-gas plants. An initial survey has indicated that more than 50,000 families in the western Sangli District are in the Milk business but they are using fuel like Firewood, Kerosene and LPG for cooking purposes. Even though the Gobar Gas generation capacity is available, its not been utilized due to the high initial investment required.

A normal house with 5 family members and 2 milking animal has the potential of being self sufficient for the energy required for their household cooking purpose. A standard 2 m3 capacity Gobar-gas plant, which would operate on available cow-dung and other domestic waste, shall generate enough gas required for the family. But due the financial barrier of the initial investment of Rs. 20,000 required to set up the unit, they are currently using the non-renewable fuel at a very high cost. Such a small family normally consumes around 3 Mt firewood in a year. In some of the villages that have better access by road, the villagers have the luxury to use LPG or Kerosene. But considering the prevailing market rate of Firewood at Rs. 2,000 / Mt, Rs. 20 /Lit of Kerosene and Rs. 350 /Cylinder of LPG the average family is spending Rs. 3,000–3,500 annually on the energy required for Household cooking purpose. The only reason is the initial investment required for using these sources of energy is cheap.

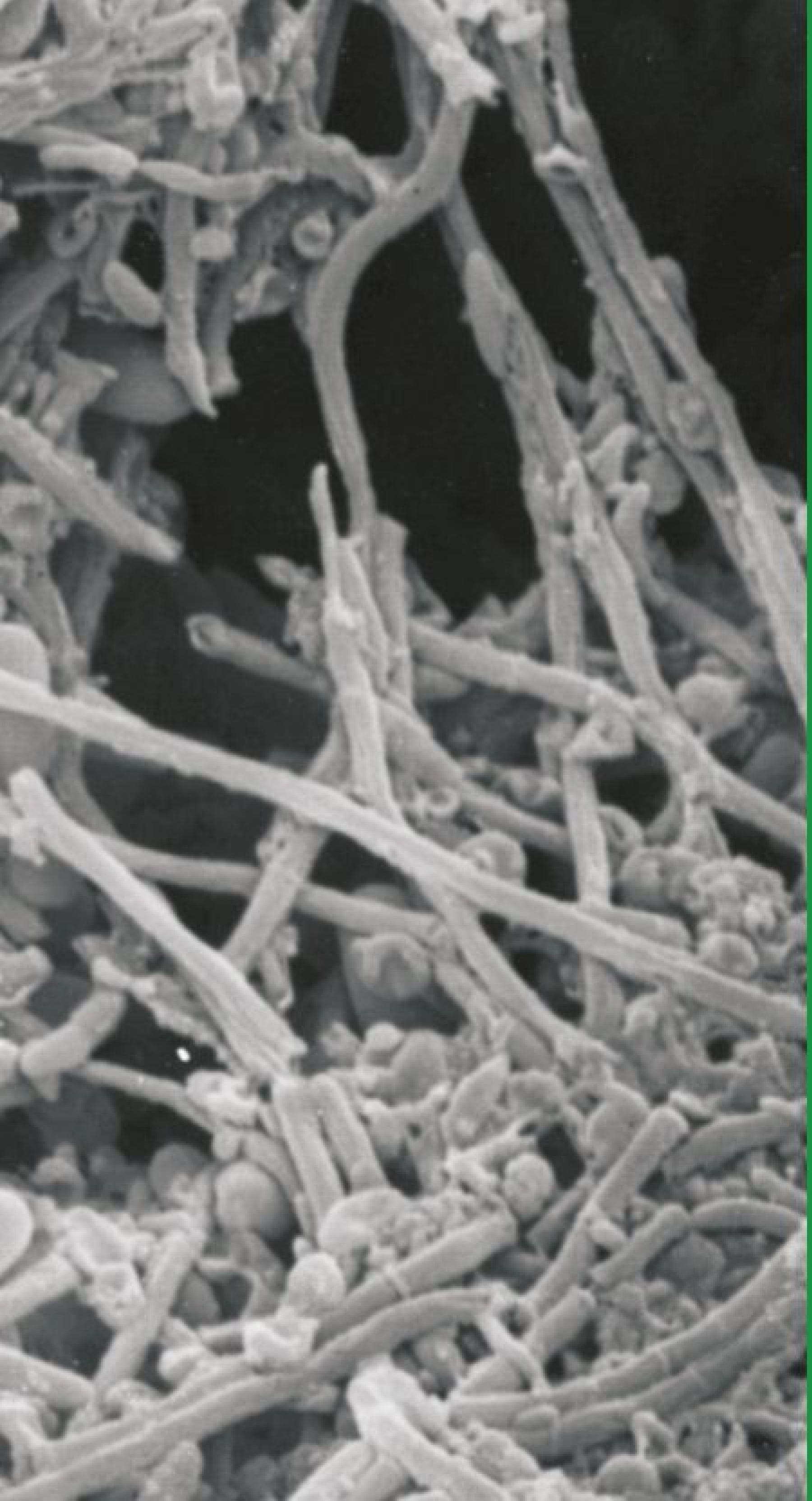
Technology of a Bio-Gas system

Biogas technology is a complete system in itself with its set objectives (cost effective production of energy and soil nutrients), factors such as microbes, plant design, construction materials, climate, chemical and microbial characteristics of inputs, and the inter-relationships among these factors. Brief discussions on each of these factors or subsystems are presented in this section.

Bio-Gas...

This is the mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition. Biogas is mainly composed of 50 to 70 percent methane, 30 to 40 percent carbon dioxide (CO_2) and low amount of other gases.

Biogas is about 20 percent lighter than air and has an ignition temperature in the range of 650 degrees to 750 degrees C. It is an odourless and colourless gas that burns with clear blue flame similar to that of LPG gas. Its calorific value is 20 Mega Joules (MJ) per m^3 and burns with 60 percent efficiency in a conventional biogas stove.



Methanogenic Bacteria or Methanogens...

These are the bacteria that act upon organic materials and produce methane and other gases in the process of completing their life-cycle in an anaerobic condition. As living organisms, they tend to prefer certain conditions and are sensitive to micro-climate within the digester. There are many species of methanogens and their characteristics vary.

