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REPORT

On The Visit To Far East
During The Period, April 30-June 1, 1983

BY

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Thailand

Saturday 30 April 1983;

At 3.20 P.m I took the flight JL 464 from Cairo to Bankok.

Sunday 1 May 1983;

At 7.30 A.m I arrived at Bangkok air port. I moved by taxi to R.S Hotel in Bangkok where I took a rest.

Monday 2 May 1983;

At 9.00 A.m, I moved to ESCAP building to participate in the International Workshop on Uniformity of Information Reporting for Biomethanation Systems, where I met with Dr. Norman L. Brown, the organiser of the Workshop. The Workshop was held during the period 2-6 May.

10 A.M. The opening address by Mr. A.S Manalac, officer in charge, Natural Resources Division, ESCAP, UN. This was followed by welcoming comments by Dr. Irene Tinker, Director, Equity policy centre (EPOC) Washington D.C. Dr. Norman L. Brown, Equity policy centre, introduces the workshop issues. Lastly, introduction of participants in the workshop was carried.

11 A,M. The workshop dealt with problem identification. Abriefing of the situation of biogas technology in different countries was given by the participants. I briefed the meeting about the biogas developments and demonstration in Egypt.

2.00 P.M. The workshop reviewed the data on Biomethanation Systems. The workshop has identified the major problems faced in evolving a uniform set of information which if

adopted would facilitate proper evaluation of Biomethanation Systems. In view of the limited time for the workshop it was suggested that the workshop concentrate on the technical and socio-economic issues while keeping in mind other relevant issues. The workshop was subdivided in 3 groups, namely: Group I dealing with process design and construction; Group II analytical measurement and monitoring of the digester, and Group III, utilization of the ouptputs, and health, and environmental issues.

5.00 P.M. A reception was hosted by the Equity policy centre, Washington D.C., the organiser of the workshop, in honour of the participants attending the workshop, at the VIP Room, service building, U.N.

Tuesday, 3 May 1983;

9.00 A.M. The discussions was continued concerning the different topics of the workshop. The participants of the workshop were subdevided in three groups to prepare report for each of the mentioned three groups. I was the chairman of Group I "the process design and construction". The discussions were continued until 5.00 P.M. Coffee and luncheon break were organised at 10.45 and 12.30.

Wednesday 4 May 1983;

A 8.00 a meeting was carried to discuss the reports prepared by different groups. Some modification were done in the reports. The discussions continued until 12.00.

At 12.30 a study tour was organised by the National Energy Administration of Thailand to visit a large biogas plant at, Wat-Tukal-Raj Samakee, in Pan-Thong Disitrict, Chonburi province.

The biogas plant (Fig 1) is of modified Chinese type digester. The digester diameter is 6m, and its volume is about 113 m^3. The digester operates using the rice mill byproducts obtained from the 1st vibrating screen as feed. This include some broken rice, rice bran, rice hulls, and some sand and silt. The digester is fed daily with this material after mixing with water.

The abbot of the temple remedies the Osteopathy patient by using herbs as medicine. The remedy process must use the firewood for physical heat treatments. Accordingly the biogas produced substitutes for the firewood. The biogas operates 10 stoves for the remedy process, one rice cooker and one lamp. A monthly saving of 300$ (7000 baht) in firewood cost was achieved. The cost of digester is 100,00 baht (1 U.S. $ = 23 baht).

The effluent is partially recycled. It is then dryed for utilization as fertilizer.

The bad design of the outlet (Fig.1) affects very much the gas storage capacity of the digester. The gas pressure is not stable. Thus it goes up very quickly when storing of the gas liberated and also goes down very quickly when operating the gas use devices. The gas pressure is increased by pumping effluent slurry from the storage tank about 20m far from digester.

Thursday 5 May 1983;

At 9.00 A.M. the prepared reports of the three groups were discussed in general meeting. The workshop recognised the importance of minimum number of feasible and essential

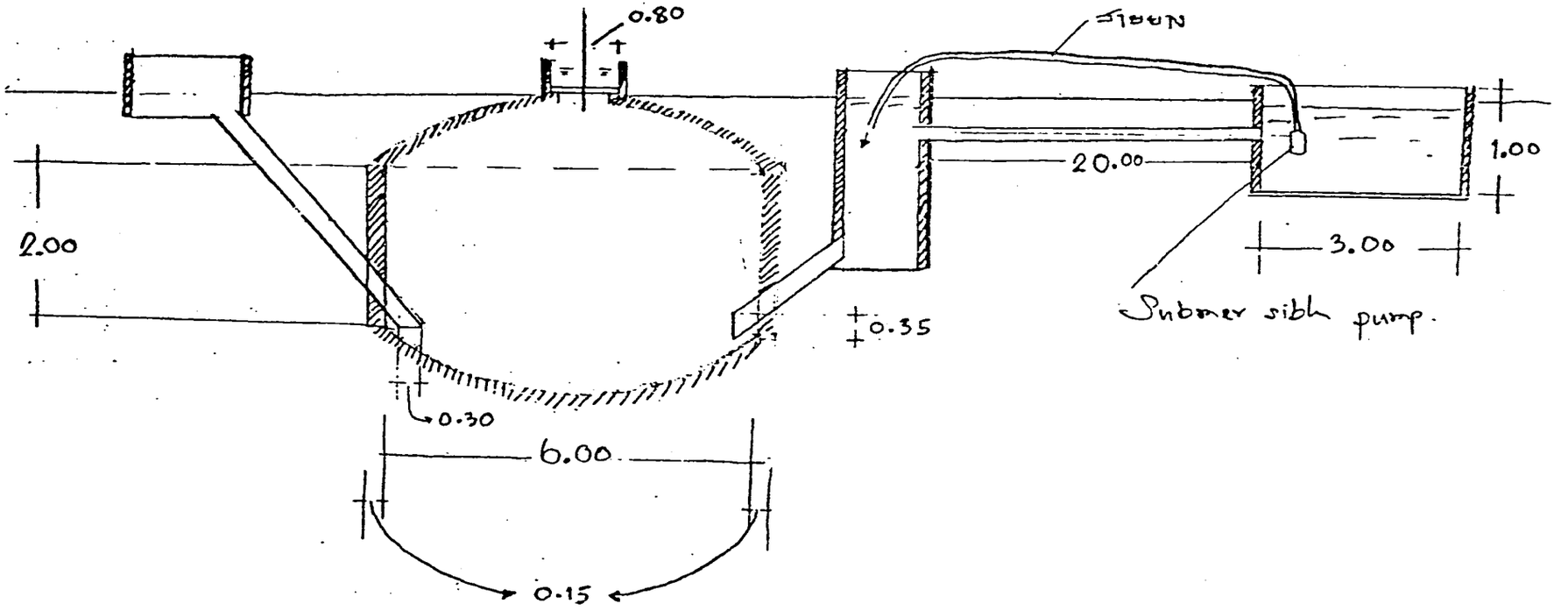


Fig. 1 Modified Chinese type digester (Thailand)

measurements for digesters in rural areas to be carried by the field workers. I was asked to prepare these simple data to be collected by the farmers and suggestion of the simple & approximate methods of evaluation, based on our experience in the field.

Accordingly a small report including the main parameters and suggestion for methods of evaluation in rural areas was prepared by me and given to the workshop for discussion. The data required include: Evaluation of amount and concentration of daily feed, PH, temperature of digester contents, and gas production rate for different types. A simple table was also included for data reporting. The suggested parameters and methods were accepted by most of the workshop participants, and it was agreed to include this part in group two report dealing with analytical methods and monitoring of digesters.

At 1.00 P.M. the three groups continued finalizing the reports and the reports were given for typing to obtain the 1st draft of workshop.

Friday, 6 May 1983;

At 2.00 P.M. a closing meeting was carried. The reports of the three groups were discussed. The 1st draft of the reports is available. The workshop recommended that unified standards and parameters as contained in the report be utilized for reporting measurement results on biomethanation systems performance as fast as possible. The parameters to be measured or observed when evaluating Biomethanation Systems have been delineated. The workshop recognised the importance of minimum number of feasible measurements for digesters in rural areas, and has suggested methods of approximating measurements that can easily be done by field workers.

Biogas in Thailand

The climate in Thailand is suitable for high biogas production rate. However implementation still very low. Huge amounts of biomass (mainly rice straw) is burned in field as a disposal method. Only utilization of inorganic part of the residues is used as fertilizer.

The family size biogas palnts used in Thailand is mainly the jar type shown in Fig.2. The jars are produced in Thailand mainly for storage of water and different grain crops. A number of these jars are used as digester and all are connected to a separate gas holder seated in water.

Saturday, 7 May 1983;

At 8.00 A.M. a meeting was carried with Dr. Norman L. Brown in the Thai Hotel. The final revision of the 1st group report on process design and construction was given to him.

At 8.30 A.M. I leave the Thai Hotel to Bangkok air-port.

At 10.50 I take the Flight TG 620 to Manilla.

At 2.55 P.M. I arrived to Manilla air-port. I moved to Manilla Royal Hotel.

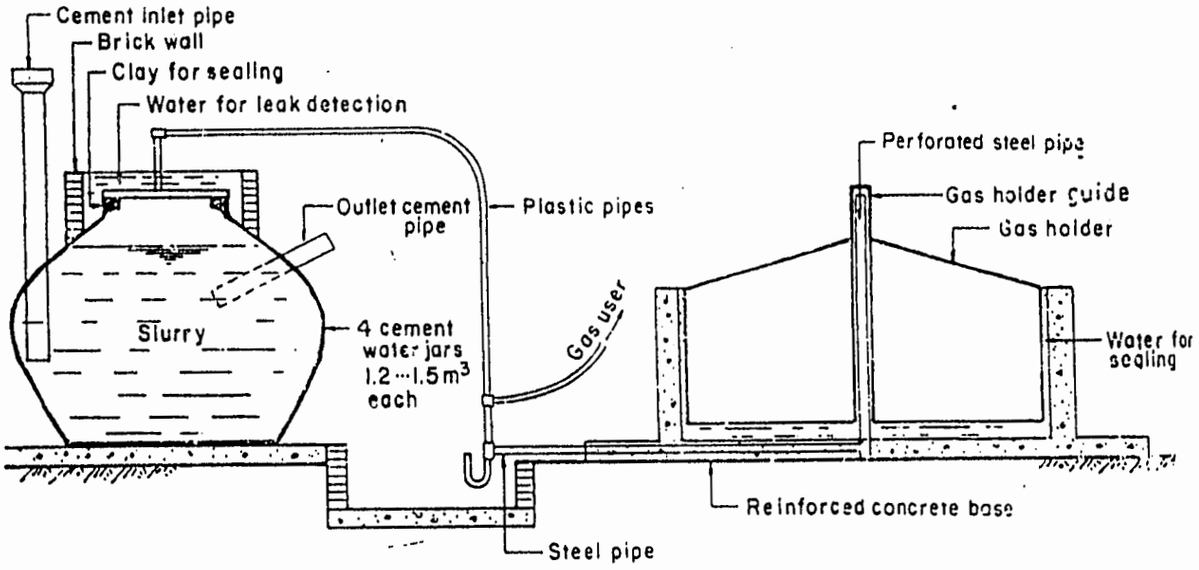


Figure 2. Jar digester with separate gas holder (Thailand)

Sunday, 8 May 1983;

I was joined to a tour to visit Tagaytay town near Manilla in the morning and sight seeing of Manilla town after noon.

Monday, 9 May 1983;

At 8.30 A.M. a contact was done with Maya Farms company, and accordingly I moved to Macaty-Manilla where the adminstration building to Maya Farms is located. A meeting was held with Dr. Felix Maramba, the head of the farms. He briefed the biogas technology activities in Maya farms, and he agreed that I have a two days visit to Maya farms during the period 10-11 May. A contact was done by him to visit a Governmental animal production sector ALABANG, Research Division, Bureu of Animal Industry,where some biogas plants are constructed. The visit was shecduled at 1.00 P.M.

At 1.00 a meeting was held with Mr. Alejandro A. Gudan, the operations vice president. A change of opinion was carried about biogas developments in Maya farms and National Research Centre. He gives briefing of the activities of Maya farms. He mentioned that the company has already enlarged and developed to include a simple and integrated system for different scales which is suitable for transfer in many developing countries and as I think, Egypt is one of those countries of high need for application of such models of development because of the many similarities present in these situations.

Maya Farms

Maya farms is the agro-industrial division of liberty flour mills, it spreads over 36 hectares in the Antipolo hills just outside Metro Manilla, Philippines. It is a fully integrated

Philippines

livestock farm, meat processing and canning enterprice. The animal population by the end of the year 1983 will reache 40,000 pigs, more than 6000 ducks, and some cattle. The meat processing plant makes ham, bacon, hotdogs and other special products. The canning plant produces a line of canned meat products.

These operations consume a lot of energy and produce a large amount of wastes. Maya farms has developed a total waste recycling system which controls pollution and generates a fuel gas as well as other farm inputs. The bones, blood and meat scraps from the slaughterhouse and processing plants are converted into feed ingredients. The large volume of daily manure, together with the pen washings and industrial wastewater are used for the biogas production. More than 3500 m^3 biogas is produced per day. Maya farms expects to have sufficient biogas and other indigenous energy sources to provide all the power needed to run the whole agro-industrial enterprise.

At 3.00 I met with Mr. Carlos R. Campos, Planning and Managment staff, Bureau of animal industry, Station Mesa, Manilla, and he accompanied me to Alabang research division, where I was accompanied by Miss Gosefina Marinay from the mentioned division to visit three biogas units. The first one is a small biogas unit, volume about $3m^3$ of the Indian type. The unit is fed manually, and utilized only a small part of the dung produced in the nearby animal shed, while the rest of manure is thrown to dry near the animal shed. The gas produced is utilized in one of the nearby houses for kitchen utilization and also for one office of the research division.

The second unit was a mettalic prefabricated unit, it consists of a mixing tank for the manure, a hand pump for pumping the slurry inside the digester and an outlet pipe and a pipe for gas outlet. The unit was not in operation at that time.

The third unit visited is of Taiwanese type consisting of two parallel compartments, volume $14m^3$, of rectangular type. The gas produced is collected in a sharp edged metallic gas holder. The unit seems to be built during the year 1978. However the gas holder is already corroded and may be also the gas pipes and thus no gas is obtained. However work still continuing on evaluating the effluent as animal feed, fish-pond feed and chlorella plantation. The fibrous materials are separated from liquid slurry by decantation. The fibrous material is dried, while the supernatent is utilized for fish and chlorella. A wind mill is utilized for operating a pump which pumps the slurry water to the chlorella basin and fish-pond.

Tuesday, 10 May;

At 6.15 I met with Dr. Maramba and Mr. Abgandro Gudan in Makati region near the Maya farms office. I was accompanied by them to the Maya farms in Angona-Rizal about 40 km far from the down town of Manilla. We arrived at the company at 7.00 A.M.

I was accompanied by Mr. Engineer Taganas, the civil engineer of the farms, involved in designing and construction of the biogas plants. The farms has constructed a quite big number of digesters. The digesters operated on the manure of pigs. The volume of digesters varies between $5m^3$ and about $1000m^3$.

The largest is of rectangular type. Its dimensions are 80ft length, 46ft width, and 8.5ft depth. The digester consists of 4 internally separate parallel digesters. The digesters are preceded by mixing and conditioning chambers for the feed. On the other end, located the outlets of these parallel digesters. Mixing is carried manually. A very large number of mixers are distributed all over the digesters roofs, and mixing is carried once daily. The effluent flows by gravity to a nearby lagoon for settling and airation. The sediment is dryed for using as animal feed addition in the range of 10-25 % of the ration (10% for pigs and 25% for ducks). The liquid effluent is used either as fertilizer or for fish and algae feeding.

The digester which is newly constructed suffers from a lot of gas leaks mainly from the roofs. Many cracks are seen to be already remeded while some still leaking gas, and one can hear the noise of the flowing gas and can feel it by touch.

The gas produced is collected through the many gas pipes distributed all over the roof of the digester. These pipes are collected in one large pipe which transport the gas to a number of gas holders for storage. The gas holders used are of metallic type dipped in water. The construction is mainly located above the ground for easy repairing. However it is more costly but they claim that it is better and more safe. The big gas holders used are of about 5m hight and $100m^3$ volume. The gas pressure is about 45cm. Gas holders are constructed from a 4.3 mm thickness steel sheets.

The gas production rate ranges between 0.3 and 0.8 m^3/m^3 day for the cold and hot season respectively.

In Maya farms there is a lot of big digesters. The total gas production is about 3500 m^3/day.

The produced biogas is used as follows:

Cooking and heating in the canning plant, canteen and dormitory.
Firing retorts in the rendering plant.
Fueling 3 internal combustion engines pumping about 550 g.p.m of water for about 15 hours per day.
Fueling two internal combustion engines operating a 37.5 kw and 60 kw generators to light the livestock pens and heat the brooders.
Fueling internal combustion engines operating the compressors for the freezers in the processing plant.
Fueling 5 internal combustion engines that pump the fresh slurry and / or the sludge.
Fueling 5 engines that power the mills.
Fueling an engine that runs a 188 kw generator to operate electric motors in the meat processing plant.
Fueling 3 engines that run 60 kw electric generator each for the dryers in the meat processing and canning plants.

The waste heat from the internal combustion engines is used to preheat the feed water for the steam boiler, heat the scalding tank in the slaughter house and heat the pilot distilling plant.

Conversion of Gasoline Engine to Biogas:

Maya farms utilize gasoline engines to produce electrical power. They mentioned that;they found gasoline engine to be much better to operate on biogas than diesel engines. The conversion of engine to operate on biogas is very easy. The carburater is removed and instead a pipe with flange is fixed. A gas inlet is connected to this pipe. The end of the pipe acts as air inlet with butterfly controlling the air rate required. The amount of air-gas mixture required is controlled by a butterfly also as shown in Fig. 3 or a valve as shown in Fig.4.

