Energy from Biogas

Conserving Power and Protecting the Environment

At a time of growing global awareness of the need to conserve both energy and the environment, the use of biogas digesters as a waste treatment system and source of energy offers many advantages. One group with expertise in this field is Action for Food Production (AFPRO), a national non-governmental organization (NGO), based in New Delhi, which provides technical support to grass roots NGOs in India and other countries. In this article, Raymond M Myles, executive director of AFPRO, explains the basic processes involved in biogas production and reports on the transfer of the technology to Cambodia.

NOCTURNAL observers over the centuries have been intrigued by the mysterious, flickering lights that can sometimes be seen hovering over the surface of swamps. People used to think they were ghosts or demons, but by the 18th century scientists had discovered that they were caused by an inflammable gas. This gas, now known as methane or biogas, is produced through the action of millions of bacteria breaking down vegetable, animal or human waste. Because the bacteria work in the absence of oxygen, the process is known as anaerobic digestion.

By the late 19th century this process had begun to be applied in the treatment of sewage, and practical uses were being discovered for the resulting gas. As early as 1897, in Bombay, India, methane from human waste was being used to provide lighting. Since then the process of producing biogas has been greatly refined, and today the technology is being used increasingly as an energy source and a method of treating waste in many parts of the world.

Today more than half the world's people cook and heat with firewood, dung and crop residues. These methods, however, are becoming increasingly unsustainable. The use of firewood depletes the forests, and the burning of dung and agricultural residues wastes precious nitrogen, phosphorus, potassium and other nutrients that could be returned to the soil. Biogas production from organic materials not only provides energy but also leaves a nutrient-rich effluent that makes a superb fertilizer and soil conditioner. This material can be as much as 30 per cent more effective than raw manure in raising agricultural productivity. This is because it has a higher nitrogen content than ordinary compost, and the action of the bacteria enhances the nutritional effect of the nitrogen.

Biogas technology is also of great benefit in the area of public health and pollution control. It is a highly efficient method of treating sanitation wastes, reducing their harmful bacterial and parasitic content by over 90 per cent. It can thus help to prevent infection from drinking water, which in many rural areas is untreated.

Biogas plants, or "digesters", come in many different designs, but the most common in developing countries is the fixed dome variety, originally developed in China. This consists of a gas-tight digester made of brick, stone or poured concrete, with hemispherical floor and ceiling. Waste mixed with water is poured in through an inlet pipe. As bacteria break down the waste, gas accumulates in the dome and flows out through a pipe set into the cover of a manhole in the roof. Effluent is displaced into a smaller tank beside the main digester.

It is this design of digester that has been transferred by AFPRO to Cambodia as well as to Nepal and to a number of African countries, using a variant known as the Deenbandhu (meaning "friend of the poor" in Hindi). This model was designed by AFPRO and rigorously tested under different geographical and climatic conditions for over a year. In 1986, India's Ministry of Non-Conventional Energy Sources approved the model for large-scale dissemination in India, and it is currently the cheapest model available in the country as well as being one of the strongest. It is capable of being adapted to locally available construction materials.

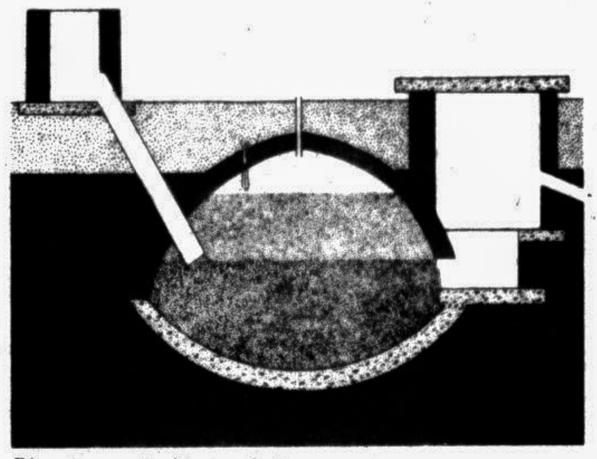
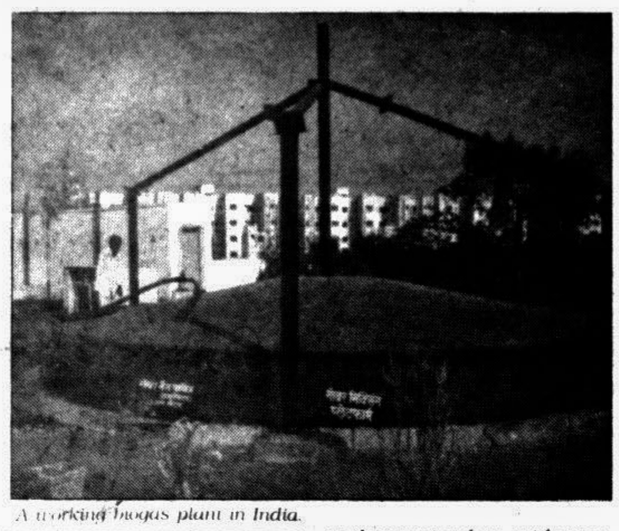