A considerable level of scientific knowledge and skill is required to isolate methanogenic bacteria in pure culture and maintain them in a laboratory. Methanogenic bacteria develop slowly and are sensitive to a sudden change in physical and chemical conditions. For example, a sudden fall in the slurry temperature by even 2°C may significantly affect their growth and gas production rate.

The biodigester is a physical structure, commonly known as the biogas plant. Since various chemical and microbiological reactions take place in the biodigester, it is also known as bio-reactor or anaerobic reactor. The main function of this structure is to provide anaerobic condition within it. As a chamber, it should be air and water tight. It can be made of various construction materials and in different shape and size. Construction of this structure forms a major part of the investment cost.

Few of the commonly used designs.

Floating drum digester...

Experiment on Bio-Gas technology in India began in 1937. In 1956, Jashu Bhai J Patel developed a design of floating drum Bio-Gas plant popularly known as Gobar Gas plant. In 1962, Patel's design was approved by the Khadi and Village Industries Commission (KVIC) of India and this design soon became popular in India and the world. In this design, the digester chamber is made of brick masonry in cement mortar. A mild steel drum is placed on top of the digester to collect the biogas produced from the digester. Thus, there are two separate structures for gas production and collection.

Fixed dome digester...

Fixed dome Chinese model biogas plant (also called drumless digester) was built in China as early as 1936. It consists of an underground brick masonry compartment (fermentation chamber) with a dome on the top for gas storage. In this design, the fermentation chamber and gas holder are combined as one unit. This design eliminates the use of costlier mild steel gas holder which is susceptible to corrosion.

Deenbandhu Model...

In an effort to further bring down the investment cost, Deenbandhu model was put forth in 1984 by the Action for Food Production (AFPRO), New Delhi. This model proved 30 percent cheaper than Janata Model (also developed in India) which is the first fixed dome plant based on Chinese technology. It also proved to be about 45 percent cheaper than a KVIC plant of comparable size. Deenbandhu plants are made entirely of brick masonry work with a spherical shaped gas holder at the top and a concave bottom.

The main factors that influence the selection of a particular design or model of a Bio-Gas plant are as follows:

Economic...