Maya Farming Model of 1.2 Hektare:

Maya farms is demonstrating an intersting model of farming which depend on self sufficiency in food, feed and energy. They claim that the model is applicable for phillipnes conditions. The total area owned by the farmer Basilio Barba in the demonstrated model is 1.2 hektare. Of this area, one hektare is used as cropland and the remaining 2000 square meters utilized for the farm house, the hog house, cattle shed, the biogas plant, a 200m^2 fishpond yard, and pathways. The farmer has a wife and five childrens. The infrastructures of the farm are:

Piggery operations: The farmer should take care of 4 saw units, and all of its offsprings until marketable age of 7 to 8 months old. During my visit the total number of pigs was more than 50 units including the small ones. The money obtained from selling of pigs is sufficient for other family needs.

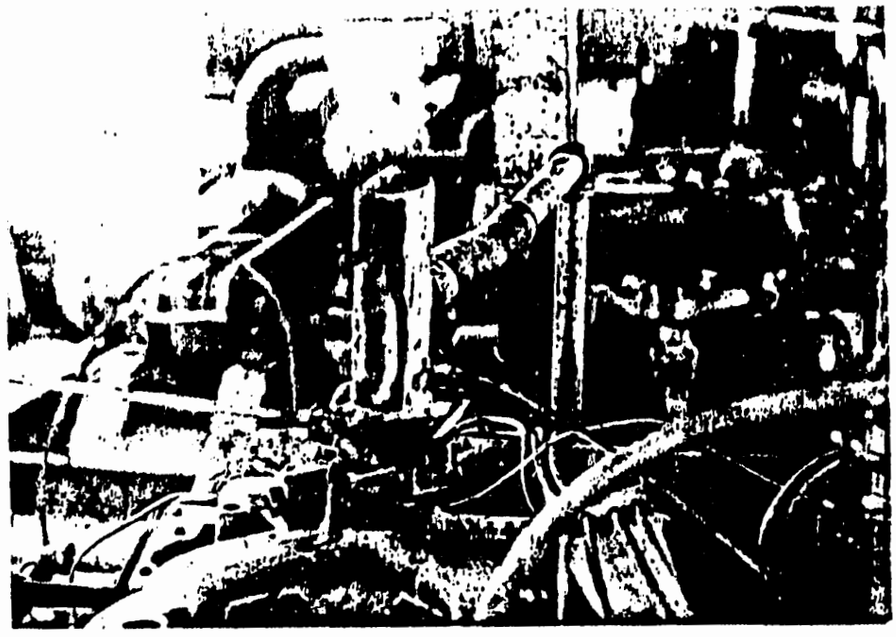


Fig. 3 Modification of gasoline engine to operate on biogas.

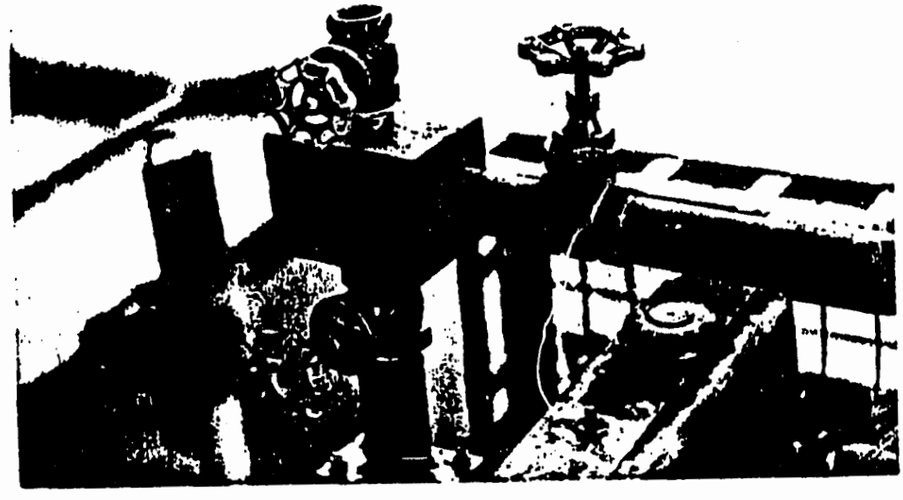


Fig 4 Modification of gasoline engine to operate on porducer gas or biogas.

Animals: The farmer has three cows. They are fed from the land products. The female produces milk, while the male serves as work animal.

Poultry: The family maintained a complement of ducks and chicken out of which they sold or use some for their consumption. The poultry subsist on pen washing precipitates and feed sweepings.

Fishpond: A 200 square meters tilapia fish-pond is used. He fertilizes it with some sludge coming from his biogas digester. The fish feed on the algae and plankton whose growth is enhanced by the sludge. His tilapia harvest supplements the family's food fare.

Cultivated land: The farmer grows two crops of corn and one crop of rice per year and 1000 sq.m of giant ipilipil and some fruits (banana) on the bath ways and land borders. There is sufficient corn and rice bran to feed the pigs. The cattle feed on crop residues, weeds and ipilipil leaves. The rice is sufficient for family needs. The solid sludge from biogas digester constitutes 10% of the hog feed and 25% of the duck feed.

The cultivation of land depends only on the labour power of the family. Accordingly the land of corn crop is devided in many parts. Each part is cultivated during one week, and not at the same time. Fig. (5) shows the different partitions of corn cultivated at different times. Fig. 6 shows the other side of farm located near the farmer's house, where a lot of fruit trees are cultivated.

Biogas plant:

The biogas plant constructed in this pilot project uses the Maya farms design (Fig 7&8). It is rectangular in shape, 6 feet wide, 12 feet long, and 5 feet deep, with 2 chambers for the digester and the gas holder is integrated over the second chamber. The plant is charged daily with the fresh manure output of the hogs and cows. It has a daily biogas production of about $5m^3$, which is more than enough to supply the family's requirements for cooking, ironing, lighting using mantle lamps, and fuel for an 8-cubic feet gas refrigerator.

The effluent from digester is partially filtered to obtain the concentrated sludge, which is used for pigs and ducks feeding. The filtration process is very simple, as straw is used as the filtering media as illustrated in Fig. 9.

The liquid sludge is used to fertilize the cropland of one hektare and the fish-pond. The farmer did not use any chemical fertilizer for his cropping operations for rice and corn. Fig. 10 shows the aerobic composting of agricultural residues to obtain additional organic manure. The residues are mixed with digester effluent. It is mixed every two weaks for about three months. The integrated crop-livestock-fish farm would be a subsistence farm. It was found that with the integrated system of farming, a farm family would be able to afford a comfortable standard of living on such a small area.

Fig. 5 Corn crops of different ages at farm model.

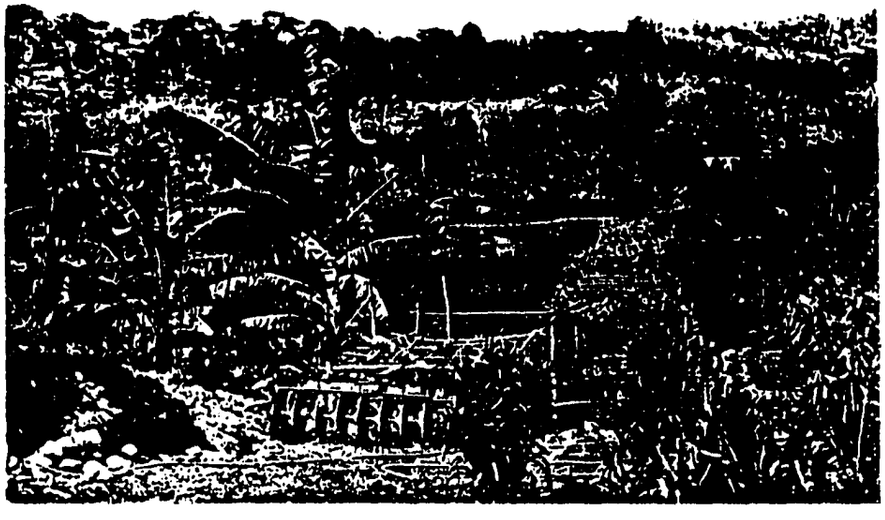


Fig. 6 1.2 hektare farm model.

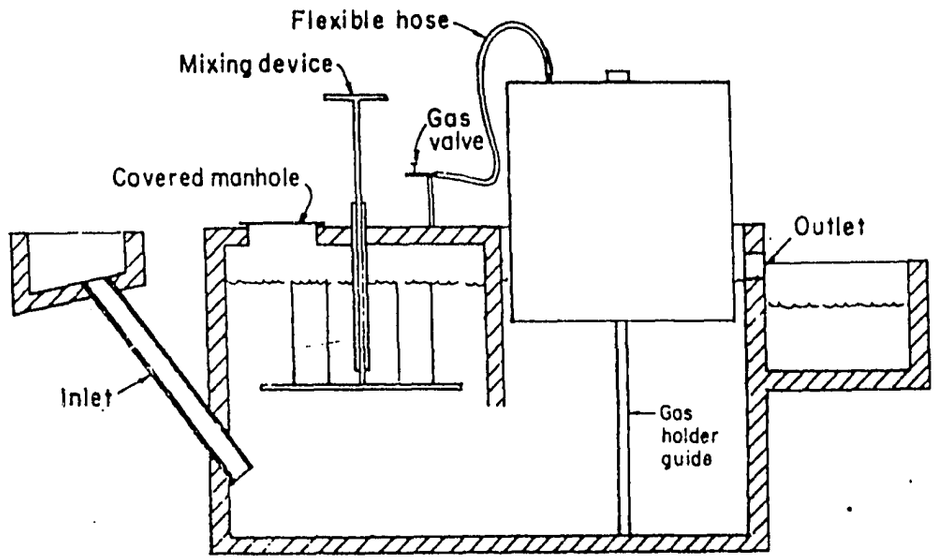


Figure 7 Two-chamber rectangular digester with floating gas holder (Philippines)

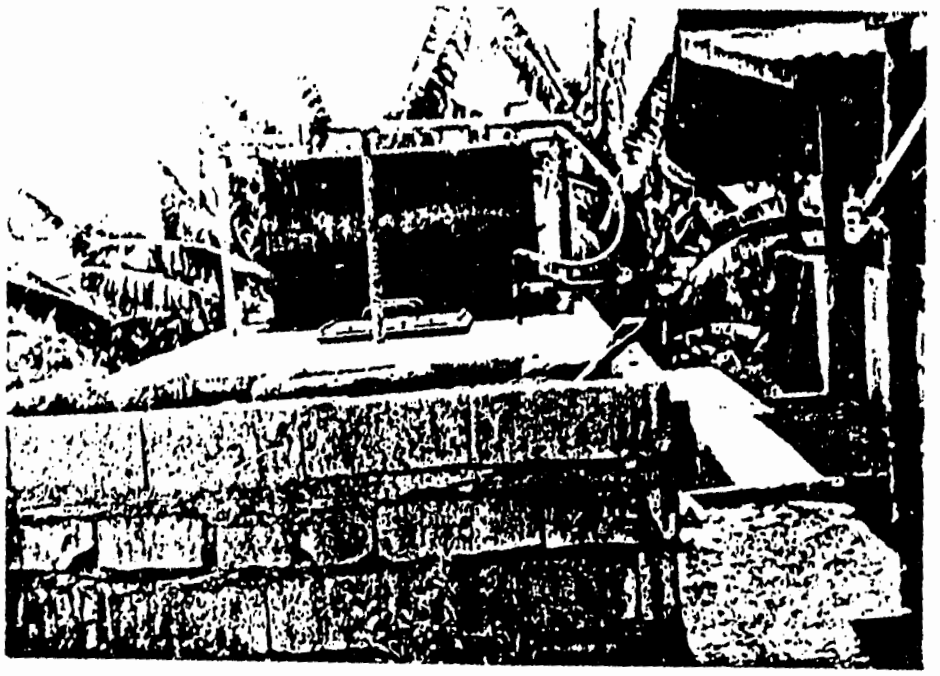


Fig. 8 Biogas plant at 1.2 h farm model

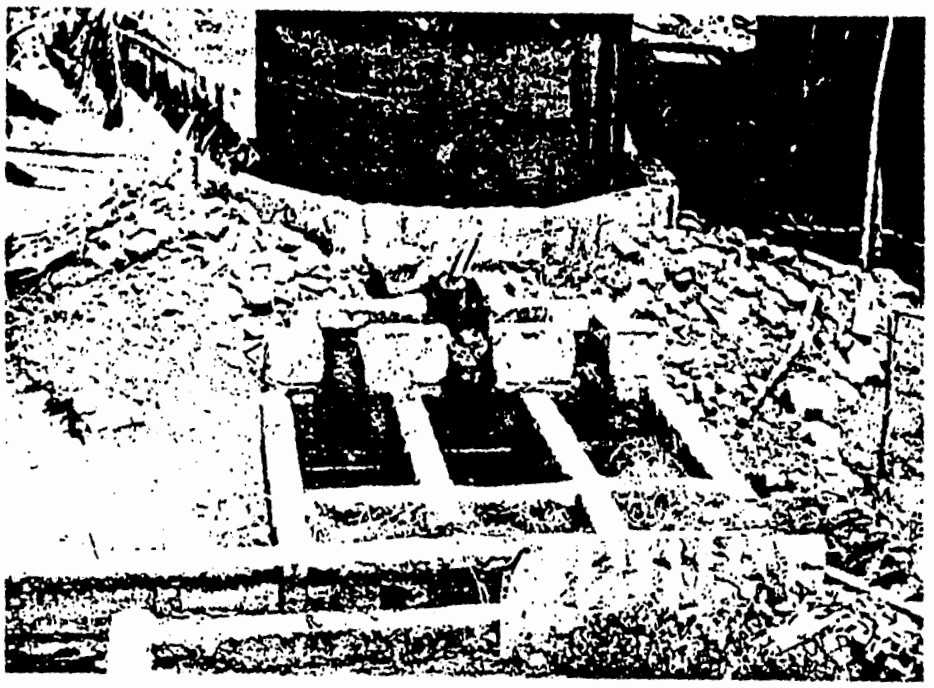


Fig. 9 Digester outlet and filtration of effluent.

Fig. 10 Composting of agricultural residues

Coconut - Fuel, Maya Farms Model:

Maya farms has developed a simple technology for small self-powered coconut oil extraction mill with a capacity of 20 kg of oil per hour. The mill can be used as one of the farm operations. The mill (Fig.11) consists of:

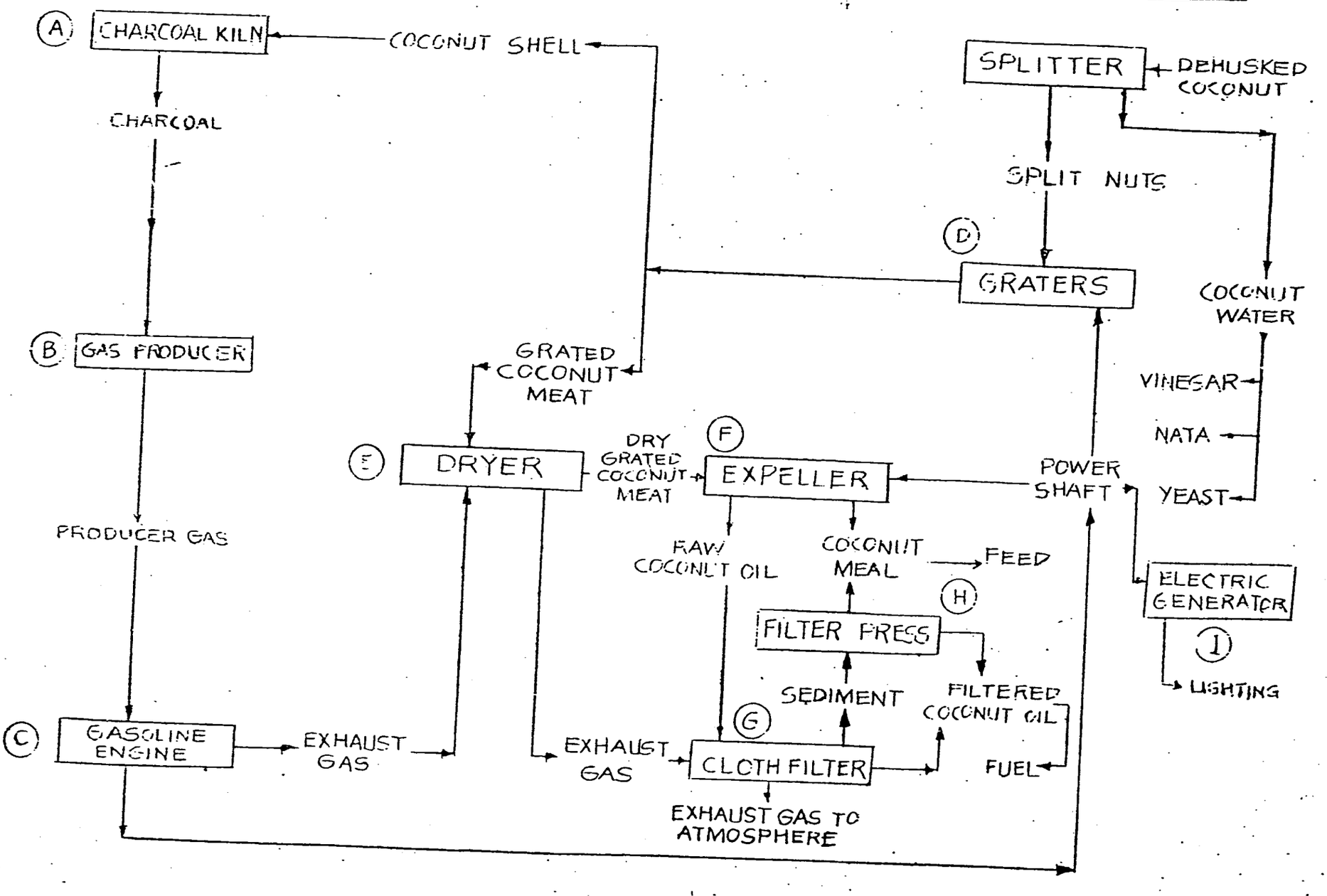
- A charcoal kiln (Fig. 12)
- A charcoal gas producer (Fig. 13)
- A gasoline engine converted to use producer gas as fuel
- 4 coconut meat graters
- Grated coconut driers
- A 20 kg oil capacity expeller
- An oil filtering system
- 1.2 kw electric generator.

