# A SMALL-SCALE BIOGAS DIGESTER MODEL FOR HEN MANURE TREATMENT: EVALUATION AND SUGGESTIONS

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## SUMMARY

In this case study, a small-scale biogas plant in treatment of manure wastes was proposed for a hen farm (Dortler Farm on Ankara Highway in Corum city of Turkey) selected as model pilot plant. A fixed-dome Chinese model biogas reactor (FDCMBR) having a digester volume of 280 $m^3$ was found to be appropriate in treatment of hen manure wastes. Calculations based on design criteria and literature data were presented. The proposed biogas plant was designed for local possibilities, and low cost conditions based on local information and experimental studies given in the literature. In Corum city, the total daily biogas production (about 7625 $m^3$ $day^{-1}$) can be provided from individual biogas plants, operating at 58 active hen farms having different waste loads. By considering the population of Corum city (161000 people), this total production was estimated to compensate the daily requirements of 290 families (5 members) including heating, cooking, cooling and lighting. The number of people who make use of this biogas energy (1452 people) was found to be equal to approximately 1% of the total population of Corum city. In this case study, revenues and expenditures (R&E) were also estimated for the proposed FDCMBR. The R&E analysis showed that revenues that can be provided from selling of stabilized manure were estimated to be € 15500 per year. This value was found to be nearly equal to total operating and construction expenditures of the proposed biogas plant. Moreover, results of some experimental studies including projection criteria were also presented. More importantly, this case study is expected to provide a useful background and a scientific contribution in manure management for rural areas of Turkey.

**KEYWORDS:** fixed-dome biogas reactor, hen manure, biogas plants, renewable energy.

## INTRODUCTION

The poultry industry is growing rapidly along with human population. The increased trend in both developed and developing countries results in large quantities of animal wastes which must be treated in order to prevent major environmental impacts. For example, improper management of manure can result in severe consequences to the environment, such as odor problem, attraction of rodents, insects and other pests, release of animal pathogens, groundwater contamination, surface water runoff, deterioration of biological structure of the earth, and catastrophic spills [1].

Investigations conducted in 2002 demonstrated that the number of farm animals (including sheep, cattle, broiler, layer, turkey, duck and goose) was about 288 million in Turkey. Animal wastes obtained from this sector can provide a great biomass resource in the production of biogas. In Turkey, 12% and 30% of 135 million tons fresh manure are used in agricultural land applications, and in dried form as fuel source in houses of rural areas, respectively. The remainder portion is applied in pastures as nutrient sources.

Corum city of Turkey is the trade center for a farm region where grains, fruits, sheep and goats are produced. The increasing animal waste generation is one of the most urgent environmental problems in Corum city. The Turkish Statical Institute (TURKSTAT) emphasized that the number of hens, which was about 3 million in 1999, showed a continuos variation. While the number of hens was 2.8 million in 2001, it was about 1.7 million in 2003 [2]. According to investigations carried out for Corum city, 58 of 156 hen farms are active in production. Production capacities and waste loads of these active farms are given in Figure 1.

Anaerobic digesters offer many potential benefits to farmers and environment, including odor and fly control, renewable energy production, distributed generation of electricity, potential increase in the value of manure as a fertilizer, pathogen reduction, weed seed destruction, greenhouse gas reduction, reduction in total oxygen demand and evaluation of digested effluent for agricultural applications regarding regulations. In the absence of oxygen, anaerobic digesters biologically convert organic wastes into