An ideal plant should be as low-cost as possible (in terms of the production cost per unit volume of biogas) both to the user as well as to the society. At present, with subsidy, the cost of a plant to the society is higher than to an individual user.

Simple design...

The design should be simple not only for construction but also for operation and maintenance (O&M). This is an important consideration especially in a country like India where the rate of literacy is low and the availability of skilled human resource is scarce.

Utilization of local materials...

Use of easily available local materials should be emphasized in the construction of a Bio-Gas plant.

Durability...

Construction of a biogas plant requires certain degree of specialized skill which may not be easily available. A plant of short life could also be cost effective but such a plant may not be reconstructed once its useful life ends. Especially in situation where people are yet to be motivated for the adoption of this technology and the necessary skill and materials are not readily available, it is necessary to construct plants that are more durable although this may require a higher initial investment.

Suitable for the type of inputs...

The design should be compatible with the type of inputs that would be used. If plant materials such as rice straw, maize straw or similar agricultural wastes are to be used, then the batch feeding design or discontinuous system should be used instead of a design for continuous or semi-continuous feeding.

Frequency of using inputs and outputs...

Selection of a particular design and size of its various components also depend on how frequently the user can feed the system and utilize the gas.

Any biodegradable organic material can be used as inputs for processing inside the biodigester. However, for economic and technical reasons, some materials are more preferred as inputs than others. If the inputs are costly or have to be purchased, then the economic benefits of outputs such as gas and slurry will become low. Also, if easily available biodegradable wastes are used as inputs, then the benefits could be of two folds:

(a) economic value of Bio-Gas and its slurry; and

(b) environmental cost avoided in dealing with the biodegradable waste in some other ways such as disposal in landfill.

One of the main attractions of biogas technology is its ability to generate biogas out of organic wastes that are abundant and freely available. It is the cattle dung that is most commonly used as an input mainly because of its availability. The potential gas production from some animal dung is given in following table.

GAS PRODUCTION POTENTIAL OF VARIOUS TYPES OF DUNG

TYPES OF DUNG	GAS PRODUCTION PER KG DUNG (m^3)
Cattel (Cow and Buffalo)	0.023 - 0.040
Pig	0.040 - 0.059
Poultry (Chicken)	0.065 - 0.116
Human	0.020 - 0.028

In addition to the animal and human wastes, plant materials can also be used to produce biogas and bio-manure. For example, one kg of pre-treated crop waste and water hyacinth have the potential of producing of producing 0.037 and 0.045 m3 of biogas, respectively. Since different organic materials have different bio-chemical characteristics, their potential for gas production also varies. Two or more of such materials can be used together provided that some basic requirements for gas production or for normal growth of methanogens are met.

Some characteristics of these inputs which have significant impact on the level of gas production are described below.

C/N Ratio...

The relationship between the amount of carbon and nitrogen present in organic materials is expressed in terms of the Carbon/Nitrogen (C/N) ratio. A C/N ratio ranging from 20 to 30 is considered optimum for anaerobic digestion. Animal waste, particularly cattle dung, has an average C/N ratio of about 24.

Dilution and consistency of inputs...

Before feeding the digester, the excreta, especially fresh cattle dung, has to be mixed with water at the ratio of 1:1 on a unit volume basis (i.e. same volume of water for a given volume of dung). However, if the dung is in dry form, the quantity of water has to be increased accordingly to arrive at the desired consistency of the inputs (e.g. ratio could vary from 1:1.25 to even 1:2). The dilution should be made to maintain the total solids from 7 to 10 percent.

Volatile solids...

The weight of organic solids burned off when heated to about 538 degrees C is defined as volatile solids. The higher the volatile solid content in a unit volume of fresh dung, the higher the gas production. For example, a kg of volatile solids in cow dung would yield about 0.25 m3 biogas.

pH value...

The optimum biogas production is achieved when the pH value of input mixture in the digester is between 6 and 7.

Temperature...

The methanogens are inactive in extreme high and low temperatures. The optimum temperature is 35 degrees C. When the ambient temperature goes down to 10 degrees C, gas production virtually stops. Satisfactory gas production takes place in the mesophilic range, between 25^0C to 30 ^{0}C.