The coconut shell is made into charcoal for use as fuel for the gas producer. The gasoline engine converted to use producer gas supplies the power to operate the expeller, graters and electric generator. The meat in the halved coconut is grated and dried in the dryers heated by the exhaust gas of the engine. The electric generator lights the building when the mill operates in two shifts. The coconut meal is used as animal feed. The filtered coconut oil is used also as fuel for gasoline engine cars.

Wednesday, 11 May;

At 6.10 A.M. I moved by taxi to another region in Manilla in order to meat Mr. Egnr. C. Taganas for accompanying him to Maya farms. However, I could not met him. May be he left before my arrival or I was not brought to the right place. I try to

FIG 11 SELF-POWERED COCONUT OIL EXTRACTION MILL



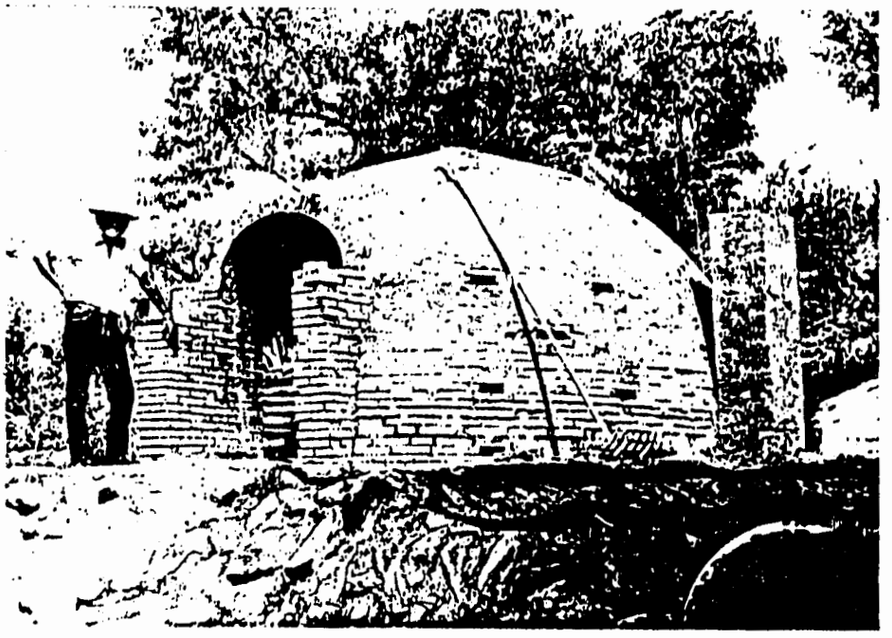


Fig. 12 Charcoal Kiln

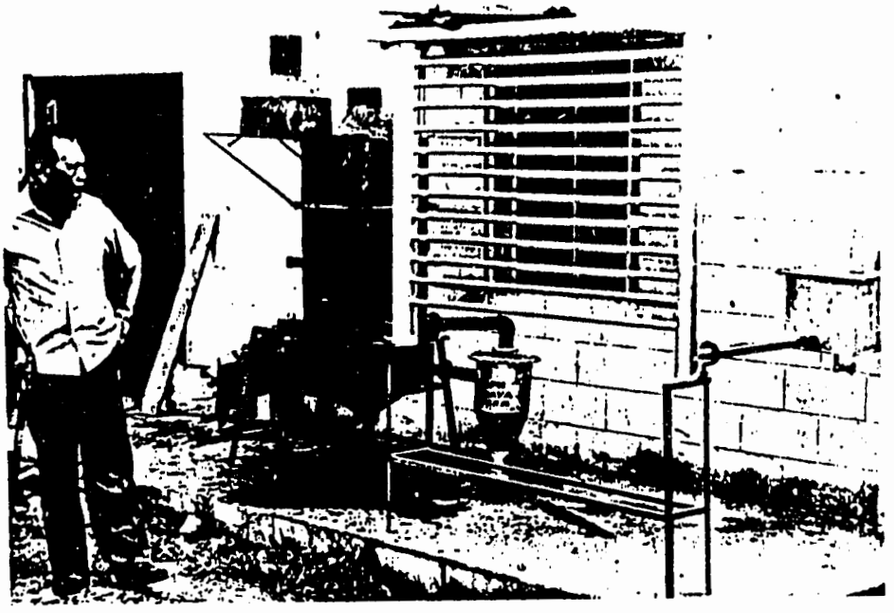


Fig. 13 Charcoal gas producer

go to the Maya farms alone by general transport but I did not succeed.

At 9.00 A.M. I try to contact Prof. Romeo Alikpusan from the National Institute of science and Technology. It was very difficult to have a contact.

At 10.00 A.M. after many trials I talk with Dr. R. Alikpusan and I asked him to give me the chance to visit the Institute and be aquainted with the achievments in biogas technology. He welcomed and adviced me to wait in my room at Manilla Hotel as some body will take me from the hotel at about 11.00 A.M. However, no body comes. At 12.30 I call the institute, enquiring about the abscence of the accompanying man. The secretary told me that he already moved and is in way. At 3.00 P.M. I call Dr. R.Alikpusan enquiring, he told me that the man should be at 11 A.M., and promised me to know what happens.

At 4.00 P.M. Dr. Silvestre V. Javiea, National Institute of Science and Technology Authority, Manilla., came to the hotel. He accompanied me to the National Institute of Science and Technology. A quick visit was done to the laboratory engaged in biogas technology. A small pilot unit of about 20 liters volume is operating in the laboratory. The pilot unit is of the Indian floating gas holder type (Fig. 14). Some gas use devices are present for demonstration. There is a program in the Institute for utilization and promotion of non-conventional sources of energy in rural and urban areas. Through the promotion and introduction of non-conventional

sources of energy such as biogas digesters, gasfiers, alcohol production, solar dryers, the program aims to widen its utilization in the urban as well as in the rural areas.

Some digesters located nearby to the Institute was visited. These digesters are of different types. Indian type digester with floating gas holder was constructed. The digester is constructed from round prefabricated concrete segments. Two walls are constructed. The gas holder is located in the annular space. The gas holder is water sealed. A large Chinese type digester was also visited. In the construction of the digester, the main design parameters are not taken in consideration, so the digester is not operating due to the gas and liquid leak (Fig. 15).

Fig. 14 Small biogas model (Philippines)

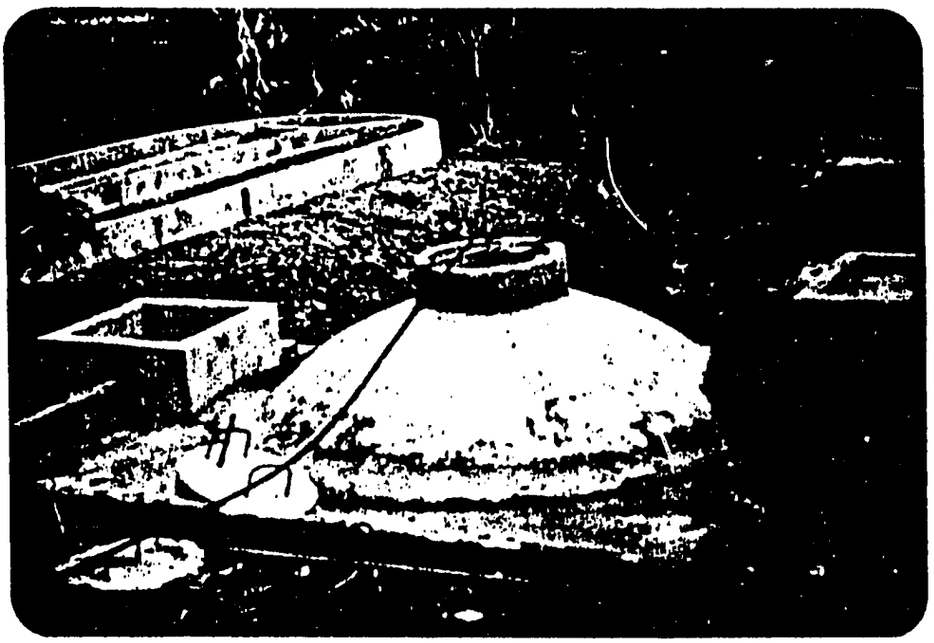


Fig. 15 Chinese type digester (Philippenes)

Thursday, 12 May 1983;

At 9.30 A.M. I leave Manilla Royal Hotel to Manilla International air port. At 12.20 I take the Korean Flight No. 622 to Seoul.

At. 5.00 P.M. I arrived to Kimpo International air port of Seoul.

At 6.00 P.M., in the air port I was recieved by Mr. Lee K.O from the Korea Science and Engineering Foundation (KOSEF). He accompanied me to Samjung Hotel in Seoul.

Friday, 13 May

At. 8.00 A.M. I was accompanied by Mr. Moon from KOSEF to the railway station of Seoul.

At 9.00 I take the train to Taejeon.

At 10.50 A.M. I arrived to Taejeon town. At the railway station I was recieved by Dr. Hong C.J., the Director of Department of Biomass, Korea Institute of Energy and Resources. He accompanied me to the Institute located some what near to the Taejeon Town. A change of opinion about the Biogas Technology in Egypt and Korea was carried. The cold climate in Korea make the Chinese type and Indian type technologies not suitable for Korea. As the gas liberation stopped totaly during the cold season. For this reason the Institute has developed a reinforced fiber glass-plastic digester (R.F.P). The digester is manufactured from P.V.C reinforced with fiber glass. Digester walls thickness is about 7 mm. The lower sides and the base of the digester is insulated, while the higher sides and roofs are covered with a mixture of crop

residue, dung and digester effluent for composting. The exothermic heat of composting is utilized for maintaining the slurry temperature nearer to the optimum, specially during the cold season, in which the atmospheric temperature may be lower than -10°C. The temperature is measured and recorded in different locations in both the slurry and composted material. The temperature of the slurry during May was about 31°C. The gas production rate is about $0.4m^3/m^3$ day. Two units are constructed and still under investigation. One digester is of 10 m^3 while the other is of 2.5 m^3 volume (Fig 16-19). The gas obtained is utilized for demonstration of some gas use devices. This include: a stove, a gas lamp, and an electrical generator. The engine used is gasoline engine type and is modified in such a way that it can operate either on gasoline or biogas without difficulties (Fig 20). The modification is very simple. It includes insertion of gas feeder pipe in the air stream before carburator. This assists operation of the engine on both gasoline and biogas. In other places the carburator is totaly removed and instead a small mixing chamber is fixed with the required air and gas inlets. The gas rate is controlled by a valve while the air amount is controlled by using a butter fly system like that used in the engines carburater. A published book and some published papers were obtained about the performance of the units, which indicates the high success of the recommended design. However, the cost of digester is still high and reaches about 3000$ for the 10 m^3 unit.

A quick visit was done for the other branches of the institute. A different passive solar heated houses and also active systems using panels are constructed and still under evaluation. A research work is carried on energy conservation in houses

〔그림 4-9〕 메탄탱크제작설계

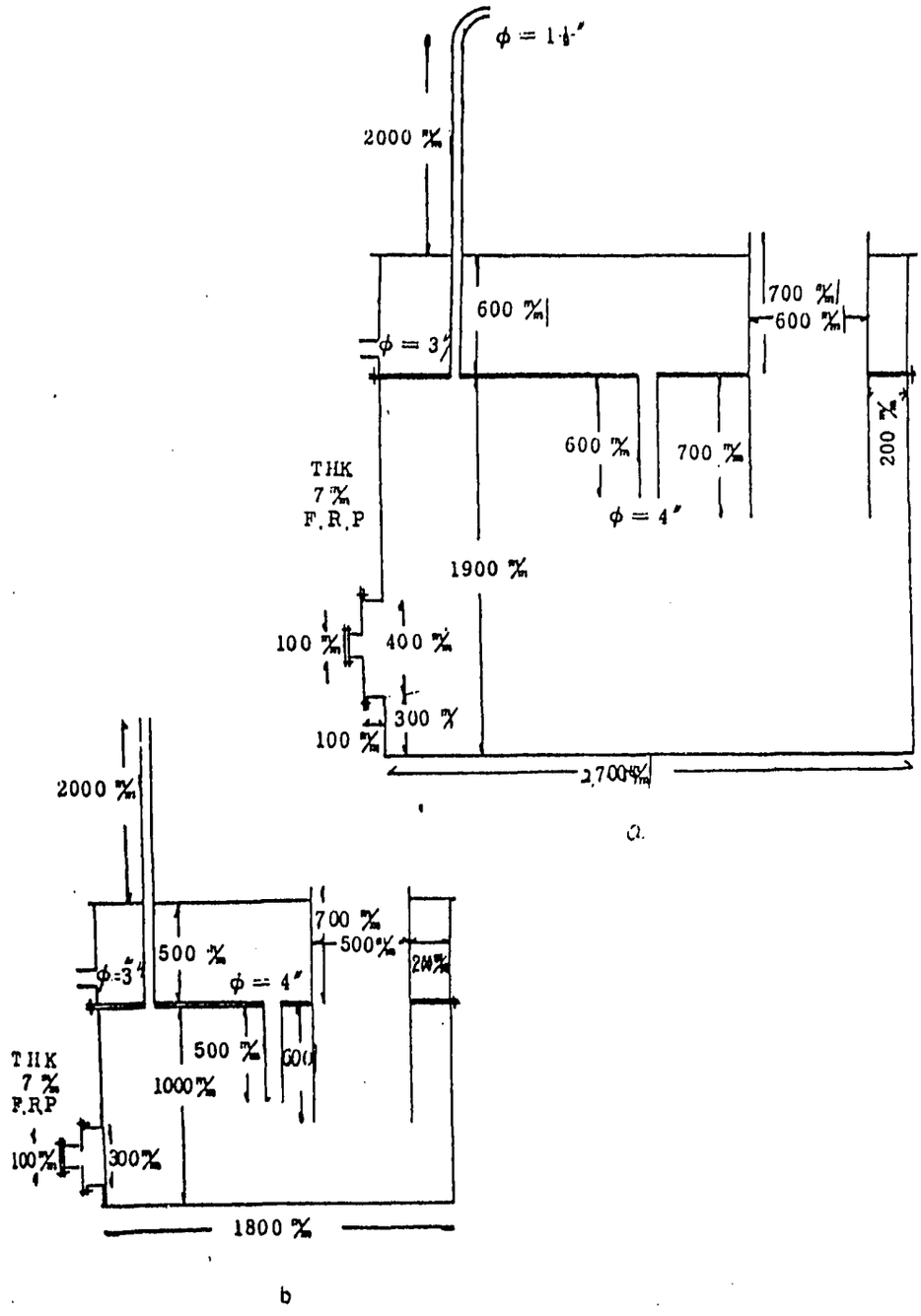
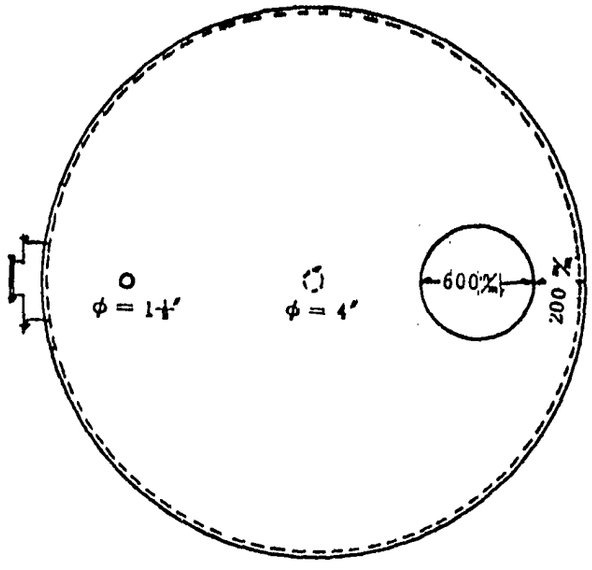
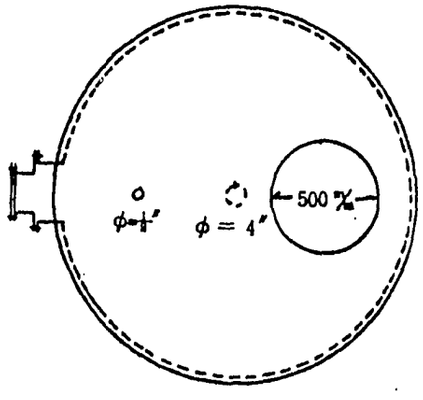


Fig. 16 Elevation of F.R.P. digester (Korea)
digester volume a: $10m^3$
b: $2.5\ m^3$



a) 중형 FRP 뱅크



b) 소형 FRP 뱅크

Fig. 17 Plan of F.R.P. digesters (Korea)
a: 10 m^3
b: 2.5m^3

Korea

〔그림 4-10〕 퇴비혐이용 메탄탱크의 유형도

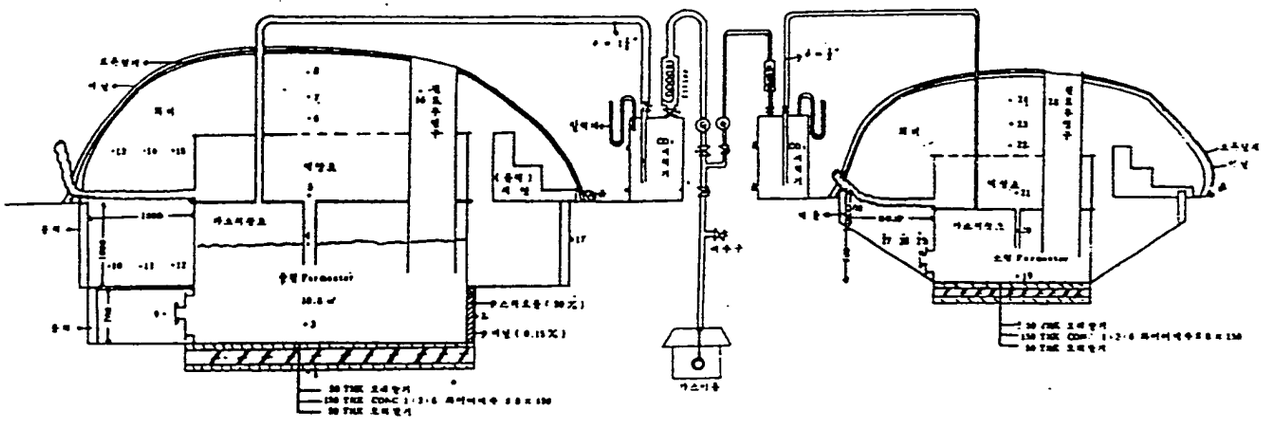


Fig. 18 F.R.P. digesters with insulation and composter

Fig. 19 F.R.P. digester and demonstration site (Korea)

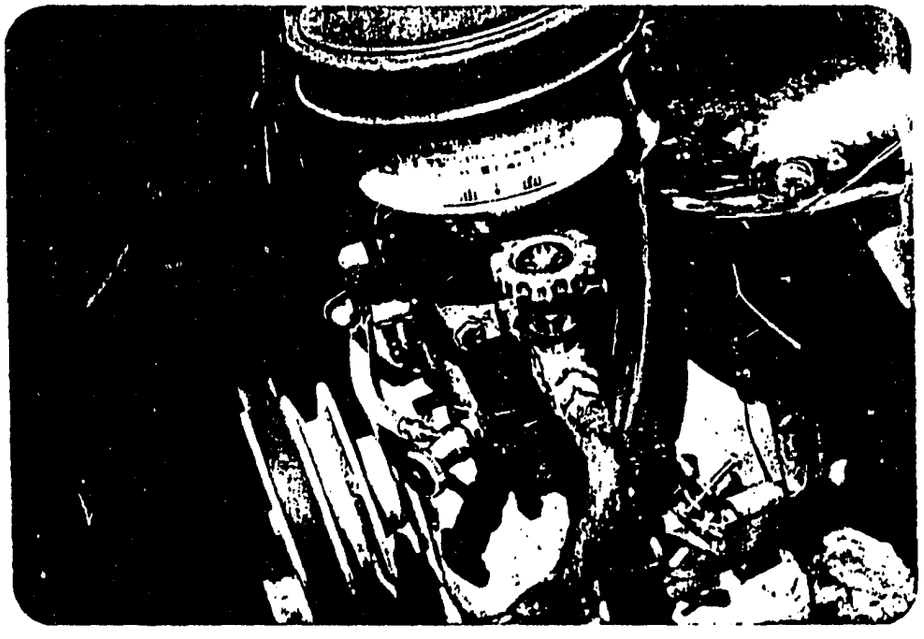


Fig. 20 Gasoline - biogas engine (Korea).

heating. Hybrid systems are also used.