Diagramme of a biogas plant

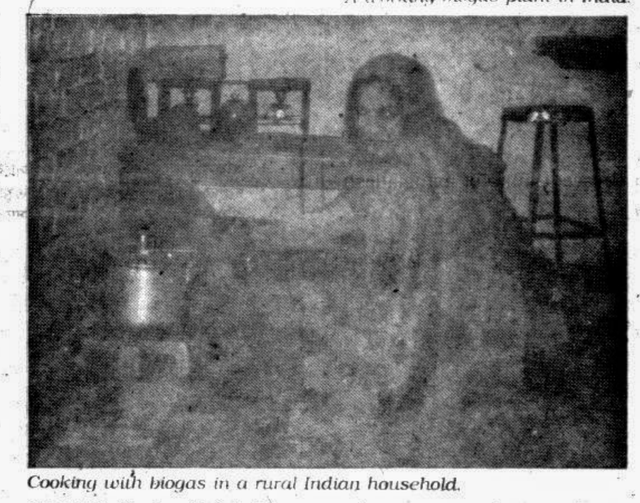
A number of factors have made the Cambodians interested in the development of biogas technology. At a time when the country is still re-establishing its agricultural base after the devastation that occurred during the civil turbulence of the 1970s, the Cambodians are receptive to technologies from other developing countries that can assist the recovery process.



A working biogas plant in India.

Up to the 1960s, some three quarters of the country was covered by forest. Since then, however, large-scale deforestation has occurred, as trees have been used up for fuel, rubber and timber. As firewood is the principal source of fuel in Cambodia, it is clearly desirable for the country to develop alternative sources to reduce the deforestation.

Being an agrarian country with a large number of farm animals, Cambodia has excellent conditions for biogas technology. Taking into account both human and animal waste, it is estimated that enough gas could be generated to meet the energy requirements of 50 per cent of the present Cambodian population of some eight million. Climatic conditions are also favourable, as the country does not have a winter season, the temperature ranging from 21 to 35 degrees Celsius. This is a great advantage for biogas generation, as the efficiency of the digestion process is reduced by cold weather.



Cooking with biogas in a rural Indian household.

In 1989 the Vice Minister in charge of the veterinary department of Cambodia's Ministry of Agriculture led a government delegation to India to explore the possibilities of technical cooperation. An important item on their three week study tour was AFPRO and its experimental farm, located at Aligarh, 120 kilometres from New Delhi. Here they saw biogas technology in action and decided that they would like to try it in Cambodia.

The outcome was that AFPRO sent a group of biogas experts to Cambodia in August and September 1990 to conduct a series of training sessions. Travel and living allowances were paid by the Church World Service (CWS), an international NGO which, among its other activities, supports technology development.

Training took place in various stages. First, a three-day workshop was held in Phnom Penh for senior government officials and representatives of international NGOs working in Cambodia. The purpose of the workshop was to give participants a general orientation in biogas technology.

The next stage was to hold a training for 14 Cambodians who would become supervisors in the construction of biogas digesters. The building of a biogas plant and gas distribution system draws on knowledge from various field, including structural and chemical engineering and gas flow dynamics. The drawings of the plant have to be followed carefully and all the dimensions strictly adhered to. Therefore an appropriately trained technical supervisor is essential. This second level of training, lasting 18 working days, covered all aspects of the supervisor's job. It was conducted at the National Draught Cattle Breeding Station at Phnom Tamao, 45 kilometres from Phnom Penh.