Retention time...

Retention time (also known as detention time) is the average period that a given quantity of input remains in the digester to be acted upon by the methanogens. In a cow dung plant, the retention time is calculated by dividing the total volume of the digester by the volume of inputs added daily. Considering the climatic conditions of India, a retention time of 50 to 60 days seems desirable.

Slurry...

This is the residue of inputs that comes out from the outlet after the substrate is acted upon by the methonogenic bacteria in an anaerobic condition inside the digester. After extraction of Bio-Gas (energy), the slurry (also known as effluent) comes out of digester as by-product of the anaerobic digestion system. It is an almost pathogen-free stabilized manure that can be used to maintain soil fertility and enhance crop production. Slurry is found in different forms inside the digester as mentioned below:

- a light rather solid fraction, mainly fibrous material, which float on the top forming the scum;
- a very liquid and watery fraction remaining in the middle layer of the digester;
- a viscous fraction below which is the real slurry or sludge; and
- heavy solids, mainly sand and soils that deposit at the bottom.

There is less separation in the slurry if the feed materials are homogenous. Appropriate ratio of urine, water and excrement and intensive mixing before feeding the digester leads to homogeneous slurry.

Use of Bio-Gas...

Of the outputs of Bio-Gas, the gas is valued for its use as a source of energy and the slurry for its fertilizing properties (soil nutrients). Energy content of Bio-Gas can also be transformed into various other forms such as mechanical energy (for running machines) and heat energy (for cooking and lighting) depending on the need and availability of the technology. Some of the common uses of biogas are : cooking, lighting, refrigeration and running internal combustion engine.

Implications of Bio-Gas system...

Bio-Gas technology is best suited to convert the organic waste from agriculture, livestock, industries, municipalities and other human activities into energy and manure. The use of energy and manure can lead to better environment, health, and other socio-economic gains is shown in the Following Chart for your reference.

BIOMETHANIZATION

AGRICULTURE WASTE SYSTEM	AGRO-INDUSTRIAL WASTE SYSTEM	MUNICIPAL WASTE SYSTEM
ENERGY GENERATION	ENVIRONMENT PROTECTION	ENVIRONMENT PROTECTION
FERTILIZER PRODUCTION	ENERGY GENERATION	ENERGY GENERATION
HYGIENE		HYGIENE
OTHER BENIFITS		

Selection of design for the program

Concrete dome design of Bio-Gas plants have some inherent drawbacks, we do not recommend these Bio-Gas plants for following reasons.

1. Space requirement is 2 to 2.5 times more than that of floating drum design.
2. Success of dome design largely depends on skill of the construction workers, curing of cement, foundation strata etc.
3. Gas delivery pressure reduces as gas is consumed.
4. We have large scale of failures recorded for such plants in the past and local people have lost faith in this design. It is better to promote floating drum design.

For all these reasons we recommend only floating drum designs. Conventional design uses steel floating drums. Steel drums are having good weight and hence provide gas at good pressure, but steel drums are very costly and they corrode in the slurry.

There are few plastic gas holders; mostly water tanks converted to gas holders are being used. Major disadvantage of these design are that these tanks do not have adequate weight and gas at burner does not have adequate pressure. As water tanks are used for this application, adding weight to this gasholder is difficult.

We have combined these two advantages in our new gasholder design. This design is in plastic so we can get the gas holder tanks at cheaper rates and also corrosion resistant. This being in HDPE, life can be easily more than 20 years. Special feature of the design is the pockets we have provided on the top and periphery to accommodate concrete blocks.

For a 2 CUM HDPE tank we can add almost 250 kg of weight easily. This is good enough to run even a small generator. For burners, we need max.100 kg of weight. Besides for continuous flow of Bio-Gas A spring is attached to the top of holder in order to create enough pressure for the bio gas.

Specially designed Bio-digester equipment, by Sintex Industries Ltd. has been selected for the program. The equipment has been approved by the Ministry of New and Renewable Energy as per their notification no. 5-5/2009-BE dated 30.06.2010. The unit shall be supplied by SINTEX with 5 years warranty.