At 3.30 P.M. a meeting was carried with Dr. Park Won-Hoon the vice president of energy of the Korea Institute of Energy and Resources. A change of opinion about the needs, research and developments concerning biogas technology and renewable energy sources in Korea and Egypt was carried.

A 3.50 P.M. a sight seeing of the Taejeon town was carried, and I was accompanied by Dr. Hong C.J.

At 4.59 P.M. I leave Taejeon by train to arrive at Seoul at 6.50 P.M., where I was recieved by Mr. Lee, who accompanied me to the hotel.

Saturday, 14 May;

At 9.45 I met with Mr. Lee K.O and he accompanies me to Korea Science and Engineering Foundation (KOSEF), where a meeting was carried with the KOSEF vice president. He clarified the job of the organisation. The main job is to faster science and engineering research capabilities, to promote science and engineering education, and to enhance International cooperation. The KOSEF organisation was started in 1977, and since that time it has carried out a variety of programs concerning:

1. Support for research, this includes: general grants and seeding fund grants for research.

2. Research fellowship, this includes: Graduate Fellowship, Overseas Pre-doctoral fellowships, Post doctoral, Technical training programs.

3. Bilateral programs with foreign Academic Institutions, this includes: cooperative research, joint seminars, workshops and exchange of scientists.

Sunday, 15 May;

A sight seeing of Seoul town was carried.

Monday, 16 May;

At 9.40 I met with Mr. Lee at hotel. He accompanied me to Suwon town.

At 10.30 A.M. we arrived to Ajou University near to Suwon town. There I met with Dr. Young I. Mok, prof. Dean at the faculty of Engineering, Ajou University. He is mainly engaged in Biomass projects concerning production of alcohol from cellulosic materials. A change of opinion was carried about the activities in the field in both Egypt and Korea.

At 11.30 A.M. I was accompanied by the head of chemical engineering department to visit the laboratories of the department.

At 1.30 P.M. a visit was carried to the office of rural development, Institute of Agricultural Sciences. I was accompanied by Dr. Y.I.Moh from Ajou University and Mr. K.O.Lee (KOSEF). I met with Dr. Dong Loo Kim, the director of research bureau, office of rural department. A change of opinion was carried about the similar organisations in Egypt and Korea. Dr. Kim D.L. clarifies the role of the organisation in rural development. There are many branch

offices distrbuted allover the country. Thus in every region there is one office. This assists the spreading and implementation of new developments. Thus the developed high-yield rice (Tongil) with its cultivation techniques was demonstrated in 1970 and used in all the country during a short period depending on these offices. Due to the lack of cultivated land and cold weather a tremendous research is going on inorder to increase land productivity. And this can be noticed from the dense agricultural methods used and the green houses which are noticed for rice, corn, vegetables, fruits and also trees.

During cold season, the farmers are free and a temporary schools open for updating the knowledge of the farmers, and almost all farmers try to attend these seminars, because they feel that seminars are helpful and valuable for them.

The rural development office deals with research in all oblasts relating to the field, these include:

1. Improvement of rice varieties and cultivation methods.

2. Improvement of barely and wheat.

3. Improvement of oil crops, vegetables and fruits.

4. Improvement of livestock.

5. Farm mechanization and managment.

6. Technical service of rural areas in different fields.

At 2.00 a meeting was carried with Dr. Chon-Suh Park. The head of department of chemistry, Institute of Agricultural

Science, office of rural development. A change of opinion about renewable energy sources in Egypt and Korea, specially Biomass was carried.

At 2.15 P.M. a meeting was carried with Dr. Y.D.Park. The head of agricultural chemistry Div., Institute of Agricultural Sciences, offfice of rural development. A change of opinion about Biogas Technology in both Egypt and Korea was carried. He is engaged in Biogas Technology development.

Dr. Park Y.D. declared that the office of Rural Development through its rural guidance bureau disseminated about 29,000 family size biogas units during the period 1969-1975, inorder to provide cooking fuel for farmers. The biogas technology was accepted by the farmers at that time. Now, however, most of the units (if not all) are no longer in operation. The reasons are many:

1. The temperature decreased during the cold season to the degree that gas production ceased, and this can continue for about 3-4 months, during the period of high fuel demand. The gas production rate during the rest of year was not high.
2. The gas holders manufactured from P.V.C did not resist the changes in temperatures and many of them were damaged after a short period.
3. The high cost of biogas compared with other substitute of conventional fuels.
4. The increase in standered of living, and accordingly no one is ready to take part in a dirty process, and the feeding of digesters were stopped.

Accordingly a research and development are going on in this Institute:

1. Development of a batch digester suitable for fermentation of agricultural residues. This is similar to what extent to the dry frementors developed initially in France and is now utilized in modified forms in many countries allover the world. The digester is a rectangular brick and concrete building (Fig. 21). The digester is built mostly under ground. The gas holder is constructed from flexible treated P.V.C. The main advantage of this type is the law cost, and utilization of agricultural residues mixed with manures. However the temperatures decreased during winter cold season. Insulation of the plant is carried to decrease the heat loss. The plant operates for about 4 months above after its initial load with manure and agricultural residues. The gas productivity is about 0.3 m^3/m^3 digester volume day. It is worthy to mention that the digester top is open and is covered with flexible P.V.C. sheat sealed in slurry. The gas produced is stored in a P.V.C. flexible bag type gas holder. The total solids of the batch feed is 10-20%. Dung is mixed with crop residue in the ratio of 1:1. The crop residues is pretreated by moistening with water for about 1-2 weaks without addition of any chemicals. After this treatment it's fed to digester.

2. Development of large community biogas plant is carried. A 137 m^3 pilot digester (Fig.22) was constructed and operated in a village 40 Km far from the Institute. Due to lack of time I was not able to visit the plant, however some papers concerning the design and operating parameters are obtained. The digester is designed as closed underground

Fig. 21 Dry fermenter (Korea)

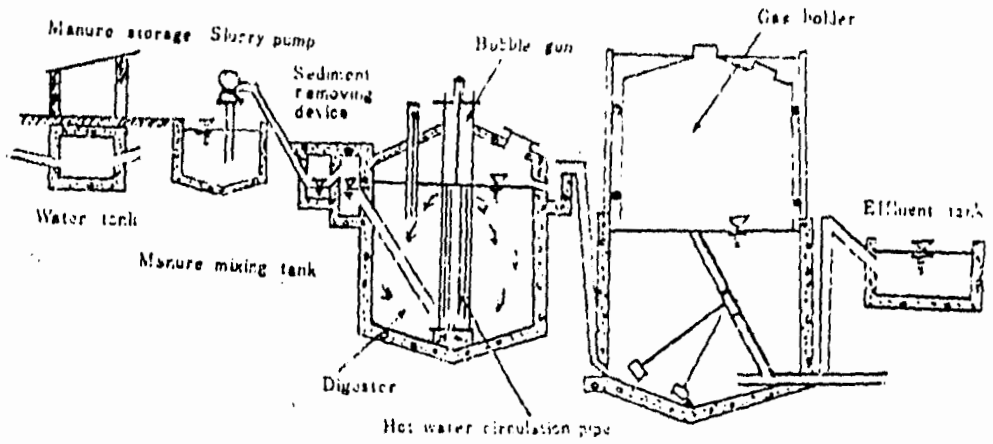


Fig. 22 Village scale biogas plant of 137m^3 volume (Korea)

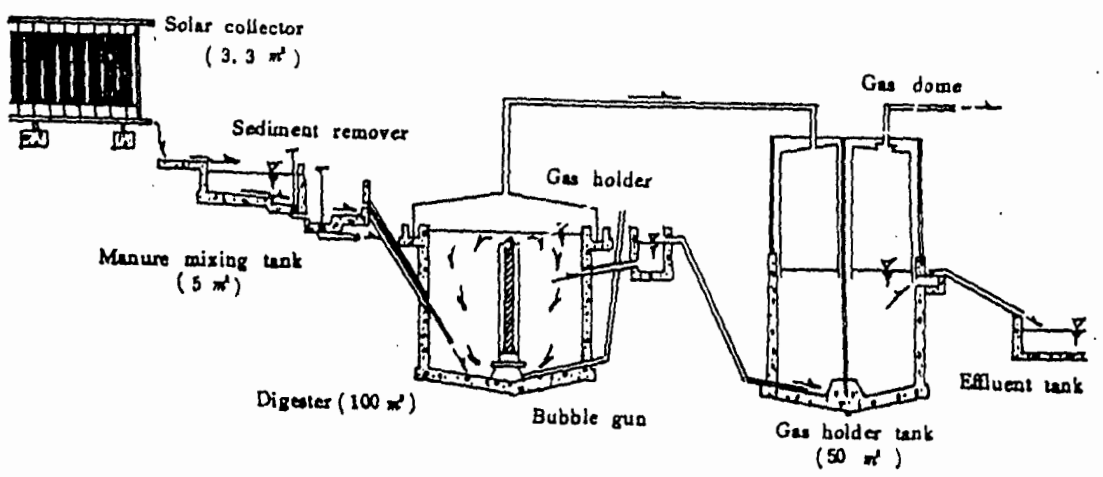


Fig. 23 Village scale biogas plant of 100m^3 volume (Korea).

concrete tank, 6 meter deep, 6m height. Heating and mixing systems are incorporated. Associated facilities with the digester are a feed mixing tank fitted with a pump, a gas holder and a lagoon for holding the effluent.

The heating and mixing devices fitted to the digester is known as a bubble gun and its action is to generate an intermittent gas bubble flow up through the inside of a mild steel cylinder which is mounted vertically at the centre of the digester. Gas recirculation is carried using a gas compressor. The central cylinder is double wall and inside hot water is recirculated. The water is heated by water boiler using a part of the biogas produced.

Digester temperature was controlled at 35°C as much as possible and hydraulic retention time was about 21 days. Average gross gas production ranged between 219-243 m^3/day Biogas yield was about 0.4 m^3/kg volatile solids.

Gas composition was about 58.2% methan and 41.6% carbon dioxide.

About 32% of the gas produced was utilized in maintaining the slurry temperature in the digester at 35°C.

Another simillar plant of 100 m^3 volume (Fig. 23) was installed and operated using pig manure as raw material the digester dome is constructed from steel to improve the gas leakage problems. However, the cost of plant is too high reaching about 26000 US$ according to 1979 prices. Also it contains two major parts of metal: gas holder and digester dome which makes the rate of

depreciation very high, solar heater was used for heating the daily feed water (about $3.3m^3$) and accordingly a saving in Biogas was attained. Thus only 16% ($30m^3$) of the gas produced was usod for controlling the temperature in the digester.

Tuesday, 17 May 1983;

At 9.10 I met with Mr. Lee K.O. at hotel, and he accompanied me to Korea advance Institute of Science and Technology, in Seoul.

At 10.00 A.M. I met with Dr. Moon H. Han, the director of food and biotechnology research division. A change of opinion about the activities of the Institute and NRC Egypt was carried. He clarifies the activities of his division. It includes Food and Animal feeding fields. No work is going now on Biogas however some research work is going on production of hydrogen by biomethods. A quick visit was carried to the different laboratories of the division.

At 11.00 A.M. a meeting was carried with Dr. Youn Young Lee, the head of Chemical Engineering Eguip. Lab. A visit was carried to the laboratories. Many processes have been developed in this division. Many pilot plants are still located after finishing the required programms. The division has developed a process for production of different Fereon compounds (F 12, F 21). The process is now in final engineering stages. A discussion was carried about the system, that enhance transfer of research to industry. He declared that the division do all the prelimenary engineering of the process and also the prelimenary technical evaluation while the specialized engineering companies, a lot of them are already operating in

Korea during the last five years, make the final and detailed engineering of the process. Then it can be checked by the division and send back to the engineering company for corrections if needed. It should be noted that Korea progress during the last ten years is quite evident. They already have their own technology in many fields, and attained sharp increase in standard of living during a short period.

At 2.00 P.M. I was accompanied by Mr. Lee to visit the sewage treatment plant in Seoul. Where I met with Mr. Eng. Uh K.B., the technical advisor at the plant. He breifs the situation concerning sewage treatment in Seoul and also he gaves briefing about the sewage treatment plant.

Most of the sewage water in Seoul is thrown directly in the river without treatment. Now, one plant is existing which treats about 1/4 the sewage water of Seoul. However it is planned to have another three large plants located in the other regions of Seoul near to the river and should be in operation before the year 1988. All treatments are based on withdrawal of the treated water in the river while the separated organic matter is used as fertilizer. Big pollution problems still existing now in the city.

The visited sewage plant consists of three main plants:

1. Cheonggae Cheon sewage treatment plant.
2. Jungrang Cheon sewage treatment plant.
3. Night soil treatment plant.

Cheonggae Cheon plant starts operation during the year 1976, with capacity 150,000 m^3/day. The treatment method is mainly

清溪川下水処理場

CHEONGGAE CHEON SEWAGE TREATMENT PLANT (Fig. 24)

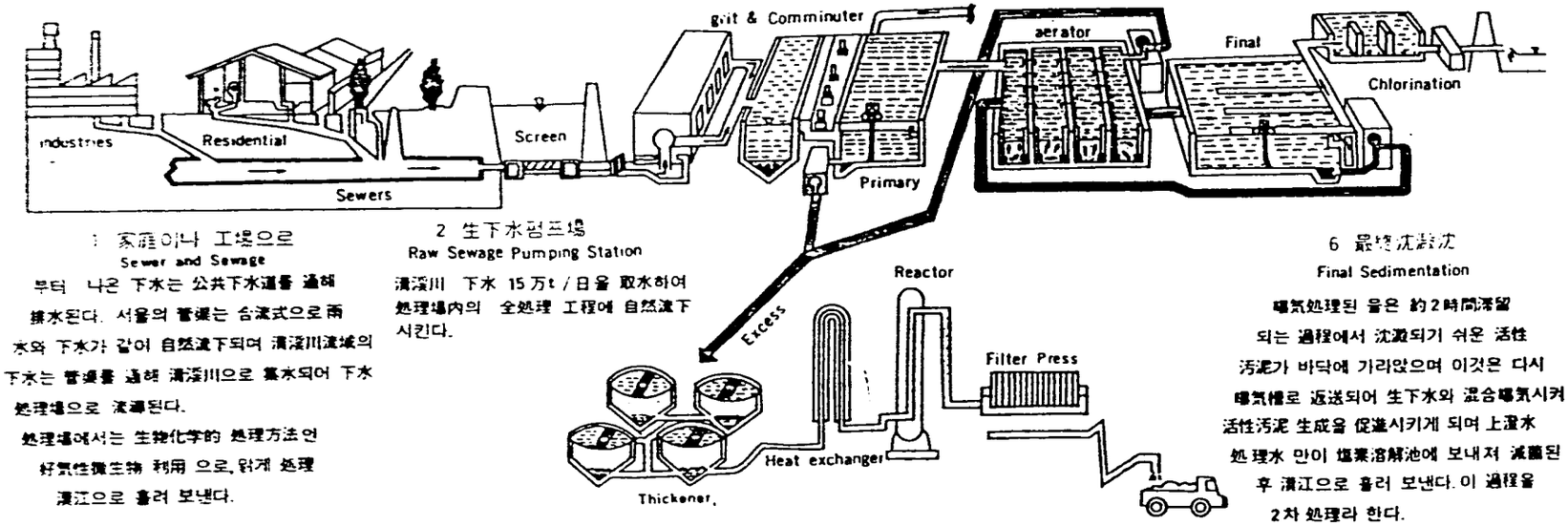
下水処理系統図
Flow chart

4 最初沈澱池
Primary Sedimentation

池内를 1.5時間 滯留하면서 沈澱性 固形物質을 沈澱시키며 表面層은 긁어모아 汚泥濃縮槽로 보낸다.
여기까지 1次処理라 하며 B.O.D는 25%~30%(350P.P.M→[illegible]P.P.M) 除去된다.