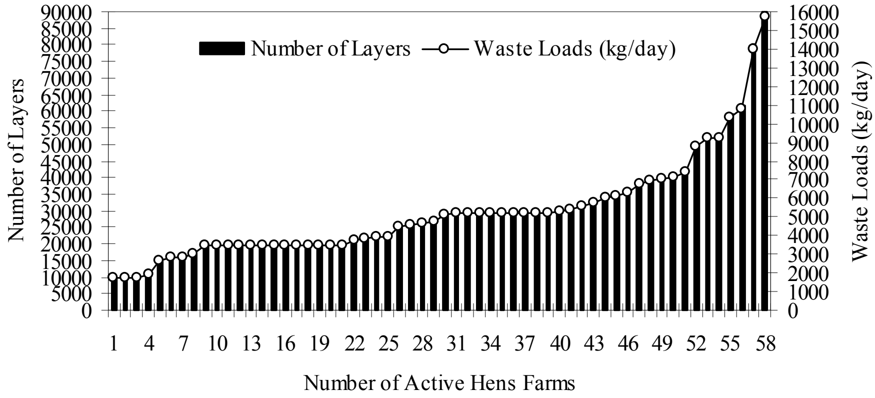


**FIGURE 1 - Production capacities and waste loads of active hen farms in Corum city.**

stable organics having characteristics differentt from that of raw organics in basic stages (hydrolysis, acidogenesis, acetogenesis and methanogenesis). Anaerobic digestion is also regarded to be a source of renewable energy in the form of methane gas. Therefore, recent investigations demonstrate that anaerobic digesters have been getting attention due to their dual role in waste treatment [3].

The anaerobic digestion of animal waste yields several economical and environmental benefits, such as production of methane for fuel use, waste reduction to slurry with high nutrient content, and deactivation of pathogens in the manure [4]. Hence, the evaluation of anaerobic digestion system as a leading process for the production of biogas will provide a renewable energy resource for many applications, in addition to waste reduction and other potential benefits. Anaerobic digestion of animal wastes will also contribute to more feasible benefits, as reduction of waste management costs for both developed and devepoling countries. A well-designed and managed anaerobic digester will minimize the risk of surface and groundwater contamination [5, 6]. Therefore, safety concerns and care must be taken in both designing of digesters and their application [1].

In the anaerobic digestion of cattle, hen and swine wastes, a number of different reactor configurations have been reported, such as large-size anaerobic digesters for poultry manure [7], hybrid UASB reactors [8], anaerobic SB reactors [9, 10], UASB thermophilic-mesophilic digestors reactors [11- 13], and two-stage [14].

1936, a fixed dome (Chinese) digester was built in Jiangsu, China. The reactor consists of a gas-tight chamber constructed of bricks, stone or poured concrete. Both the top and bottom of the reactor are hemispherical, and joined together by straight sides. The gas produced during digestion is stored under the dome, and displaces some of the digester contents into the effluent chamber [15]. In this design, the fermentation chamber and gas holder are combined as one unit. This design eliminates the use of a costlier mild steel gas holder which is susceptible to corrosion. The life of the fixed dome-type plant is longer (20-50 years) compared to that of the floating drum digesters [16]. With the introduction of this fixed dome Chinese model plant, the floating drum plants became obsolete because of comparatively high investment and maintenance costs along with other design weaknesses. Based on the principles of fixed dome model from China, Gobar Gas and Agricultural Equipment Development Company (GGC) of Nepal has developed a design popularized since the last 17 years [16].

Some studies can be cited on fixed-dome biogas reactors, such as investigation of the potential of fixed-dome biodigester effluent as a protein supplement in a straw-based diet for growing indigenous bulls [17], heat transfer analysis of fixed dome biogas plants [18, 19], evaluation of energy balance of fixed-dome biogas plants [20], transient analytical study of a fixed dome type biogas plant [21], monitoring of the performance of a static scum-breaking net for fixed-dome biogas plants [22], experimental validation for a glazed fixed-dome biogas plant [23], a case study of development of a fixed-dome biogas plant [24], mathematical modeling for a fixed dome type biogas plant [25, 26], economic analysis of a fixed-dome biogas plant [27], performance evaluation of a fixed dome plug flow anaerobic digester [28], performance evaluation of fixed-dome Janata and Deenbandhu biogas plants [29, 30], performance evaluation of fixed and floating dome biogas plants [31, 32], design of an active fixed-dome type biogas plant [33], investigations of problems with biogas plants [34], evaluation of a fixed dome Janata biogas plant in hilly conditions [35], and investigation of temperature profiles for fixed-dome biogas plants [36]. Nevertheless, very little information is available on FDCMBR for rural areas of Turkey.

The objectives of this case study were to design a small-scale fixed-dome Chinese model biogas reactor (FDCMBR) for a hen farm selected as model pilot plant (Dortler Farm) in Corum city, Turkey, to investigate the feasibility of the proposed digestion process in treatment of manure wastes generated in this farm, and to provide new scientific contribution regarding manure management for rural areas of Turkey. In this study, calculations based on design criteria and literature data were described. In addition, economical, technical and environmental benefits obtained from the proposed system were also presented.