In the third stage, lasting about 25 working days, 15 Cambodian masons learned the construction method by participating in the building of three biogas plants, two at Phnom Tamao and the third at the village of Svay Pak. The two digesters at Phnom Tamao were for cattle manure, while the third was for pig manure.

Certain difficulties were experienced during the training. For example, the Cambodians use bricks that are about half the size of the standard Indian brick. So we had to revise our calculations to include a large number of bricks and therefore more cement and sand. Another constraint was the language factor. The trainees spoke little English, so AFPRO had to rely fully on interpreters.

When we began the training, the Cambodians found it difficult to imagine that it was possible to generate gas from cattle manure. When the first digester was complete and the first gas was drawn off they were astounded and delighted.

After completion of the training mission, the Cambodians who had been trained as supervisors were given the task of monitoring the performance of the digesters for one year and sending reports back to AFPRO. At the time of writing, two of the plants are working smoothly, while the third has experienced some difficulties. As these were the very first biogas digesters to be built in Cambodia, it is too early to say whether the country is likely to adopt the technology on a large scale. However, a good start has been made, and the viability of biogas technology for Cambodia has been clearly demonstrated.

— *UNDP*

Water Pollution: A Common Environmental Problem

by Saqib Hussain Shirazi

'AN Enemy of the People' — a play written by Henrick Ibsen. In this story, a doctor tried to refrain people from drinking polluted water. However, at last the doctor couldn't succeed. Ibsen wrote the play in 19th century but in the last decade of the 20th century, can our modern civilization supply us pure drinking waters?

The drinking water of most communities and municipalities is obtained from surface sources — rivers, streams, lakes. Water that is free from disease producing microbes and chemical substances deleterious to health is called potable water. Water contaminated with either domestic or industrial wastes is called non-potable or polluted water. Water is polluted mainly by two ways: 1) Pollution by chemical substances; 2) Pollution by harmful microbes.

Chemical pollution is an acute problem. A source of industrial water pollution involves mercury used in the manufacture of paper. The metallic mercury is allowed to flow into water ways as waste. It is assumed that the mercury is inert and would remain segregated in the water. However, bacteria in the sediments incorporate the mercury into a soluble chemical compound which is then eaten up by fish. When such sea food is a substantial part of human diet, the mercury concentrations can accumulate devastating effects on the nervous system.

Addition of certain chemicals such as phosphates into lakes cause 'eutrophication'. Eutrophication is a biological term, meaning 'well nourished'. It is the process in which the addition of large amounts of nutrients to water results in massive growth of algae. These algae eventually die and are broken down by bacteria. During this process, the oxygen in the water is used up. Undigested remnants settle to the bottom and hasten the filling of the lake. Eutrophication can also result from the addition of raw sewage, agricultural run off or industrial wastes to lakes.

Both organic and inorganic compounds are added by industrial wastes. For example, slaughter houses, sugar factories, paper mills add organic substances, mines and metal industries contribute acids and salts of metals and other inorganic wastes.

Contamination of water supplies by pathogens is an important factor in the spread of many diseases. There are thousands of microbes present in water, many of them being non-pathogenic. Therefore, it is very difficult as well as time consuming to detect only pathogenic microbes from water. Thus, certain bacterial species are treated as indicators for pathogenic microbes. The presence of any of these indicators in water is evidence of pollution of water. These indicator organisms are designated as 'coliforms'. The classical species of coliform group are Escherichia Coli and acrogenes. In this regard, it should be noted that there is no universal indicator organism for detecting water quality under different conditions different populations may be better indicators than others.