5 曝 気 槽
Aeration Tank

最初沈澱池에서 流入된 生下水에 送風室로부터 空気를 供給받아 約6時間 程度 曝気를 한다. 이사이에 好気性 微生物이 下水中의 有機質을 營養으로하여 繁殖되며 凝集現象을 이루어 最終沈澱池로 보내진다.



1 家庭이나 工場으로
Sewer and Sewage

부터 나온 下水는 公共下水道를 通해 排水된다. 서울의 管渠는 合流式으로 雨水와 下水가 같이 自然流下되며 清溪川流域의 下水는 管渠를 通해 清溪川으로 集水되어 下水処理場으로 流導된다.
処理場에서는 生物化学的 処理方法인 好気性微生物 利用 으로, 맑게 処理 漢江으로 흘려 보낸다.

2 生下水揚水場
Raw Sewage Pumping Station

清溪川 下水 15万t/日을 取水하여 処理場内의 全処理 工程에 自然流下 시킨다.

3 沈砂池 및 粉砕施設
Grit Chamber

池内流入水中의 土砂類및 雜物을 沈澱除去시킨다.
粉砕機는 除去되지 않은 固形物 粒子를 粉砕 시킨다.

7 汚泥濃縮槽
Sludge Thickener

最初沈澱池에서 沈澱된 生汚泥와 曝気槽에서 圧送된 剩余汚泥는 여기 서 含水比가 96%로 濃縮되어 汚泥処理施設로 보내진다.

8 汚泥処理施設
Sludge Treatment installation

濃縮된 汚泥는 熱交換機및 反応塔에서 一定의 高圧과 高温이 加해져서 酸化反応을 일으키는 湿式酸化法으로 処理되고 加圧濾過機로 脱水시켜 汚泥케잌을 만들어 処理한다.

6 最終沈澱池
Final Sedimentation

曝気処理된 물은 約2時間滯留되는 過程에서 沈澱되기 쉬운 活性汚泥가 바닥에 가라앉으며 이것은 다시 曝気槽로 返送되어 生下水와 混合曝気시켜 活性汚泥 生成을 促進시키게 되며 上澄水 処理水 만이 塩素溶解池에 보내져 滅菌된 후 漢江으로 흘러 보낸다. 이 過程을 2차 処理라 한다.
B.O.D 의 95% 가(350P.P.M→19P.P.M) 除去된다.

aerobic fermentation (Activated sludge method). The steps of treatments (Fig. 24) are screening and homogenising, aeration thickening and separation. The liquid phase gets further sedimentation and then chlorination as the last sterlization treatment and then drained into the river. The sludge separated residue is thermally oxidized under high pressure and temperature in special reactors as the final treatment and then separated either by filter press on rotary vaccum filter. The filtered semidry sludge is transported by cars for using as fertilizer. No biogas is produced in this plant.

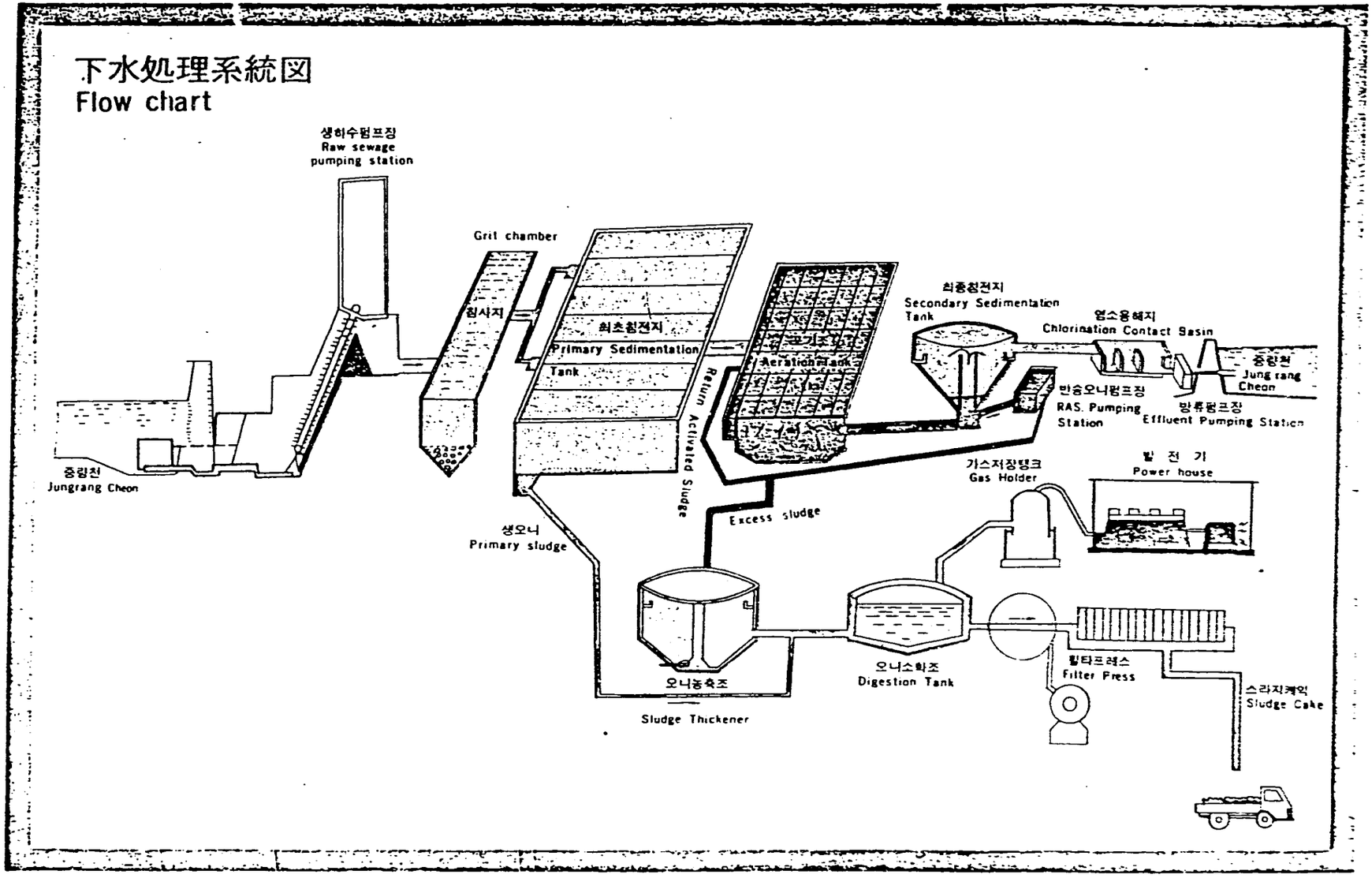
Jungrang Cheon Sewage Treatment Plant:

The capacity of the plant is 210,000 m^3/day. The plant was constructed during the period Dec. 1975-Dec. 1979. The method of treatment (Fig. 25) depend on utilization of both aerobic and anaerobic treatments. The treatment method is smillar to the previous one. But instead of thermal treatment of thickened sewage, anaerobic digestion is carried. Anaerobic digestion produce biogas which is used for production of electrical power. It also affects about 50% reduction in organic matter. The residual organic matter is separated by filter presses and vaccum filters and used as fertilizer.

The biogas digesters: 10 digesters of 23m diameter and 8.9m height are used. The total volume of digesters is 38000 m^3. The system used is single stage with heating for controlling the temperature of fermentation. Retention time is 23 days. One gas holder of about 7000 m^3 volume is used. The biogas produced is used for producing electrical power using two dual fuel generation sets of 845 kw each and 3.3kv, 720 r.pm. Exhaust heat recovery units are incorporated. The biogas

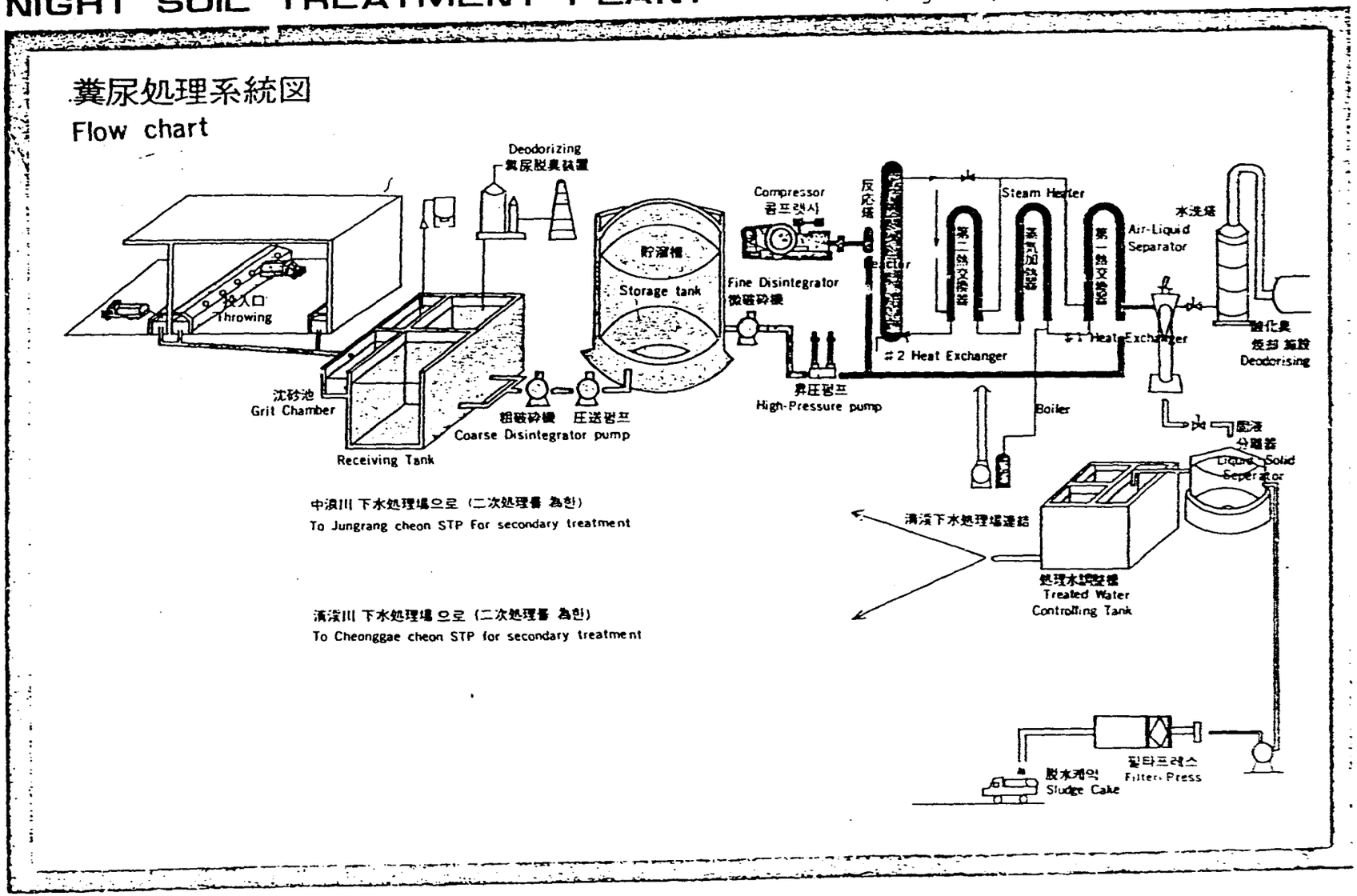
中浪川下水処理場

JUNGRANG CHEON SEWAGE TREATMENT PLANT (Fig. 25)



東部衛生処理場
NIGHT SOIL TREATMENT PLANT

(Fig. 26)



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produced is sufficient for about 60% of the electrical power needed for the whole plant.

Night Soil Treatment Plant:

The plant started operating during the year 1976. Its maximum capacity is 600 m^3/day. The main treatment in this plant (Fig. 26) is wet thermal oxidation process. The night soil is oxidized by air in special reactors at a temperature of 245°C and under high pressure of 70 kg/cm^2, then speration of the treated material. The filtered cake is used as fertilizer while the liquid is transfered to one of the above mentioned plants for further treatments.

Wednesday 18 May 1983;

At 10.40, I was accompanied by Mr. Lee to the International air port of Seoul.

At 13.30, I take the flight JL 952 to Tokyo.

Thursday, 19 May 1983;

At 12.10, I take the bus from Ginza Tokyo Hotel to the international air port of Tokyo.

At 3.05 P.M., I take the flight No. 926 of Chinese air lines to arrive at Peking air port at 7.00 P.M. At the air port I was recieved by Mr. Zhao Yong Ren from the Froeign Affairs Bureau, Chinese Academy of Science. He invites me to dinner in the air port restaurant and then we moved to the Friendship Hotel in Peking, where I stayed.

Friday 20 May 1983;

At 8.00 A.M., I met with Mr. Zhao Y.R. It was planned to fly at the after noon flight to Chengdu, Sichuan province. However, the flight was cancelled and accordingly a sight seeing of Peking was carried during the whole day.

At 9.00 A.M., a visit was carried to the Imperial palace.

At 2.00 P.M., a visit was carried to the Summer palace.

Saturday, 21 May;

At 8.30 A.M., I met with Mr. Zhao Y.R. He accompanied me to the main square in Peking where we visited the palace of the late Chinese president, and the monument of Unkown Soldier. A visit also was done to one of the famous temples in Peking.

At 10.30 A.M., Mr. Zhao Y.R. accompanied me to the air port, to take the flight No. 4102 at 12.25 to Chengdu, Sichuan province. However, the flight was delayed and then cancelled and I moved at air port hotel, where I spent the night.

Sunday, 22 May;

At 11.00 A.M., I moved to the air port to take the flight No. 4102 at 12.25 to Chengdu. Due to some troubles in the airoplane, the flight was delayed for about 3 hrs. and I arrived to Chengdu air port at 7.15 P.M. At the air port, I was recieved by Dr. Hou Yung Sheng vice director of Science and Technology office, Chengdu Institute of Biology, The Chinese academy of Scineces and Dr. Liu Ke-Xin, head of microbiology department, and Mr. Chen Ming, translator at the cited Institute.

They accompanied me to Jiang Hotel near to Chengdu centre.

Monday, 23 May;

At 8.30 A.M., I was accompanied by Dr. Hou Yung Sheng, vice president of the Institute of Biology and Dr. Liu Ke-Xin and Mr. Chen Ming to visit the Institute.

A meeting was held with Dr. Wu Yi-Zhe the director of Chengdu Institute of Biology, the Chinese Academy of Sciences and most of the Institute Scientists. A briefing on our activities on Biogas Technology was given. Our research concerning the evaluation and development of Chinese Biogas digesters design in Egypt was clarified. The Chinese Scientists were highly impressed with our developments in their Chinese designs and agreed about its importance. Some of our publications on Biogas was given.

Dr. Wu Yi-Zhe the director of the Institute, briefs the activities of their Institute, as it includes three main fields:

1. Plants & Biomass

2. Animals
3. Microbiology

The main works in Biogas fields are:

1. Development of biogas digesters for rural areas.
2. Treatment of waste water in urban areas.
3. Development of anaerobic micro-organism for biogas technology.

Dr. We Yi-Zhe and some other scientists from the institute talked about the biogas technology in Sichuan province and in China. Chengdu is the capital of Sichuan province. Chengdu is about 1600 km far from Peking. Sichuan province is in the middle of China, the population of the province is about 100 million, about 90% of them are working in agriculture. Sichuan province in one of the main agricultural centres in China. Chengdu population is about 4 millions.

In Sichuan province there are still about 2.5 million biogas digesters in operation now. However, it should be noted that during the flooding of the year 1981, more than 50% of the rural digesters were destroyed. In China, there still about 6.5 million of biogas units operating well.

The lowest ambient temperature in the province during winter season ranges between 0-5°C while during summer season the highest ambient temperature ranges between 32-36 °C. The slurry temperature ranges between 12°C as minimum during winter season and reaches a maximum of 25-26°C during summer season. Accordingly the gas production rates range between 0.09 (and some times less) to a maximum of 0.25-0.3 m^3/day during the winter and summer seasons respectively. The average gas production rate around the year is about 0.15 m^3/m^3 day.

A quick visit was carried to the different laboratories of the Institute. Experimental work is going on dry fermentation of rice straw. The straw is first pretreated by mixing it with effluent slurry in aerobic conditions for one day. Then it mixed with pig's manure using 1:1 ration based on dry weight. Experiments were carried using different solid concentrations in the range 8-25% total solids. Best results were obtained using 25% total solids. The mean gas production rate at ambient temperature (28°C) was about 0.4 m^3/m^3 day. The gas production starts after 3 days. The maximum gas rate obtained after a period of about 90 days, after which gas rate declines. The lowest gas production rate is about 0.1 m^3/m^3. day, while the maximum is about 0.9 m^3/m^3. day.

Thermophelic treatment of sewage waste is studied. The solid content of the feed is 3.5%, retention time is 8 days. The mean gas production rate is 2.2 m^3/m^3. day. COD removal attained was about 90%.

Different research works are going on for testing some new and modified digester designs. The study is carried using small volume (5-10 lt.) digesters of transparent plastics. These types include, circular and shallow Chinese type digester with buffle, tubular plug flow digester with one buffle and also with multi buffles system.

At 12.30 P.M., I visited Chong ging county, about 50 km far from Chengdu. The county consists of some communs and many village commities. A number of village groups belong to each communs. The main products of the county is rice, wheat, oil crops, traditional medical Chinese crops, and vegetables. Small industries are also present. These

include machinary factory for production of spare parts, and other small rural industries.