CDM ASPECT OF THE PROJECT

To combat the harmful effects of climate change two major agreements have been adopted by the international community: The United Nations Framework Convention on Climate Change, 1992 and the Kyoto Protocol, 1997. The second of these agreements sets quantified and binding commitments on the reduction of greenhouse gas (GHG) emissions for industrialized countries for the 2008/12 period. In order to achieve these reductions countries are permitted to utilise a number of flexibility mechanisms, CDMs being one these mechanisms. A Clean Development Mechanism (CDM) is basically an investment in a developing country that reduces GHG emissions through energy efficiency, the generation of renewable energy or other measures that abate the six GHGs (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6). The resultant emission reduction (carbon credits- CERs) expressed in tonnes of CO_2, may be sold to an industrialised country to offset its domestic emissions commitment.

The average 2 m^3 capacity Gobar / bio Gas unit will be eligible to get 3.5 CERs per year. At the conceptual level, just ten year's CERs sold upfront at 10 Euros/ CER should generate enough funds required to set up the individual Unit.

The Company 'YASHWANT ENERGY PVT. LTD.' proposes to implement this program with the help of local Public Sector bank at the Micro-finance level. In the initial survey conducted in area of operation of 'Yashwant Dugdh' and 'Yashwant Glucose', about 20000 farmers had showed the willingness to join the program. A self help group / joint liability group of minimum 5 eligible farmers shall be formed at the village level. The repayment amount for the loan Rs. 3,400 per annum will be recovered from the farmers at Rs. 1700 on half yearly basis (13 installments). Six months moratorium period has been considered for the repayment, while half yearly loan repayment has been suggested while considering lean and flush season of the milk. This amount payable from the farmers shall be deducted from their Milk bills that are paid fortnightly by 'Yashwant Dugdh Prakriya Ltd.'.

The 80% of the CER amount shall be reimbursed to the farmers. Depending upon the CER prices available in the market this reimbursement of the CDM funds shall cover 40 to 60 % of their loan repayment. The CER revenue, for the price of CERs hedged at 8 Euro/ CER post Qyoto scenario, covers 46% of loan liability of the farmers.

The individual unit is also eligible for subsidy of Rs. 2700 from Ministry of New and Renewable Energy, New Delhi that shall be adjusted in the loan account after the first year of operation.

Yashwant Energy will enter into agreement with farmers for the operation and maintenance of the plants for the 7 years of CDM crediting period. The estimated amount Rs. 300-400 per year required to set up and maintain the infrastructure for the operation and maintenance and supervision of the units shall also be covered through the sale of CERs. Yashwant Energy is in discussion with Insurance companies to provide medical insurance to these participating families at a discounted rate that shall be also born through CERs funding.

Justification for the location of the project

Yashwant Group, is an established Maize and Milk processing industry, reputed for its consistent and High Quality products. Location of this kind of pilot project at carefully selected site where adequate institutional support is available for operation of systems components so also infrastructural provisions for trouble shooting, is an extremely important aspect from point of its demonstrational value.

Yashwant Group being closely linked with local farmers and social development progems, it needs no further reference to state that the information gathered and experience generated will be a public property available to all including other similar industries desirous of executing such a project. Yashwant Group has the necessary infrastructural facilities for monitoring, data collection and analysis, which would be a basis for other units.

A resourceful industrial group like Yashwant which by itself is known for its pragmatic, approach and had long standing reputation for innovative approach. For the success of this kind of venture project, it provides the right kind of environment and is therefore the right place for locating such a project.

Benefits for the nation

Developed countries have been pointing at developing and under developed countries as responsible for GHG, while the fact is otherwise. By reducing emission of hazardous gases, credit will be made available to developed countries. Thus India can boast of positively and actively contributing in reducing Greenhouse effect.

Energy saved is energy generated under the prevailing energy conditions utilization of such non conventional energy sources would boost the energy profile of the nation,

The cow dung and kitchen waste treatment will not only lower energy input but also with energy generation would be important from environmental safety view point.

Experience gained and successful operation of such a project would undoubtedly start a chain of such projects for similar nature, thereby reducing the external energy needs of our nation and thus achieving overall saving of conventional sources.

Thank You...