USA water standards for coliform contamination:-

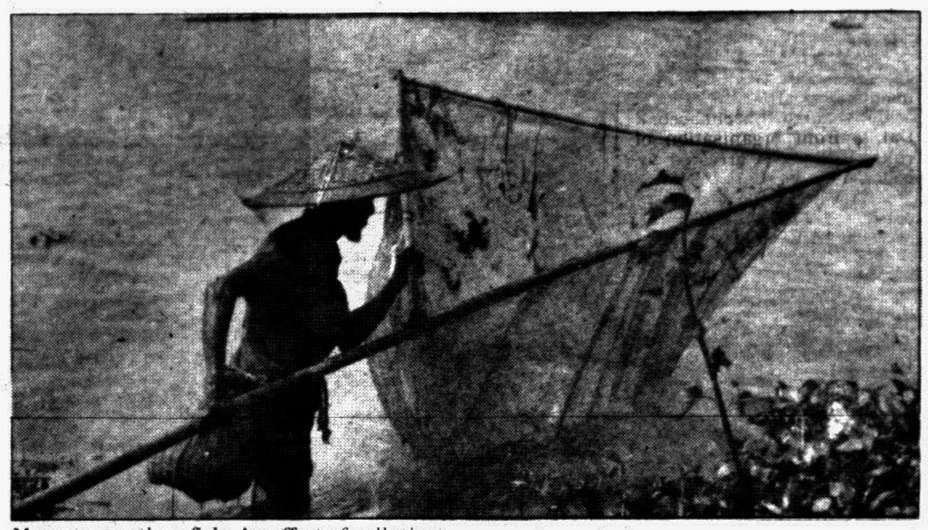
Water use	Maximum number of possible Coliform present in 100 ml
Municipal drinking water	1
Water used for shell fishing	70
Recreational water	1000

According to WHO (World Health Organization), for developing countries, the number of acceptable fecal coliform (i. e coliform from intestinal discharges of animals or humans) in water should be nil/100ml and number of acceptable non fecal coliform in water should be 4/100 ml. It is known that the pathogens that gain entrance into bodies of water arrive there via intestinal discharges of humans and/or animals. Thus, the presence of any coliform in water is evidence of fecal pollution of human or animal origin.

Water in swimming pools may be a health hazard. Swimming pools and surrounding areas may be involved in the transmission of infections of the eye, nose, throat and intestinal tract. In swimming pools, a bacteria called Pseudomonas acruginosa can be found. In this case the count is more important than coliforms.

Besides bacteria, viruses, protozoa and algae also contaminate water bodies. Algae are present in all natural aquatic environments. They are involved in the creation of turbidity in water. There is evidence that infectious hepatitis was, on occasion, spread by water supplies. Spread of polio infection through water supplies and/or recreational use of beaches has been suspected in some cases but causative proof is lacking. Considerable research is underway for the development of a routine test method for the detection of viruses in water.

The demand for larger qualities of potable water continues to grow world wide. The gravity of the water pollution problem is reflected in the following quotation taken from Nandan Proge's article," Fresh water supplies were all important in the establishment and growth of civilizations. Much of man's bitterest fightings has been indicated by altercations over water rights, and the course of history may well be written round the theme of primitive and modern man's need for water."



More wastes than fish: An effect of pollution

Wildlife Society Gets into Power Politics

by Felix Mponda Blantyre

In the wake of parliamentary elections and the defeat of Life President Hastings Banda, the new government in Malawi is keen to deliver power to the people. But, reports Gemini News Service, first it has to meet the demands of the local Wildlife Society.

AFRICA has remained relatively free of the big-dam disputes that have accompanied large-scale infrastructure development in Asia and Latin America. But that is beginning to change as the tapping of of the continent's hydropower potential gets underway.

The controversy around Malawi's $112 million Kapichira hydroelectric power scheme, for example, repeats many of the now familiar environmental claims and counter-claims, although as elsewhere in Africa the local environmental lobby is no match for the development lobby.

"It's a model project," insists Daud Bauleni, an environmental officer with the parastatal Electricity Supply Commission of Malawi (ESCOM).

That is music to the ears of the International Development Association, soft-loan affiliate of the World Bank, which is providing the finance, together with the Commonwealth Development Corporation and a Dutch organisation. The World Bank is particularly eager not to get involved in another bruising clash with anti-dam environmentalists.