In the county, about 71% of the population are using biogas as fuel for cooking and lighting. The total volume of the digesters in the county is about 663000 m^3. Thus about 73500 digesters are constructed. The digester volumes range between 6-10m^3. The types used are mostly from circular and domed type (Fig. 27), some are of the rectangular type. The director of the county mentioned that one technician of biogas is included in each village group. The biogas technician deals with operation and maintenance of the biogas plants. For each county there is a biogas office. In this office, 13 persons are working. Four trained technicians are dealing with digester design and construction in the county. They get their training in the central office of biogas of the Sichuan province in Chengdu. The other members of the office are working in adminstrative and service divisions.

During my visit to the county I was accompanied by Dr. Hou Yung Sheng, Dr. Liu Ke-Xin and Mr. Chen Ming. We took lunch in the county dinning room and then moved to one of the county villages. The village director accompanied me to visit some of the biogas units in the village. Every house was served by two biogas units (Fig. 28). Both units are connected to the pig shed. However one of them operates mainly on crop residue (rice straw) using the batch system. The contents of the unit is discharged twice a year. While the other unit operates mainly on pig manure and urine. The unit also is dishcarged twice a year due to the need of the slurry content for land fertelizing. There is one month delay between the discharging of the two units. The village director mentioned that the biogas produced is just sufficient for cooking during winter season, while excess gas can be

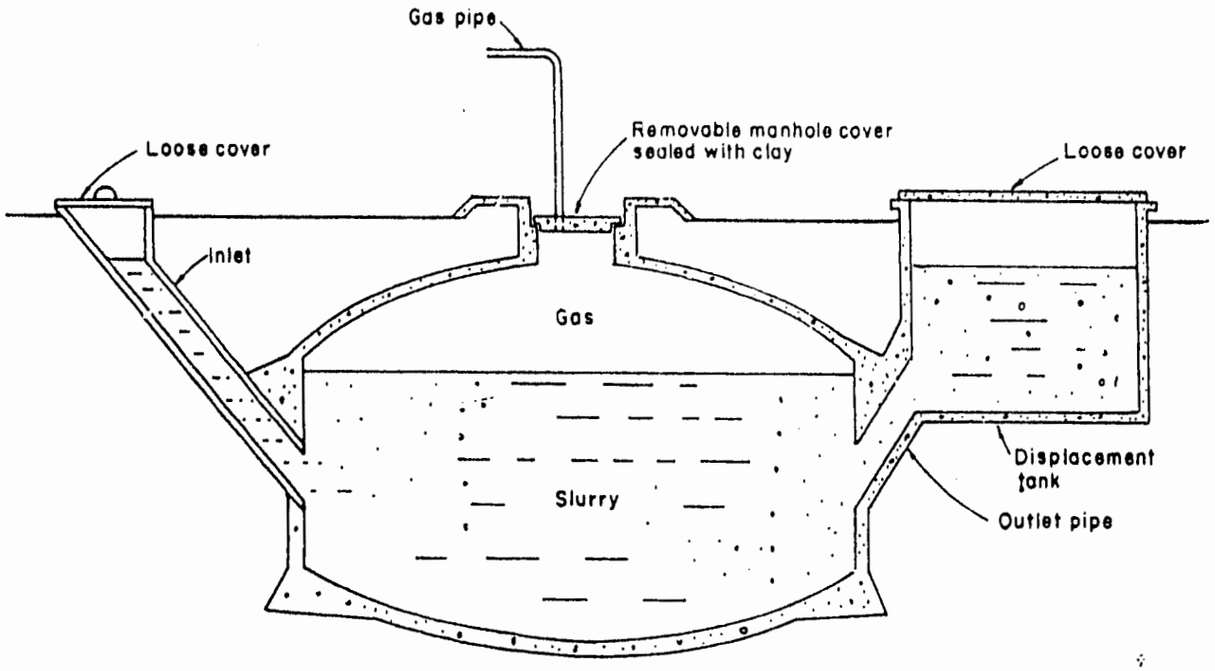


Fig. 27 Improved design of the fixed dome digester (China).

produced during summer season and this is used for cooking the food of the pigs and other house utilization. It is worthy to mention that the kitchens I visited in the village are almost the same. It contains a set of 3 stoves: one operating on biogas while the other two are operating on solid crop residues available (Fig. 29). The first stove is mainly for cooking using biogas, the second is for cooking using crop residue during the period of gas shortage. The third stove is used for cooking the feed of the pigs. The last two stoves are connected to a chimney and thus the kitchen was very clean and beautifully decorated.

In all houses visited, a gas lamp was connected. China uses very simple designs of gas lamps, Fig 30 shows one of this designs it consists of four parts: an aluminium tube a gas diffuser to which the mantle is attached, a disc reflector and a slim glass or plastic tube that acts as a nozzle. The aluminium tube is about 100 mm long and 15 mm in diameter. A little below the top of the tube there are four air holes 3 to 4 mm. The reflectors fits at the bottom of the alimunium tube just above the diffuser. A more simplified construction is shown in Fig. 31. Here the tube and the gas diffuser are made in one piece from clay. The reflector is made also of clay.

At 4.00 P.M. I moved to Chengdu.

At 7.00 P.M. a reception was hosted by Chengdu Institute of Biology. Dr. Wu Yi-Zhe the director of the Institute of Biology and some Scientists dealing with biogas technology in the Institute, were present. A discussion was carried about problems of biogas technology and the planned future

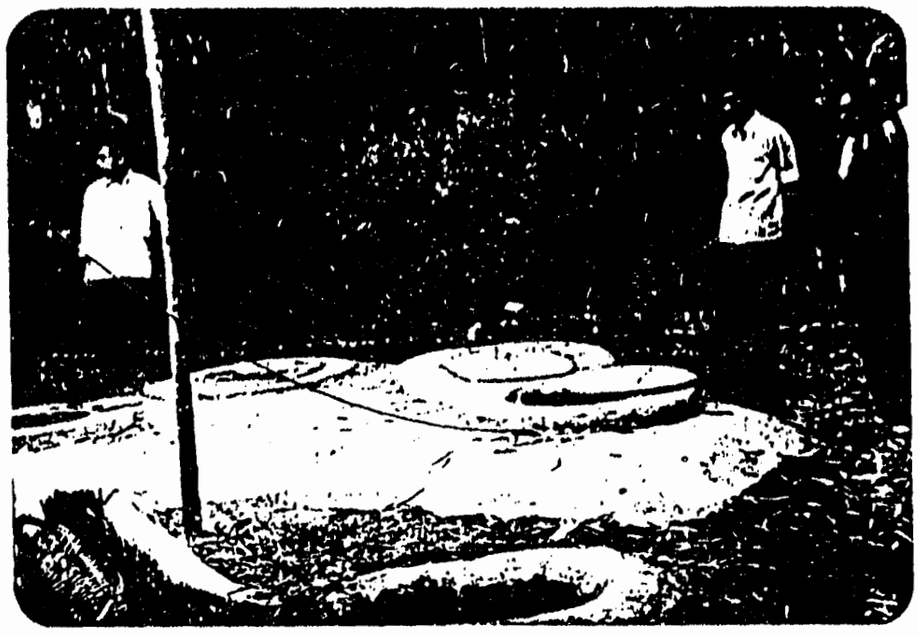


Fig. 28 Two biogas digesters connected to a family house (China).

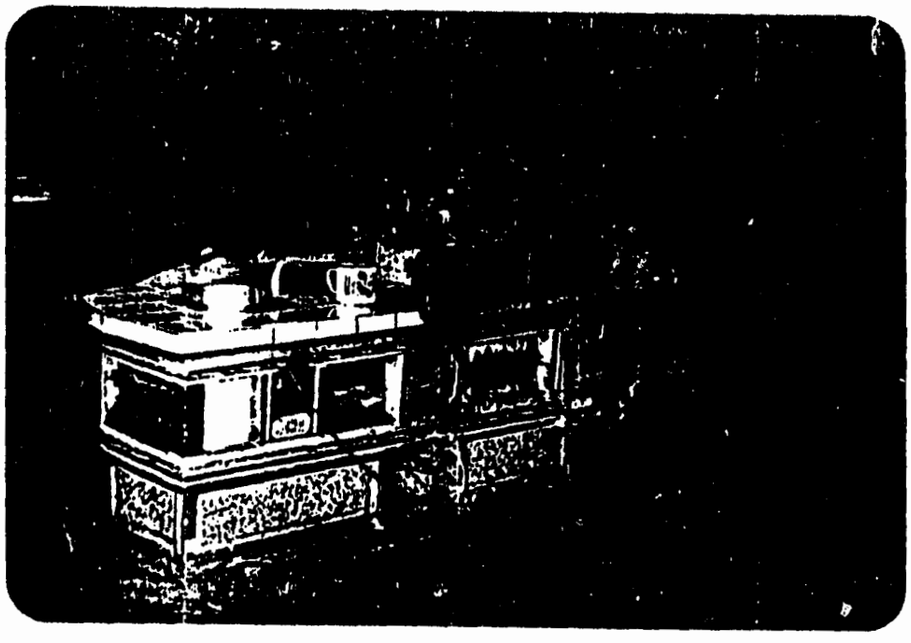
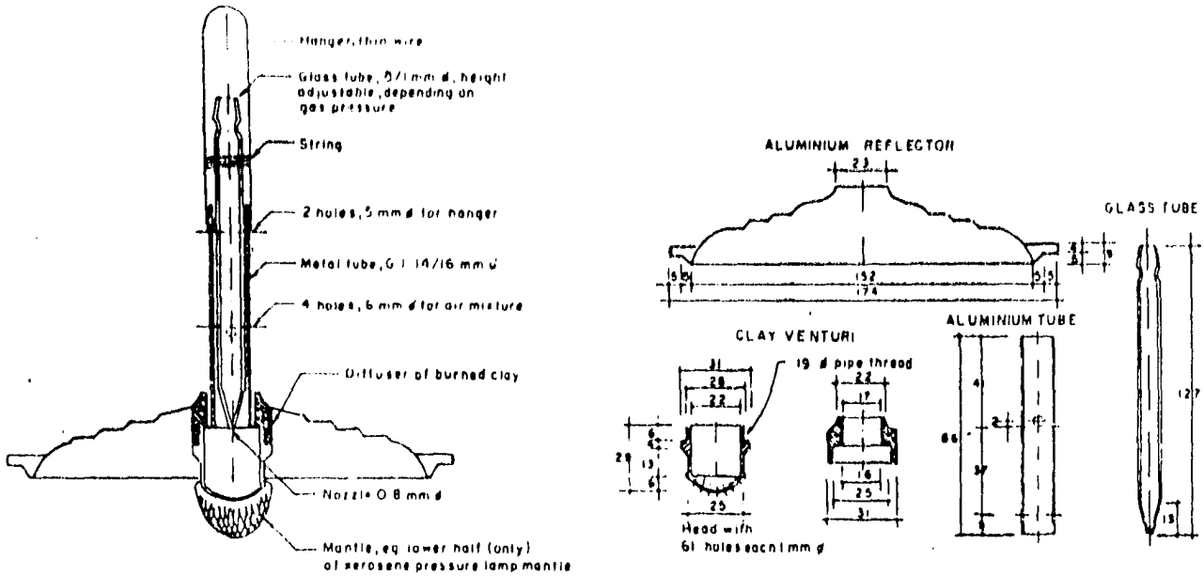


Fig. 29 Kitchen stoves operated on biogas and crop residues (China)



i) Section elevation of the lamp assembly

ii) Details of lamp parts

Figure 30 Simple biogas lamp (China)

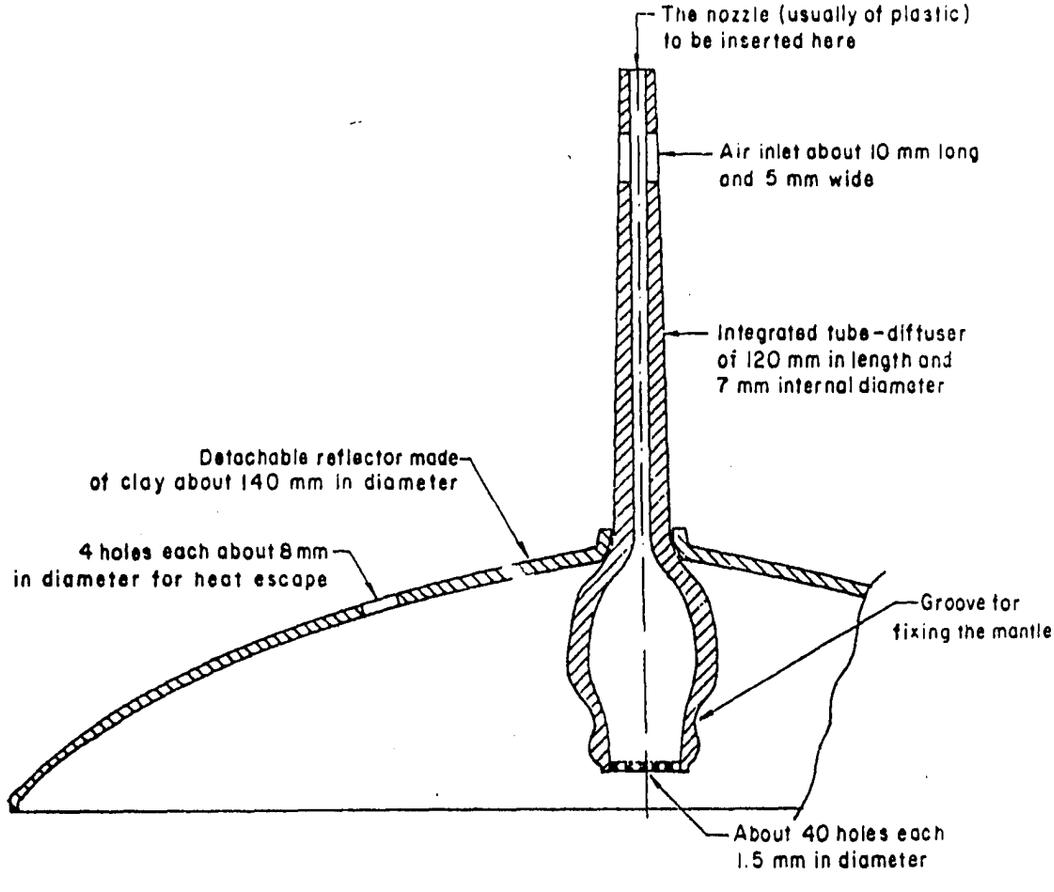


Figure 31 Clay biogas lamp (China)

development in China.

Tuseday, 24 May;

At 7.30 A.M., I was accompanied by Dr. Hou Yung Sheng the vice director of Chengdu Institute, Dr. Liu Ke-Xin, and Mr. Chen Ming, the translator to visit the Rongxian county distillery. The distillery factory is located at about 150 km east to Chengdu.

At 11.15 A.M. we arrived to the plant. I was recieved by the director of the plant and some engineers.

The director briefs the history of the plant. The construction of the distillery started in 1971 and completed in 1973. The raw material used for fermentation is sweet potatoes. About 4000 tons/year of dry sweet potatoes are fermented to produce 2000 tons ethyle-alcohol/year. Also corn is used as raw material (about 1500 tons/year). The factory produces some wines. The total production is equal to about 4,3 million Yuan/year. About 320 labours are working in the distillery.

The plant was not following the pollution control rules and thus 20,000 Yuan was paid yearly. Because of this pollution problems, the distillery was forced to shut down for 8 months between 1975-1977 causing a loss of more than 1.35 million Yuan.

In 1976 research work starts to solve the pollution problem.

In April 1981 a digester of 2000 m^3 volume was built mainly as a solution for pollution problem. However, the digester serves now for many purposes, (Fig. 32) thus;

- 130 m^3 waste water containing about 3.8% total solids are treated per day as solution for pollution problem and COD decreased by about 90%.

- Biogas as a source of energy is produced. 2500-3100 m^3/day of biogas are produced.

The gas produced is used for many purposes:

- Driving cars and trucks using compressed gas in cylinders. 8 small cylinders are fixed in the car and connected to a main line for charging and also connected to the carburater of the engine. The compressed biogas is at a high pressure reaching 100 kg/cm^2. Hydrogen compressor is used for compressing the biogas in cylinders. No problems was noticed during gas compression.

- Electrical power generation:
  two generator sets are present each 120 kwh. However one only operates for 16 hrs a day and produces the energy required for the whole plant. Waste heat is not used, however there is a plan to use it in future.

- Steam generation:
  The gas is used for steam production. The gas is used partially with coal and consists only 20% of the fuel. Boiler capacity is 6.5 tons/hr. steam of 13 kg/cm^2. The coal necessary for operating the boiler is about 16 tons/day.