## MATERIALS AND METHODS

### Fixed-Dome Chinese Model Biogas Reactor

A fixed-dome plant comprises of a closed, dome-shaped digester with an immovable, rigid gas-holder and a displacement pit, also named "compensation tank". The gas is stored in the upper part of the digester. When gas production commences, the slurry is displaced into the compensating tank. Gas pressure increases with the volume of gas stored and the height difference between the slurry levels in digester and compensation tank. If there is little gas in the gasholder, the gas pressure is low. The basic function of a fixed-dome biogas plant is illustrated in Figure 2 [37].

Nienhuys [38] reported that only 9% of the population of Nepal (roughly 2 million) lives in the high-mountain areas, and this population is highly dependent on firewood for its energy needs (cooking, water and space heating). About 3 tons of firewood are consumed per family per year at lower altitudes (upto 1500 m), an amount which increases with altitude. Firewood consumption at the higher altitudes has an increased impact on deforestation as compared to the lower altitudes. With regard to biogas, he observed that many smallholder farms have two buffaloes to assist them in agricultural activities, such as tilling of the land and milk supply. These buffaloes are mainly kept in stables and considered to be an excellent source for biogas production. The Nepalese biogas programme, developed with the support of many local experts and more than 50 construction companies and with subsidy supports, has reached a phase in which it needs wider application and the largest possible range of farmers with cattle should have access to this Renewable Energy (RE) technology. The author emphasized that the technology of the current fixed-dome design had reached maturity in construction quality, quality control, subsidy and management mechanisms, training and implementation in all easily accessible areas. In addition to fixed-dome design, he proposed the Remote Area Biogas Reactor (RABR), which is an insulated bag reactor for the remote areas at high altitudes.

The cost of a fixed-dome biogas plant is relatively low, and it is simple as no moving parts exist. There are also no rusting steel parts and, hence, a long life of the plant (20 years or more) can be expected. The plant is constructed underground, protecting it from physical damage and temperature changes. While the underground digester is protected from low temperatures at night and during cold seasons, sunshine and warm seasons take longer to heat up the digester. No day/night fluctuations of temperature in the digester positively influence the bacteriological processes. In order to prevent heavy losses of biogas, the construction should be supervised by experienced biogas technicians [37].

### Design Criteria and Calculations

In most bioreactors, the rate of gas production varies with time, seasonal temperature and substrate quality. According to literature studies [37, 39-45] and local data [46] gathered from the case study, some projection parameters were selected in design of FDCMBR. Main input variables (dilution ratio, HRT, SBPR, etc.) were chosen from operating ranges of these values given by different researchers, and calculations were made based on selected values for each parameter. In this paper, the reactor design was described for sample values. It is obvious that different input parameters will yield different outputs.

Projection criteria proposed by Information and Advisory Service on Appropriate Technology – GATE (German Appropriate Technology Exchange) in Deutsche Gesellschaft für Technische Zusammenarbeit (ISAT-GTZ) were considered in design of the FDCMBR. The Provincial Directorate of Environment and Forestry of Corum City reported that the number of breeding hens in the pilot farm was about 10000. The average quantity of waste generated per hen was obtained to be 175 g $hen^{-1}$ $day^{-1}$. In calculations, dilution ratio (manure:water) and hydraulic retention time (HRT) were selected as 1:3 and 40 days, respectively. Specific biogas production rate (SBPR) was considered to be 60 L kg of $manure^{-1}$ [43]. The volume of gasholder was selected as 50% of the daily gas production rate [46]. Fi-

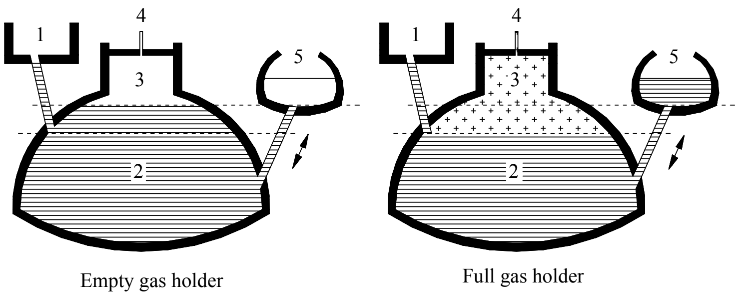


**FIGURE 2 - The basic function of a FDCMBR: 1. Mixing pit, 2. Digestion Part, 3. Gasholder, 4. Gas outlet pipe, 5. Displacement pit.**