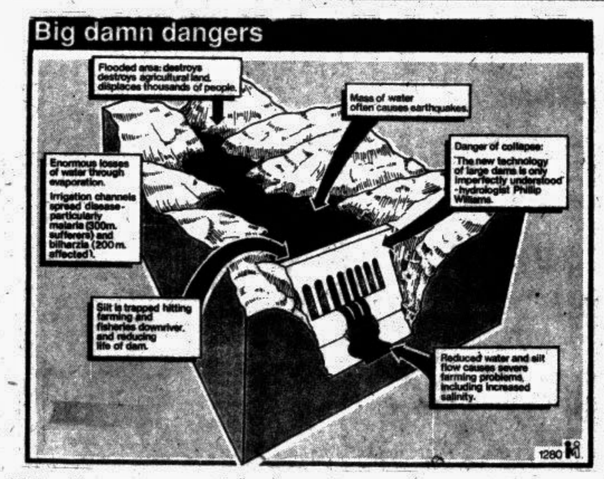
Bauleni points out that although there will be a 26 metre dam, most of the construction will be on a natural rock shelf which will require little excavation, and that feasibility studies favoured the site because of its "high power potential and few negative environmental impacts."

The Commission is keen to go ahead with the scheme on the Shire river as part of a plan to expand Malawi's generating capacity from 164 megawatts to 342 megawatts to meet increased demand.

The Shire, Malawi's longest river, flows out of Lake Malawi and joins the Zambezi in Mozambique.

Kapichira will be the third power station on the river when it is switched on in 2002.

The Wildlife Society of Malawi is not so sure that the results will all be beneficial.



It is particularly concerned about impact on the nearby Majete Game Reserve. 57 hectares of which will be flooded by the 3.5-kilometre-long reservoir.

Another 78 hectares of the Blantyre City Fuelwood Project will be affected, plus 135 hectares of forest.

A total of 36,000 trees will be cut and sold as firewood, for which ESCOM will pay $80,000 compensation to the National Parks and Wildlife Department.

The National Herbarium and Botanical gardens has agreed to transfer nine rare forest species on the 'Zomba Plateau.

Concern is also being voiced about the danger of inadvertently introducing tiger fish or the ubiquitous, water-choking water hyacinth to the water above the Kapichira falls.

Tiger fish feed on chambo (tilapia), which provides three-quarters of the animal protein intake of some groups of Malawians.

"All chambo could disappear if tiger fish are around," says Bauleni. "That's why there are no chambo below Kapichira falls."

ESCOM promises it will take care with resettlement and says labour camps will be located four kilometres away from the site in order to keep the 1,000 employees out of the Majete reserve. Game rangers will be given access to labour camps to investigate poaching.

It also says it will insist on strict environmental protection clauses in all construction contracts. Contractors will be required to protect vegetation, restore landscapes, control dust, dispose of waste and reclaim quarries.

The Wildlife Society is looking over ESCOM's shoulder. It aims to see that all environmental measures are carried out to the letter. A sign of potential friction comes from programme officer Francis Epulani, who already accuses ESCOM of failing to give practical effect to its pledges.

Though the Commission carries great clout, the Wildlife Society has shown it is capable of biting : two years ago it pressured the government to stop a $20 million irrigation scheme on the Shire which the administration said would benefit 300,000 people.

The Society successfully argued that the proposed canal would damage wildlife in two reserves already under pressure from human encroachment. — GEMINI NEWS

About the Author : FELIX MPONDA is a Blantyre-based freelance journalist and correspondent for Agence France Presse.

Lawyers for Checking Environment Pollution

A High Court bench on March 29th issued *rule nisi* on the government to show cause as to why it should not be directed to take effective steps to check pollution caused by hazardous smokes from motor vehicles and the use of unduly shrill and loud horns.

The bench comprising Justice AM Mahmudur Rahman and Justice Mahfuzur Rahman issued the rule on the Chairman of Bangladesh Road Transport Authority (BRTA) and the Commissioner of Dhaka Metropolitan Police (DMP) on a writ petition filed by advocate Dr Mohiuddin Farooque.

In his petition, Dr Farooque, who is the Secretary General of Bangladesh Environmental Lawyers Association (BELA), said the lives of the city dwellers and its environment are endangered by the air pollution from faulty motor vehicles.

He said the failures of the respondents in the performance of their statutory and public duties are depriving people of their fundamental rights disturbing the public peace creating public annoyance.