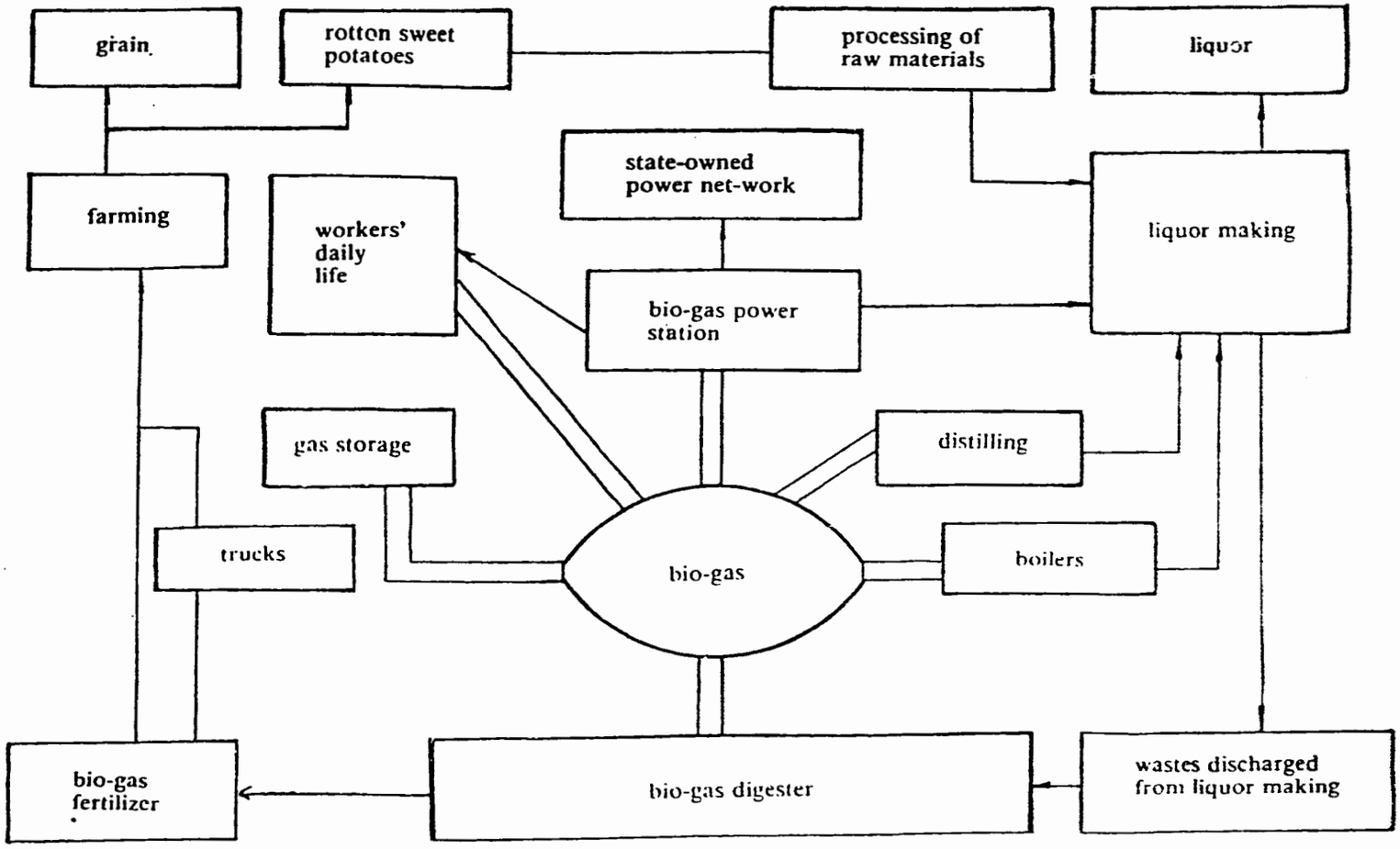


Fig. 32 Distillery and biogas digester (China).

- Domestic uses:
  The gas is used as fuel for cooking in the kitchen for 200 persons living in the area of the factory. Also there is a nearby hotel which uses part of the produced gas.

Digester Characteristics:

The digester is a tunnel type with a U-shape. Digester width is 4m while height is 5.8 m. Volume is about 2000 m^3. The digester is composed of four simillar parts connected in series using a pipe of 0.8m diameter or opening in the wall of 1.2 x 1m. The digester was built from large bricks (sand bricks) present in the field. The roof is constructed from reinforced concrete. The base is made from normal concrete. Plastering of walls and roof was carried using a mixture of cement and sand, in a multilayers of very thin layers.

Mixing of slurry in digester is carried using compressed biogas recirculated from the gas storage. Air compressor of 10 kg/cm^2 is used. About 20 points for mixing is distributed all over the length of digester. Mixing was carried for about 2 minutes every 8 hrs. Gas holder, is metallic type of cylindrical shape. It was constructed from 6 mm sheets thickness. The dimensions of the gas holder are 13m diameter, and 8m height. The building is mostly under ground. The volume of gas holder is about 800 m^3. The gas pressure is about 60 cm water head.

Digester operation: the hot effluent from the distillery is collected in a 40 m^3 tank where it is neutralized with lime and cooled. Every 8 hours, the material is fed to the digester. The retention time is about 15 days. Inlet temperature to the digester is 55°C while outlet temperature is about 51°C. No heating is required to maintain the temperature. The effluent

from digester is separated in a thickner. The concentrated organic residue is recycled to the digester, while supernatant liquid flows by gravity and is used as fertilizer. It is disposed far away from the plant using a pipe. The plant is covered by water to prevent gas losses.

The plant is supplied with some accessories as fire trap and H_2S removal (using iron bed).

The plant is a good achievement, specially that thermophelic fermentation is carried in a quite cheap cement-brik digester. Gas productivity is quite high. However the water bath on the digester can be used as solar pond for controlling the temperature of fermentation. Also integrated system should be considered to remove totally the pollution and to make the project more profitable.

At 4,00 P.M. we moved to Chengdu to arrive at 7.30 P.M.

Wednesday, 25 May;

At 5.40 A.M. I moved to Chengdu air port I was accompanied by Dr. Wu Yi-Zhe the director of the Chengdu Institute of Biology and some other scientists.

At 8.00 A.M. we take the flight CA 4101 to Peking to arrive at 11.10 A.M.

At the air port I was recieved by Mr. Zhao. He accompanied me to the Friendship Hotel.

At 2.30 P.M. a contact was carried with the National office for biogas, regarding the possibility of visiting. A meeting was carried with one of the specialist of the office. A change of opinion was carried concerning the methods of propagation of biogas technology in rural areas. He briefs the activities of biogas in China, and the methods used for assisting the propagation of the technology.

Research on biogas started in China since the year 1920, however the big movement in research was in the year 1958 In 1968 implementation on large scale started in central rural areas of China for using biogas as fuel source and as a solution for the difficiency of energy in these areas.

During the period 1968-1975 propagation of biogas technology in all rural areas of China takes place. Many digesters were constructed in Sichuan province. However, during this period not too much attention was considered for the system used or design of digesters and material of construction used. Accordingly many problems arised.

In 1975 attention for biogas development was considered. In 1978 much attention was carried for the digester construction materials, mesophelic fermentation at ambient temperature and the feed materials for the digesters as straw, grass, corn stocks, manure. In 1979, a national meeting on biogas was carried and all regions of China were represented. In 1980, a national investigation project was carried in 20 province of China. The study was concerned with the different parameters affecting biogas technology and its propagation. The study carried assists planning of biogas technology on the national level. The study includes:

1. Evaluation of climate in different regions with stress on ambient temperatures.

I N D I A

2. Availability of raw materials suitable for digester feeding and its composition in rural areas.

3. Attention was payed also for by-products and wastes of food industries, animal farms, paper mills, leather mills and other plants.

By the year 1985 it is planned to have 10 million biogas units in rural areas of volumes 6-10 m^3.

The propagation system of biogas technology in China is very interesting. It starts by the central biogas office in Peking and branched on different levels until it reaches the production brigade level in the village. This can assist transfer of knowledge and propagation of technology very fast, if some decision has been taken.

The main organisation levels are:

- Central organisation biogas office.
- Province biogas office.
- Regional district biogas office.
- County biogas office
- Production brigade biogas office.

On each level of the mentioned above, there are definit tasks to do.

At 6.00 P.M., a reception was hosted by the head of foriegn affairs dep. in Chinese academy of sciences and some members of the department and some scientists from the academy of sciences.

Thursday, 26 May 1983;

At 7.30 A.M., I was accompanied by Mr. Zhao Y.R. to visit the great wall.

At 4.30, I take the flight BA 20 from Peking air port to arrive Bombay at mid night. I was recieved by KVIC representatives. They accompanied me to a hotel in Bombay near to KVIC building.

Friday, 27 May 1983;

At 9.00, I was accompanied to attend a meeting in Sheraton Hotel - Bombay. The meeting was a closing day for a training program in biogas system carried by KVIC and sponsered by Commonwealth Scinece Council. About 13 members of different Commonwealth countries attend the training programme. Many persons gave speach in this meeting. The president of KVIC, the director KVIC-gobar gas scheme, the representative of CSRI and Dr. Mrs Lalita Rao, the minister of public health and family welfare. I was asked to give a brief about biogas technology in China and Egypt.

A meeting was carried with Mr. H.R. Srinivasan, director gobar gas scheme, during which a change of opinion was carried out concerning the development of biogas technology in both India and Egypt.

Saturday and Sunday is generally not working days in KVIC, however Mr. Sirinivasan, director of gobar gas scheme, planned a programme for visits during these two days.

Saturday, 28 May 1983;

At 8.30 I was accompanied by Dy. chief officer in biogas

to visit the community plant in Dhaniv village located about 45 km north Bombay.

The village consists of 12 Hamlet (small village). The total population is about 1200 persons. The population of Dhaniv (the capital) is about 200 persons and consists of about 37 houses. The main work in the village is the cultivation of rice. The cultivated area in the village is about 500 hektars of low quality land.

The distribution of land is:

- 10 persons owned between 5-20 Hektars - rich people.
- 90 persons owned between 1-4 Hektars - Middle class.
- 100 persons landless - Poor class.

A primary school is present in the village. More than 80% of the population can read and write. The daily wages of the farmers varies between 5-8 R/day. However, the work is seasonaly in agriculture and accordingly the landless people work in brick factories or moved to other places. The village is generally very poor.

Biogas Plants:

The community plant consists of many digesters and gas storage systems:

1. Large community plant of 5m diameter and 6m depth totally underground with floating gas holder (Fig. 33-34). The digester is fed daily using the dung supplied by the farmers. About 20 families are participating in this plant. The dung supplied is priced at 0.02 R/kg wet.

Fig. 33 Mixing chamber (India).

Fig. 34 Community biogas plant (India).

There is one technician dealing with operation of the plant. he weighs the dung supplied by the farmers and records it in a special operating manual. The gas is supplied to any family asks for 25 R/month. The dryed effluent is sold as fertilizer with a nominal price of 0.05 R/kg dry.

The manure feeding rate during the last month (May 1983) ranged between 200-500 kg/day. Sharing of families in dung supply ranges between 15 and 50 kg/day. There are about 100 cows in the village. The gas is supplied twice a day. In the morning at a fixed time for about 1 1/2 hrs starting at 10.00 A.M. The second shift is in the evening and also for about 1 1/2 hrs. starting at 6.30 P.M.

The gas is supplied for about 20 families. The slurry effluent flows to the 2nd large digester operating on night soil for further fermentation stage.

2. Large digester connected to a toilet set. Large digester of the same volume as the above one is connected to a set of toilets serving the village peasants. The effluent of the 1st community plant is supplied mainly as feed to this digester for further treatment. Also a canal is present for direct disposal of effluent for drying.

3. Three batch digesters: Three batch digesters of 8 m^3 each are located nearby to the large community plants. The digesters are of the vertical type with floating metallic gas holders. The digesters are fed periodically using the animal bedding and crop residue as raw materials for feeding.

   Gas storage system: The gas produced is stored mainly in the gas holders present over every digester. However,

two additional small gas holders are located in the same plant site. All gas holders are connected together to form one unit from which the gas is supplied to the farmers houses.

However, the gas pressure in the gas holders are not equal to each other. Accordingly manual daily separation of gas holders is needed.

The produced gas is transported to the houses using a pipe net of steel. The main pipeline diameter is 2 1/2 inches. The connection from the main to house set is 1 1/2 inches. The connections inside the house is 1/2" steel pipe.

Suffiency of biogas produced for the different families in the village: The volume of digesters available in this location is very large. However, the gas produced was hardly sufficient for two hours operation per day of one stove for each family. Compared with the Indian habits of cooking, the duration of supply is not sufficient. In all the farmers' houses visited, stoves operating on crop residues was used for preparation of lunch.

The crop residue stoves used are of the low efficiency types without chimney. Accordingly, the house still dirty and the changes due to introduction of biogas technology in the village are not evident. This can clarifies, why most of the farmers are not willing to participate in the biogas system available in their village.

The climate in Maharashtra state is very suitable for efficient biogas production. However, the main constraint

seems to be the difficiency of cow dung. It seems to me that the solution of the energy in the rural areas of India should be based on better utilization of crop residues either to produce biogas by dry fermentation systems and/or by development of efficient and healthy stoves for direct combustion of crop residue.

At 12.30 P.M., a visit was carried for a workshop named "Super Welding Works" located at about 50 km form Bombay. The workshop is one of the 200 workshops located in Maharashtra state. These workshops construct the gas holders and also they are dealing with building of the digesters, piping and start up. They give a one year garantee for the digesters they built. This workshop constructed more than 300 digesters during the last year. In the workshop there are 10 labours, three of them are welders.

These workshops constructed more than 3000 biogas plants in Maharashtra state during the last year. Most of gas holders constructed during the last period are of the types dipped in water and not in slurry.

At 1.00 P.M., I visited "Britto Gas Engineers", a workshop for gas holder construction and also digesters. In this workshop they construct gas holder from steel and also from polyester reinfroced with fibre glass.

The gas holder is manufactured from thermoset plastics, particularly unsatruated polyester resins. These resins have good resistance to corrosion and attack by chemicals. However, they are relatively weak and brittle. The addition

of a catalyst usually methyle ethylo ketone peroxide and accelerator cobalt naphthenate (6% cobalt in solution) causes the resin to cure at room temperature without the need for pressure or heat. Glass fibres in various forms are used to reinforce polyester to bring out their more strengthen.

The first step is the making of a pattern which is generally made of wood. The mould is then prepared using this pattern as a master. Female moulds are used to obtain a high finish on the inside of a moulding and male moulds for a high finish on the outside. To obtain a high quality finish the mould surface must be absolutely smooth and is therefore polished. A layer of plastic is brushed first and then glass fiber. Then brushing to have complete wettness and pressing to remove air. Additional reinforcement is added and then polymer. This is repeated until attaining the required thickness. The mould is allowed for curing and then removed.

The prepared polyethylene reinforced with glass wool is used as the metal sheet (Fig. 35). Welding is carried using polyethylene polymer and some fiber glass is added if needed. All the inner supports of gas holder are constructed from mild steel angles as the KVIC known design. The upper cone is moulded also as shown in Fig. 36 and then fixed.

At 2.00 P.M., I visited a nearby village, where some biogas units of the family size types are constructed. All the units visited are not connected directly to the animal shed. Some are directly connected to separate toilet. Some of digesters are of water-sealed gas holder type. One of

Fig. 35 Construction of R.F.P. gas holder (India).

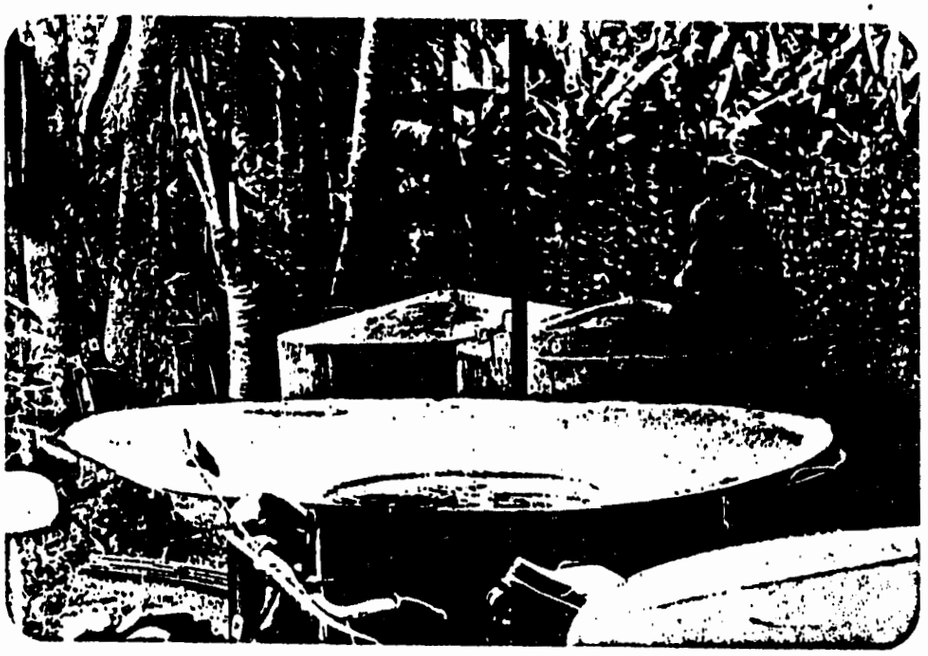


Fig. 36 Moulding of the conical roof of gas holder (India).

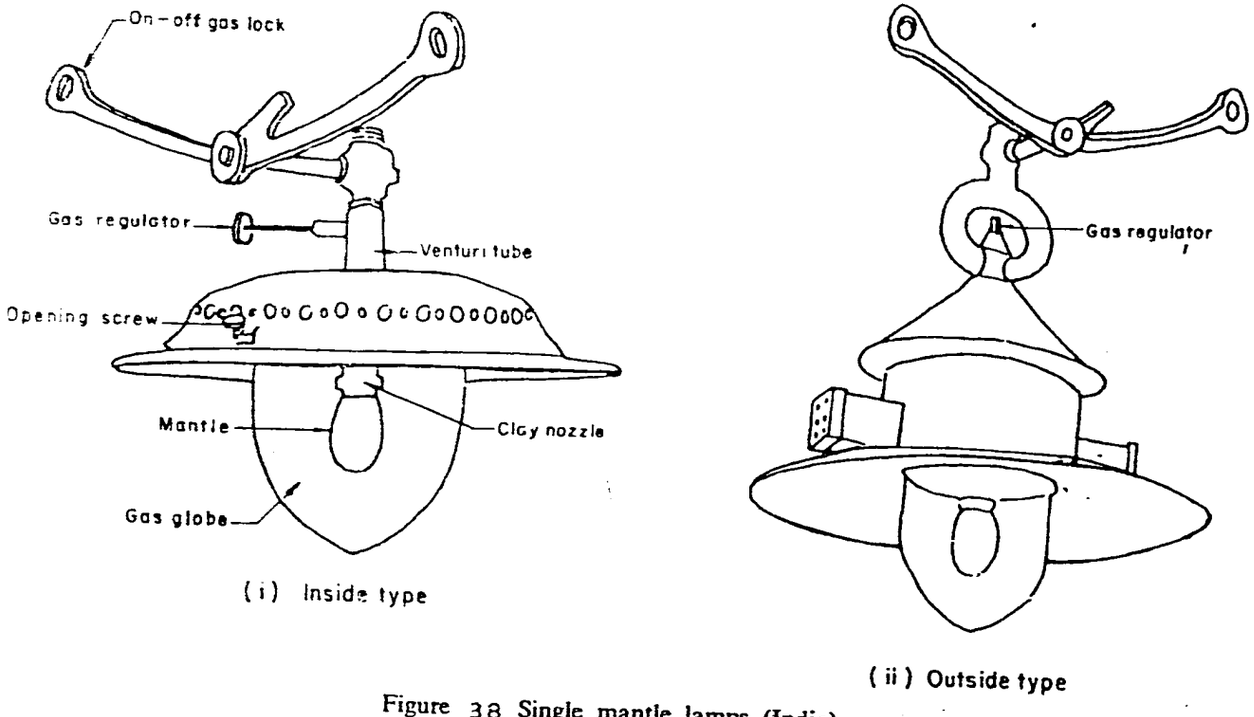
gas holders was fabricated from polyester reinforced with fiber-glass. The degree of implementation of biogas technology in this area was very high. However, in most cases the biogas produced is not sufficient for cooking in houses due to lack of raw materials needed for digester feeding. Pollution problem still present as the urine is almost not treated and flows around the animal shed. Fig. (37) illustrates the conventional KVIC digester design. Fig. (38) shows some of the gas lamp designs used in India.