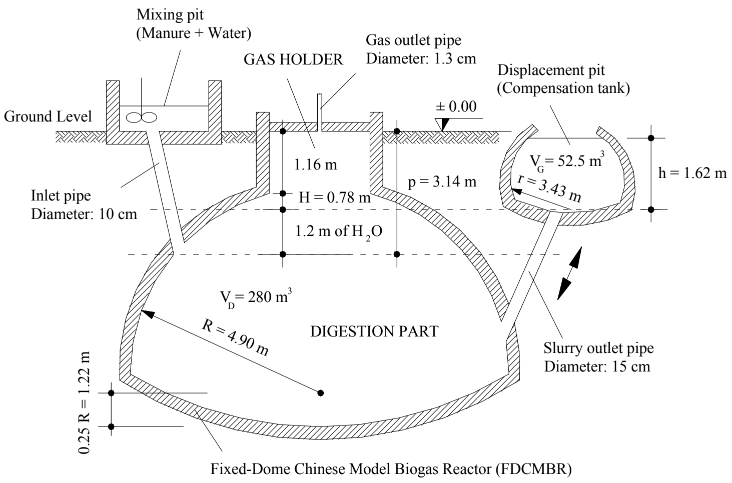


**FIGURE 3 - Cross-section of the FDCMBR with calculated projection dimensions for $V_G$:$V_D$ ratio of 1:5.**

nally, the ratio between volumes of gasholder and digester was provided as 1:5 ($V_G$:$V_D$). Some projection dimensions considered in design of the FDCMBR are presented in Table 1 [39].

**TABLE 1**
**Some projection dimensions considered for $V_G$:$V_D$ ratios [39].**

| $V_G$:$V_D$ | 1:5 | 1:6 | 1:8 |
|---|---|---|---|
| R | $\sqrt[3]{0.42V_D}$ | $\sqrt[3]{0.42V_D}$ | $\sqrt[3]{0.42V_D}$ |
| r | 0.70R | 0.66R | 0.60R |
| H | 0.16R | 0.15R | 0.14R |
| h | 0.33R | 0.31R | 0.28R |
| p | 0.64R | 0.60R | 0.53R |

$V_G$: volume of the gas holder, $V_D$: volume of the digest-er, R: radius of the FDCMBR, r: radius of the displacement pit, H: the distance between the bottom of gas holder wall and the bottom of the displacement pit, h: height of the slurry in the displacement pit, p: the distance between the ground and the entrance point of the inlet pipe.

According to local data and projection criteria, the daily waste load was obtained as follows:

$$W_L = N.C = (10000)(0.175) = 1750 \text{ kg day}^{-1} \quad (1)$$

where $W_L$ is the daily waste (manure) load (kg day$^{-1}$), N is the number of breeding hens in the farm, and C is the average quantity of waste generated per hen (kg hen$^{-1}$ day$^{-1}$). According to the dilution ratio of 1:3, the volume of slurry to be digested was calculated by Equation (2):

$$V_S = W_L + V_W = 1750 + (1750)(3) = 7000 \text{ l day}^{-1} \cong 0.30 \text{ m}^3 \text{ hour}^{-1} \quad (2)$$

where $V_S$ is the volume of the slurry (m$^3$ day$^{-1}$), $W_L$ is the daily waste load, and $V_W$ is the volume of water used to dilute the raw manure. The required digester volume was determined as follows:

$$V_D = (V_S)(HRT) = (7000 \text{ l/day})(40 \text{ days}) = 280000 \text{ l} = 280 \text{ m}^3 \quad (3)$$

where $V_D$ is the volume of the digester (m$^3$), $V_S$ is the volume of the slurry (L day$^{-1}$), and HRT is the hydraulic retention time (day). In Equation (4), the daily biogas volume was calculated by considering the specific biogas production rate as 60 L kg$^{-1}$ of manure:

$$V_B = (SBPR)(W_L) = \left[60 \text{ l ( kg of man.)}^{-1}\right](1750 \text{ kg day}^{-1}) = 105000 \text{ l day}^{-1} = 105 \text{ m}^3\text{day}^{-1} \quad (4)$$

where $V_B$ is the volume of daily produced biogas (m$^3$ day$^{-1}$), SBPR is the specific biogas production rate (L kg$^{-1}$), and $W_L$ is the daily waste load (kg day$^{-1}$). In Equation (5), the volume of gasholder ($V_G$) was calculated as 50% of the daily gas production rate. Hence, the ratio between volumes of gasholder and digester ($V_G$:$V_D$) was provided as 1:5 in Equation (6).