Dr Farooque submitted that the lead-laced gas emitted because of the use to leaded petroleum were severely affecting the lungs, liver, brain and the nervous system, resulting to high blood pressure as well as IQ and memory-retention damage among children and damage to foetuses leading to deformed babies.

The high sulphur content in the petroleum, and hence in the smoke, causes severe damage to the ecology, he said.

The lawyer further submitted that the right to a sound environment was also a fundamental right under the Constitution. Therefore, the failures of the respondents in their duties denied the people of their basic fundamental right, he added.

Dr Farooque was assisted by a team of BELA advocates comprising Mirza Quamrul Hasan, MA Hakima, Mirza Hossain Haider, Sadia R Jahan and Nahreen Parveen. — *UNB*

Water May be Killing Them Softly and Slowly

Prakash Chandra writes from New Delhi

WATER from deep tubewells in West Bengal appears to be slowly killing many of the 30 million or so villagers which use it.

A team of scientists from Jadhavpur University's School of Environmental Studies, which visited the area to assess the severity of the problem on the request of the West Bengal government, found that some 321 villagers may be suffering from arsenic poisoning and that at least 800,000 people are drinking the contaminated water.

A Calcutta newspaper, however, has speculated that the whole region probably uses the poisoned water and some 30 million people could be dying from a natural disaster they are probably not aware of.

The wells' water was found to be laced with arsenic — a poison which, in larger doses, can kill a person instantly.

The World Health Organization (WHO) says the water from Bengal wells has 20 to 30 times more arsenic than the minimum safe levels it has established.

As against a permissible 0.05 milligram of arsenic in a litre of water specified by WHO and Indian authorities, water in the six affected districts registered 0.012 to four millilitres of arsenic in a litre of water — a level which is considered "highly toxic".

But no one in Delhi or the international agencies seems to be bothered by the serious health risk faced by millions of poor people here.

Health Ministry officials have distanced themselves from the controversy, saying: "It is a state matter. The West Bengal government has not approached us. Besides it will be a major job to provide safe drinking water to the people hit by the arsenic-affected wells."

Geologists say arsenic in the form of insoluble salts occurs naturally in the bedrock that underlies much of West Bengal's 88,000-square-kilometre land area. But sometimes because of deep drilling, arsenic dissolves out of the bedrock into the groundwater.

According to researchers, millions of cubic meters of water are drawn for irrigation each year in this area and agriculture relies on this source totally except during the monsoons.

Since the village people do not get adequate protein food, arsenic poisoning becomes more tangible and potent.

It is likely that arsenic poisoning from water wells may not be confined to just West Bengal. Researchers have found some evidence suggesting that certain areas in neighbouring Bangladesh may also be affected although the later may be unaware of this.

The Jadhavpur University research team believes that tubewells, which are usually less than 450-foot deep, are unsafe because they draw water from the most contaminated layers of rock. They have found that one such well in Malda district spews out 153 kilograms of arsenic each year.

The team recommends boring to at least 500 feet and careful and regular monitoring of water from these wells.

Until recently, the poisoning was largely ignored by authorities but as the extent of the disaster has gradually surfaced, some funds are being provided for deeper tubewells.

This is only a stop-gap measure, however, as the water needs of the region's growing population are rising all the time. Over the course of their studies, the team found that tubewells may be free from arsenic this year but almost certainly would be contaminated the next year.

They have seen a 20 per cent increase at least in the incidence of arsenic poisoning each year since they began. They say that even 500-ft tubewells will soon become affected by arsenic.

Latest reports reaching the Environment Ministry say as many as six districts of West Bengal on the left bank of the Bhagirathi River have been contaminated by lethal concentrations of arsenic.

The Water Mission has admitted that nearly 30 million people living in these six districts on 34,000-sq km area have already been affected.

Excessive use of the contaminated water, it was found, causes blackening of skin, sores and lesions, and even skin cancer. High levels of arsenic also affect the liver, heart and the nervous system.

An official of the Water Mission, who has been touring the affected areas, says social tensions and problems are on the rise. In some villages, these skin eruptions were mistaken for leprosy — leading to ostracism of the afflicted persons.

Girls with skin lesions are finding it difficult to get married. — *Depthnetus Asia*