At 6 P.M., a meeting was carried with Mr. H.R. Srinivasan, the director of gobar gas scheme in KVIC. He accompanied us for seight seeing of Bombay town.

Sunday, 29 May 1983;

At 10 P.M., a meeting was carried with Mr. H.R. Sirinivasan in KVIC office. Saturday and Sunday are generally holidays in KVIC, however Mr. Sirinivasan accompanied me to KVIC offices. A change of opinion concerning biogas technology in India and Egypt was carried. Also exchange of literature was carried. Copies of our publications on biogas technology were given and some books and literature on KVIC designs and modifications were obtained.

Mr. Sirinivasan briefs the situation of biogas technology in India. It is planned to construct about half million biogas units during the coming few years. Most of the units are of KVIC design. The Chinese type units built in India suffer from gas leak problems. Most of these units in Maharashtra state has been modified to include floating gas holder.



(i) Inside type

(ii) Outside type

Figure 38 Single mantle lamps (India)

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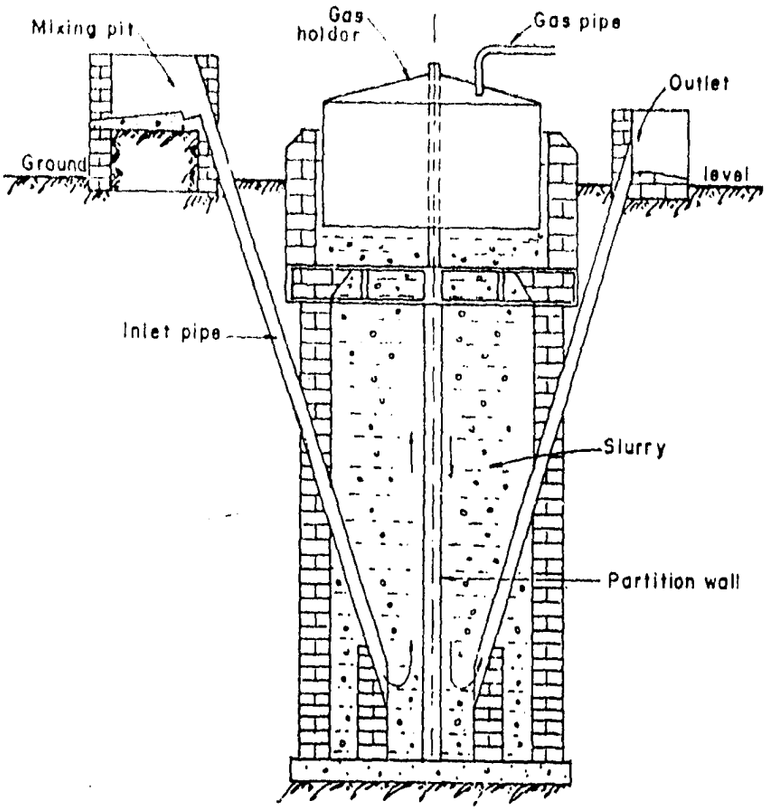


Figure 37 Common circular digester with floating gas holder (India)

Mr. Sirinvasan briefs the development works goining on in KVIC concerning biogas technology:

- Gas holder: a tryer was made to construct a ferro-cement digester and gas holder (Fig. 39&40). However, gas leak for gas holder was considerable and he thinks that this type is not suitable. A polyethylene reinforced with fiber glass sheat is now used for gas holder construction. Plastic gas holder is operating well for more than three years in farmers' house near Bombay. The gas production rate is some what higher due to the decrease in heat losses and also the effect of solar radiation. However, no actual evaluation is available.

  The gas holder gide is modified to include three legs instead of four in the original design (Fig. 41). The aim was the reduction of cost.

  The metallic gas holders are also modified to suit the water-seal type digester. The main modifications are in the inside reinforcement (Fig. 42).

- Digester: Modifications have been done for development of water-sealed digesters. Many digesters are constructed of this type todays. The upper part of the digester is constructed from two concentric walls (Fig. 43). The gas holder is located in the water filled annular space. The inner wall is fixed on cantilever from bricks. The steel of the gas holder guide should be higher than the base by about 5 mm, such that the load is transmitted

Fig. 39 Ferro-Cement digester (India).

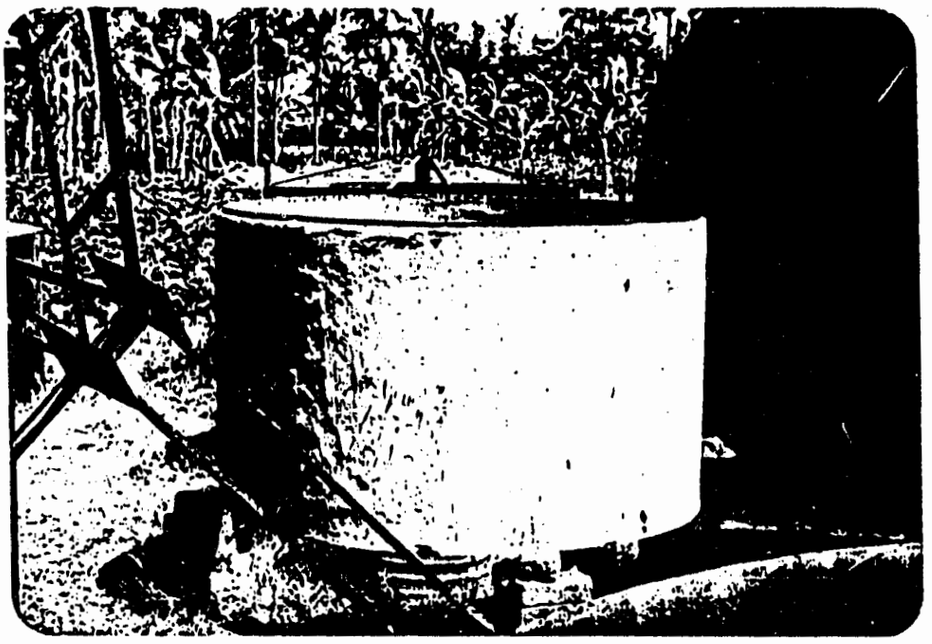


Fig. 40 Ferro-Cement gas holder (India).

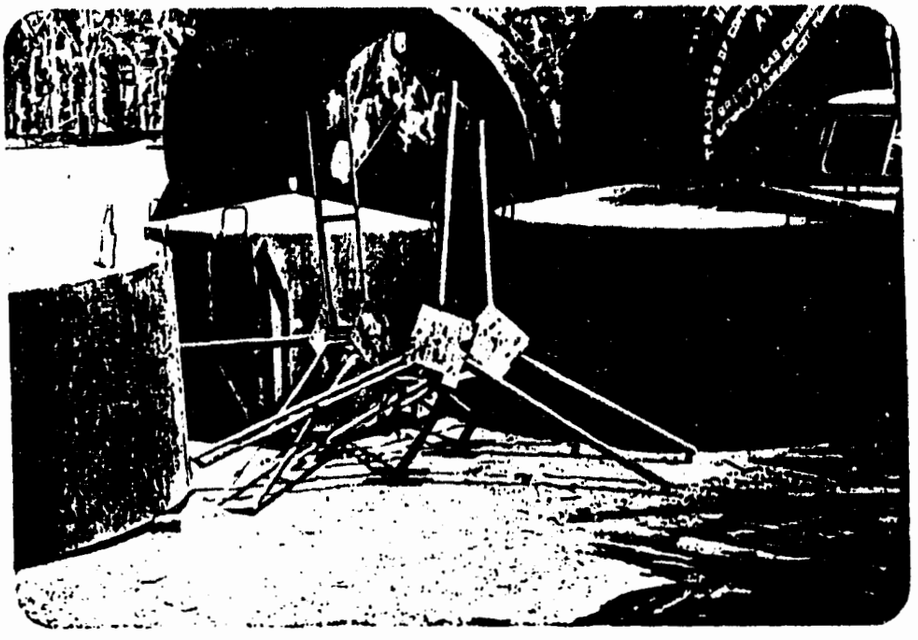
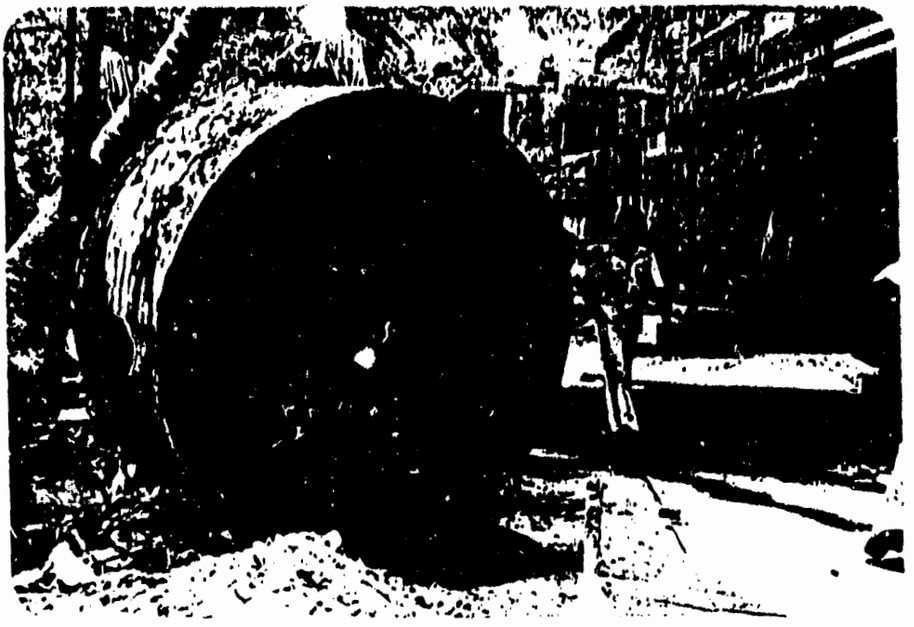
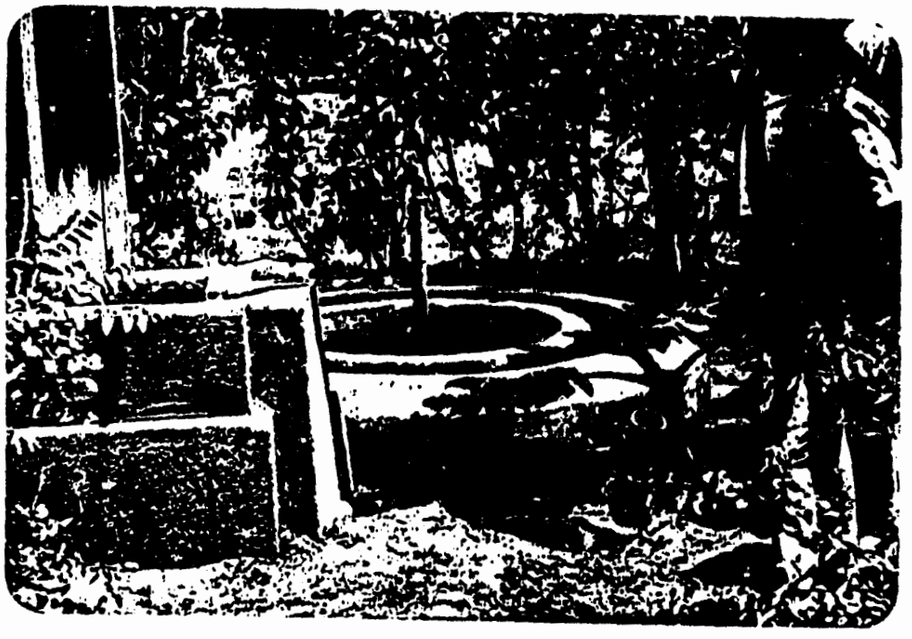


Fig. 41 Modified gas holder guide (India).



Fig, 42 Water sealed gas holder (India).



Fig, 43 Water sealed digester (India).

through the guide angles to the main walls. For large digesters steel reinforcement should be done.

A lot of work is continued for development of prefabricated concrete digesters. The digester is fabricated from 6 vertical slabs. The prefabrication can assist propagation of technology, solve transportation problems and have good quality digesters.

Sunday, 29 May;

At 2.00 P.M., I leaved KVIC to Bombay air port. At 3.05 P.M. I took the flight IC187 to Delhi.

Monday, 30 May;

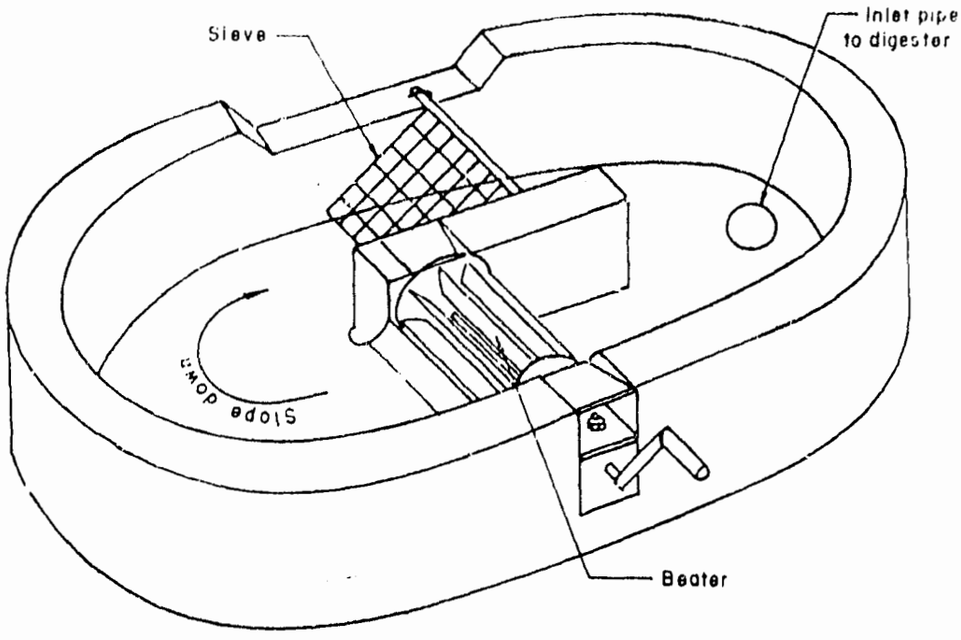
At 6.30 A.M. a tour was done to visit Agra. At 8.30 P.M. I arrived back to the hotel at Delhi.

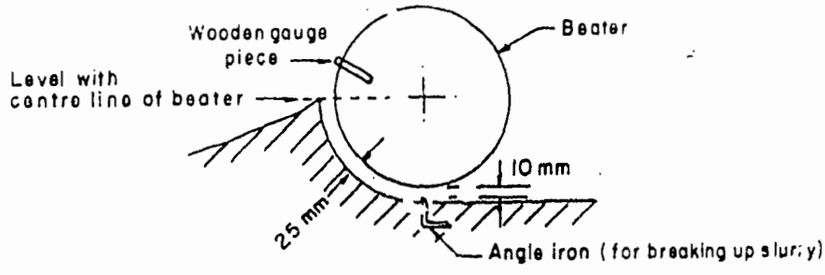
Tuesday, 31 May;

At 10 A.M., I met with Mr. Bhim Sen Sharma from KVIC-Biogas scheme, Delhi office. He accompanied me to Masudpur community plant located about 22 km south west Delhi.

The village population is about 1200 persons. 72 houses are present in the village. 50 houses of the village already have biogas connections.

Biogas plant: There are two large biogas plants and three small ones. The dung used in feeding the plants is transported from a large animal shed located about 1/2 km far from the biogas plant. The dung is mixed with water mechanically in a good made special mixing chamber (Fig. 44),





Setting of the beater

Fig. 44 Slurry mixing machine.

and then fed to the digester. Retention time is between 40-50 days. About 140 m^3 biogas is produced daily. This amount can be decreased only to 120 m^3/day during cold winter season. The high stability and large production rate of the plant is mainly due to incorporation of green house which assists in maintaining the optimum temperature of fermentation allover the year. About 14 °C increase inside the green house was noticed during the hot season. Evaluation of the green house during cold season is not finished yet. However, it is expected to have good performance effect. The green house is made from wooden supports covered with polyethylene sheets.

The village is very close to the digesters. A main pipe of 2 1/2" transports the gas to the village. Branches of 1 1/2" is used to connect the gas stream to the house and a 1/2" pipe line is used inside the house.

The gas produced is sufficient for the houses connected. Every house is to pay 25 R/month as a fee for gas. Number of houses connected to the set is increasing. However it should be noted that in this area the cultivated land is nationalized and accordingly most of the house holders are not farmers. Success of the plant is indicative of the promising industrial plants success and not the community. As the feed material is not dependent on the villagers. The effluent is dryed and utilized as fertilizer. Part of the gas is used for production of electrical power using dual engine operating on both gas and diesel oil.

The development site includes some other non-conventional energy sources like wind mill for pumping of ground water

solar cooker for preparation of food and photovoltaiec for charging of batteries. The batteries is used for operation of coloured T.V. for the community.

At 9.10 P.M. I take the flight JL 461 to arrive at Cairo at 3.00 A.M. of the 1st of June 1983.