$$V_G = (105000)(0.50) = 52500 \text{ l} = 52.5 \text{ m}^3 \quad (5)$$

$$V_G : V_D = (52500)/(280000) = 1:5 \quad (6)$$

According to projection dimensions given in Table 1, dimensions of the FDCMBR were determined from Equations 7, 8, 9, 10, 11 and 12.

$$R = \sqrt[3]{(0.42)(280)} \cong 4.90 \text{ m} \quad (7)$$

$$r = (0.70)(4.90) \cong 3.43 \text{ m} \quad (8)$$

$$H = (0.16)(4.90) \cong 0.78 \text{ m} \quad (9)$$

$$h = (0.33)(4.90) = 1.62 \text{ m} \quad (10)$$

$$p = (0.64)(4.90) \cong 3.14 \text{ m} \quad (11)$$

$$(0.25)R = (0.25)(4.90) \cong 1.23 \text{ m} \quad (12)$$

In Figure 3, projection dimensions obtained for $V_G$:$V_D$ (volume of gasholder : volume of digester) ratio of 1:5 are given on the cross-section of a fixed-dome Chinese model biogas reactor.

**TABLE 2 - Estimated Revenues and Expenditures of the proposed Fixed-Dome Chinese Model Biogas Reactor for the pilot farm . (1 EUR = 1.2646 USD, Indicative Exchange Rates Announced at 15:30 on 01/15/2004 by the Central Bank of Turkey).**

| Operating and Construction Expenditures (€ /year) | Revenues (€ /year) |
|---|---|
| *Water Consumption*<br>Cost of 1 $m^3$ of water: € 1.05 /$m^3$<br>5.25 $m^3$/day x 1.05 € /$m^3$ = € 5.5 / day<br>5.5 € / day x 360 days/year = € 1985<br>*Personnel*<br>1 person x 400 € / month x 12 months/year = € 4800<br>(an authorized person was considered for reactor operating)<br>*Construction Works*<br>Total volume of the plant: 280 + 52 =332 $m^3$<br>Production Cost of 1 $m^3$ of concrete € 13.5 / $m^3$<br>332 $m^3$ x 13.5 € / $m^3$ = € 4482<br>*Piping Works*<br>Cost of 1 m of PE pipe: € 2.4 / m<br>For 10 m of PE pipe = € 2.4 / m x 10 m = € 24<br>Feeding Pump: Approx. € 61.5<br>Level Recorder: Approx. € 42<br>Generator (2 kW): Approx. € 322<br>Other Expenditures: Approx. € 5000 | *Stabilized Manure*<br>Daily production: 1475 kg/day<br>Selling price: € 0.029 / kg<br>€ 0.029 / kg x 1475 kg/day x 360 days/year x 0.75 = € 15550<br>(75 % of stabilized manure was considered for selling)<br>*Electricity*<br>Net production: 0.4 kW for 250 min/day<br>Selling price: € 0.030 / kWh<br>€ 0.030 / kWh x 0.4 kW x 250 min/day x 360 days/year x<br>1 h/60 min = € 6480 (63 days interruption electricity)<br>*Hot Water*<br>Net production: 4 kW for 150 h/year<br>Selling price: € 0.024 / kWh<br>€ 0.024 / kWh x 4 kW x 150h/year x 360 days/year = € 5184 |
| ≈ € 17000 / year | ≈ € 27000 / year |

**Estimated Revenues and Expenditures (R&E) of the proposed FDCMBR for the pilot farm**

Kocak-Enturk [46] estimated the revenue and expenditures (R&E) can be obtained from the proposed FDCMBR for the pilot farm in Corum city. The estimated R&E analysis is given in Table 2.

## RESULTS AND DISCUSSION

In this study, FDCMBR was designed as an appropriate digestion process in treatment of hen manure wastes generated in a pilot farm in Corum city, Turkey. In addition to projection, an estimated revenues and expenditures analysis was presented for this model plant (Table 2). Kalia and Singh [40] made a basic assumption in designing a fixed dome biogas plant: The biogas plant is to be run on cattle manure slurry prepared by mixing cattle manure with water in equal proportions. 1 kg cattle manure mixed with an equal quantity of water occupies a volume of nearly 0.002 $m^3$ and produces 35-40 L of biogas with hydraulic retention time (HRT) of 55-60 days at mean summer ambient temperatures of 24-26 °C. Thus, a daily feeding rate of nearly 25 kg cattle dung requires a digester volume of 2.75-3.0 $m^3$. Khoiyangbam et al. [41] conducted a study on methane emission from fixed-dome biogas plants in hilly and plain regions. They reported that the highest temperature (33°C) was recorded in June and remained in the optimum range (32-33°C) upto August. Correspondingly, $CH_4$ emission rates from the slurry displacement chambers of biogas plants were higher during these months. Karki and Gauham [42] obtained the actual gas production to be 5.75 $m^3$ $day^{-1}$ for feeding 115 kg of human excreta into a fixed dome biodigester having a volume of 15 $m^3$. Rehling [43] and Wellinger [44] proposed a 20-40 days range of HRT in treatment of liquid hen manure. Actually, the optimum value of retention time depends on many factors, like feed stock, environment temperature, and type of gas plant. Singh et al. [45] emphasized that different retention times are used for unheated biogas plants, depending upon the climate. They reported that the current practice is to use a retention time of about 30 days in relatively warm regions, 40 days in northern plains, and 55 days for the colder hilly regions. Based on the literature data, a dilution ratio (manure:water) of 1:3, a HRT of 40 days, SBPR of 60 L per kg manure, and a ratio of 1:5 between volumes of gasholder and digester ($V_G$:$V_D$) were selected (Table 1) in design of FDCMBR. Moreover, the basic function of the proposed FDCMBR is shown in Figure 3.

Gripentrog et al. [47] reported some calculations to design an on-farm biogas plant for a particular farm (Højtofte) situated in the village of Kustrup, in the Local Authority of Middelfart, County of Funen, in Denmark. They designed a biodigester for a substrate input of 9.23 tons $day^{-1}$. The mixing ratio of dung to water and required retention for cattle manure were chosen to be 1:2 and 60 days, respectively. According to these projection parameters, they obtained the volume of biodigester to be 1300 $m^3$. The proportion of degradable materials (volatile solids, VS) present on the organic waste and the mean gas yield in cattle manure were considered to be 13% and 0.2 $m^3$ $(kg\ VS)^{-1}$, respectively. Finally, they determined the monthly biogas production to be 7202 $m^3$. These calculations were followed by determination of the potential power production. In selection of the mean gas yield for the cattle manure, they considered the values given by Information and Advisory Service on Appropriate Technology – GATE (German Appropriate Technology Exchange) in Deutsche Gesellschaft für Technische Zusammenarbeit (ISAT-GTZ), also cited in this paper. It can be stated that the hierarchy of calculations given in this present study was obviously in agreement with the study of Gripentrog et al. [47]. According to projection parameters for poultry droppings given by ISAT-GTZ in 1996, they stated the proportion of VS and the gas yield range to be 17% and 0.31-0.62 $m^3$ (kg VS)$^{-1}$, respectively. Based on these projection parameters given for poultry droppings, the quantity of total volatile solids was obtained to be 297.5 kg VS day$^{-1}$ for a waste load of 1750 kg day$^{-1}$ calculated in the present paper. Considering this quantity of total VS, the biogas production was determined to be between 92.2-184.4 $m^3$ day$^{-1}$. It can be concluded that the daily biogas production (105 $m^3$ day$^{-1}$) obtained from equation (4) proved to be satisfactory in this range for the present study.

R&E analysis carried out for the model plant showed that the daily biogas production provided an interrupted production of electricity about 63 days for the pilot farm. This system can run a 2-kW generator for 250 min. Kossman et al. [37] and Intermediate Technical Development Group (ITDG) [4] reported that the energy obtained from a biogas plant can be evaluated for several purposes as follows:

1) A biogas lamp consumes approximately 120-150 L of biogas per day.
2) 2000 L of biogas can be sufficient for a cooling system with a volume of 100 L.
3) The biogas production rates between 300-900 L day$^{-1}$ and 30-40 L day$^{-1}$ can be sufficient for cooking and 1 $m^3$ of hot water supply, respectively.
4) 500 L of biogas equals to 1 kg of coal for heating purposes.
5) 1 $m^3$ of biogas can generate 1.25 kWh of electricity and run a one horse power motor for 2 hours and also equals to 60-100 watt bulb for 6 hours.

According to the information above, 26 $m^3$ of biogas can be sufficient for several requirements, such as heating, cooking, cooling and hot water supply of a 5-member family. Hence, 105 $m^3$ of biogas obtained from the proposed FDCMBR will easily compensate daily requirements of four such families.

As a different approach, the total daily biogas production which can be provided from individual biogas plants, operated at 58 active hen farms having different waste loads, is about 7625 $m^3$ day$^{-1}$. By considering the population of Corum city as 161000 people, this total production can compensate the daily requirements of 290 families of 5 people including heating, cooking, cooling and lighting. Hence, the number of people who make use of this biogas energy (1452 people) equals approximately 1% of Corum city population.

Because of the potential increase in the value of manure as a fertilizer, evaluation of digested effluent for agricultural land applications regarding regulations will provide potential benefits to farmers and the environment. Revenues provided from selling of stabilized manure were estimated to be € 15500 per year (1 EUR = 1.2646 USD, Indicative Exchange Rates Announced at 15:30 on 01/15/2004 by the Central Bank of Turkey). This value was nearly equal to total operating and construction expenditures of the proposed plant. Briefly, the proposed plant can amortize itself in 8-10 months. However, authors emphasize a certain financing for investment of the plant in the first step. This financing can be provided by the government-supported foreigner credit or private users. In some countries, financial support can be provided by the government or purchasers.

Köttner [48] reported that there are 16 million cattle, 26 million pigs, 114 million poultry and about 4 million horses and sheep in Germany. Their excrements of 57500 tons organic dry substance per day could be digested. Technically from an organisational and economical point of view over half of the excrements from farm animals could be used energetically by farm or centralized biogas plants. The author stated that the advantages of this technology are not only generation of energy (e.g. electricity and heating), but also the avoidance of bad odors, nitrous oxide emissions, the saving of fertilizers and chemical sprays, the reduction of landfill area, and the protection of groundwater. He also emphasized that a big potential for biogas utilization is available in the Benelux, France, Spain, Italy and Turkey. Worldwide, the most interesting markets for export and technology exchange are to be seen in China, Japan, India and the United States. There is a growing interest in the technology, especially in central Europe and Asia (China, India) for tackling the huge waste problems of the sprawling cities and metropolitan areas. At the moment, it is still possible to dump or incinerate the waste, but more and more environmental and energetic problems arise. When there is a source separation of bio-waste, then composting is the traditional way of treatment, but liquid and half-liquid organic waste cause emission problems, which lead to additional costs of a closed off-treatment process. Even being more expensive, anaerobic digestion systems can offer a cost effective and environmentally sound alternative considering energy production for own consumption and selling it to the public grid.

Small-scale biogas production in rural areas is now a well-established technology, particularly in countries such as China and India. At the end of 1993, about five and a quarter million farmer households had biogas digesters, with an annual production of approximately 1.2 billion cubic-meters of methane (both China and India), as well as 3500 kW installed capacity of biogas-fuelled electricity plant. In rural areas of the world, development and dissemination of biogas technology will meet a variety of rural energy needs, such as irrigation pumping and village electrification [4].

The small-scale biogas technology is reasonably simple and cheap, and can be manufactured locally. Improvement and encouragement of these types of clean technologies will contribute several economical, technical and environmental benefits for Corum city, but also developing regions of Turkey. Although much of the biomass requirement for energy production can be met by utilizing residues from the poultry industry or other commercial activities, careful planning of energy is required to prevent undue stress on the environment. It can be stated that biogas obtained by digesting manure wastes in an environment containing no free or dissolved oxygen, is a great source of energy for Turkey, as the conditions of rural areas are concerned. Hence, the necessary infrastructure should be constructed to be able to make use of biogas, an important alternative energy, in Turkey. Authors concluded that results obtained from this local study will be helpful for engineers, designers and other researchers concerned with the poultry sector.

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