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UNIDO

Industrial Biogas Technology Demonstration Plant and Experimentation Station, Beijing

Final Report

UNIDO Project No. US/CPR/81/171

June 1994

Carl Bro International a|s
Consulting Engineers and Planners

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1. Introduction

Carl Bro International a¦s has with this report completed the contract launched by UNIDO to assist Beijing Municipal Government and Beijing Solar Energy Research Institute.

Carl Bro International a¦s has involved the company Biowaste as Subconsultant.

The biogas plant in Daxing has been designed and established in a cooperation between a German Subcontractor and Beijing Solar Energy Research Institute. During the work under this contract, it turned out that the design and supervision under establishment have been incomplete. The result of this has been several problems, which had to be solved before the operation could start.

The project has given the staff of the plant and BSERI an important information of how a biogas plant can be turned into stable operation with a good economy through a combined treatment of different types of industrial waste.

Biogas plants have never been used for treatment of solid waste in China before. Most of the solid waste from households and industries is dumped in landfills. The plant in Daxing can with a few changes in the installation and organisation be used as an demonstration of biogas plants for solid waste treatment.

However, the time under this contract did not allow a refurbishment and reorganisation of the plant, which is necessary to achieve results which make the plant a good demonstration plant.

A continuation of the UNIDO involvement with the aim to exploit the installation for demonstration of industrial solid waste treatment has therefore been discussed with both the Chinese counterpart and UNIDO.

Carl Bro International a¦s has at the end of each of the 4 missions, under this contract, performed an interim report. To a wide extent, this final report summarizes the 4 interim reports.

2. History of the Industrial Biogas Technology Demonstration Plant and Experimental Station, Beijing

The development of the Daxing Biogas and Experimental Station has been performed in three parts, namely:

1. The pilot tests, from 1981 to 1985

2. The design and erection of the plant, from 1989 to 1992

3. Testing, start up and optimisation of the process, from 1992 to 1993

The Pilot Tests

The pilot tests were stopped in 1985, and due to poor results of the tests and to the fact that the Chinese counterpart and the German Subcontractor had different opinions of the appropriate design for the biogas plant, the second part was not started until the beginning of 1989.

Design and Erection of the Plant

The design work was performed in a cooperation between the German Subcontractor and the Chinese Counterpart, Beijing Solar Energy Research Institute (BSERI).

The German Counterpart carried the overall responsibility for the design. The work was partly carried out in Germany and partly in Beijing.

Before the erection of the plant was completed, UNIDO terminated the contract with the German Subcontractor, resulting in further delay of the project. However, in the spring of 1992, the construction work was completed and all the equipment was delivered by UNIDO.

The plant was designed to treat waste water from a brewery and distillery in Daxing. However, after the plant had been designed, the beer production was stopped and later the distillery decreased activity to such a degree that the factory had no problem disposing the waste to nearby farmers, who use the waste as cattle feed. The distillery even get paid by the farmers.

In November 1993, it was finally made clear that the fermentation and thereby the production of waste at the distillery will be stopped by the end of 1993.

UNIDO has as part of the project purchased equipment for the pilot installations in phase 1 as well as for the biogas plant in Daxing.

Testing and Starting Up

Carl Bro International a¦s was given the contract for testing and starting up the biogas plant. The activities of the contract were started in November 1993.

In connection with testing the plant, several parts of the installation were found incorrectly working, and changes had to be done before the plant finally could be started up in spring 1993.

Within a few months after the process was started up, treatment of different types of industrial waste was initiated for two reasons. First of all, the amount of waste coming from the distillery was decreasing to such a level that the loading of the plant was far too low to give a viable operation. And secondly, both BSERI and UNIDO wanted to test industrial waste in biogas plants with the aim of finding a basis for a viable operation of the Daxing Biogas Plant and to evaluate the possibilities for replication of the plant in Daxing.

3. The Design and Construction of the Biogas Plant

After firm considerations, the design of the plant was chosen to be the activated sludge digestion.

The project consists of the following two main parts:
- Treatment of solid organic waste from the distillery
- Biogas plant

Treatment of Solid Organic Waste from the Distillery
During the 1980's, disposal of solid waste from the fermentation process caused severe problems for the distillery.

During the pilot test, BSERI had found out that the solids could be reused in the distillery after treatment. The aim of this treatment was to remove easily digestible parts from the solids very efficiently. The easily digestible solids removed from the solids should afterwards be treated at the biogas plant.

The design of the treatment plant for the solids was prepared by BSERI. The plant is situated at the distillery very close to the workshops where the waste was produced.

The installation originally consisted of an arch sieve and a centrifuge. The centrifuge was replaced with a band filter press after testing as it could not work on the semi solid material from the arch sieve.

The treatment is performed by mixing the solids with water from the distillery. Originally, it was planned to use hot water for the treatment in the form of condensate from the steam distribution pipes in the distillery.

Shortly after the start of the operation of the biogas plant, the distillery started to add chlorine to the condensate, and the condensate was unusable for the treatment. Instead cold tap water was used.

However, using cold tap water the treatment process is not nearly as good as using hot water.

The Biogas Plant
The biogas plant is designed by a Chinese/German cooperation. The German Subcontractor to UNIDO had the overall responsibility for the technical design. The Chinese Counterpart had the responsibility for ensuring that the project was in accordance with Chinese law, local design standards, codes of practise and other local conditions.

Part of the design was carried in Germany at one of the German Subcontractor's offices supervised by the Subcontractor. The final part of the design work was carried out in Beijing. Some parts of the project were never designed or the design was never ensured by the German Subcontractor to be in accordance with the needs for the operation.

Because of the missing parts of the detailed design and drawings, supervision of the establishment was very important. However, the supervision should have been performed in the period where the contract with the German Subcontractor was finally terminated. Therefore, the Chinese counterpart did never get the necessary supervision during the construction phase.

The biogas plant consists of a prestorage tank, two digesters, a settling tank with recycling pump for settled sludge, a biogas storage, and a boiler installation.

On the principle diagram, figure 1, the installation is illustrated.

Liquid from the distillery is pumped daily, or whenever it is produced, to the prestorage tank. The feed pumps for the biogas digesters are placed in this tank.

The liquid is pumped from the prestorage tank to one of two 400 m^3 digesters. The digesters are concrete tanks equipped with mixers, heating coils, and a biogas evacuation system.

The digestion takes place at a temperature of 30-35°C. The level in the digesters is controlled by an overflow leading to the settling tank.

The biogas produced was in the original design evacuated from the digesters at an overpressure of 30-40 mbar. The biogas is led to a 400 m^3 gas dome and further from here to the biogas boiler at the biogas plant or to the gas flare.

Because of gas leakages in the concrete digesters, a biogas evacuation pump had to be installed before the start-up period was initiated. After the pump was installed, the gas is evacuated from the digesters at an overpressure of 1-2 mbar.

Leaving the digester, the liquid is led to the settling tank in which active biomass is settled. By use of a scraper and a sludge recycling pump, the sludge is returned to the digesters.

From the settler, the liquid is discharged to the sewer.

To control the biogas plant, a PLC is installed. The software for the control is made by the Chinese counterpart.

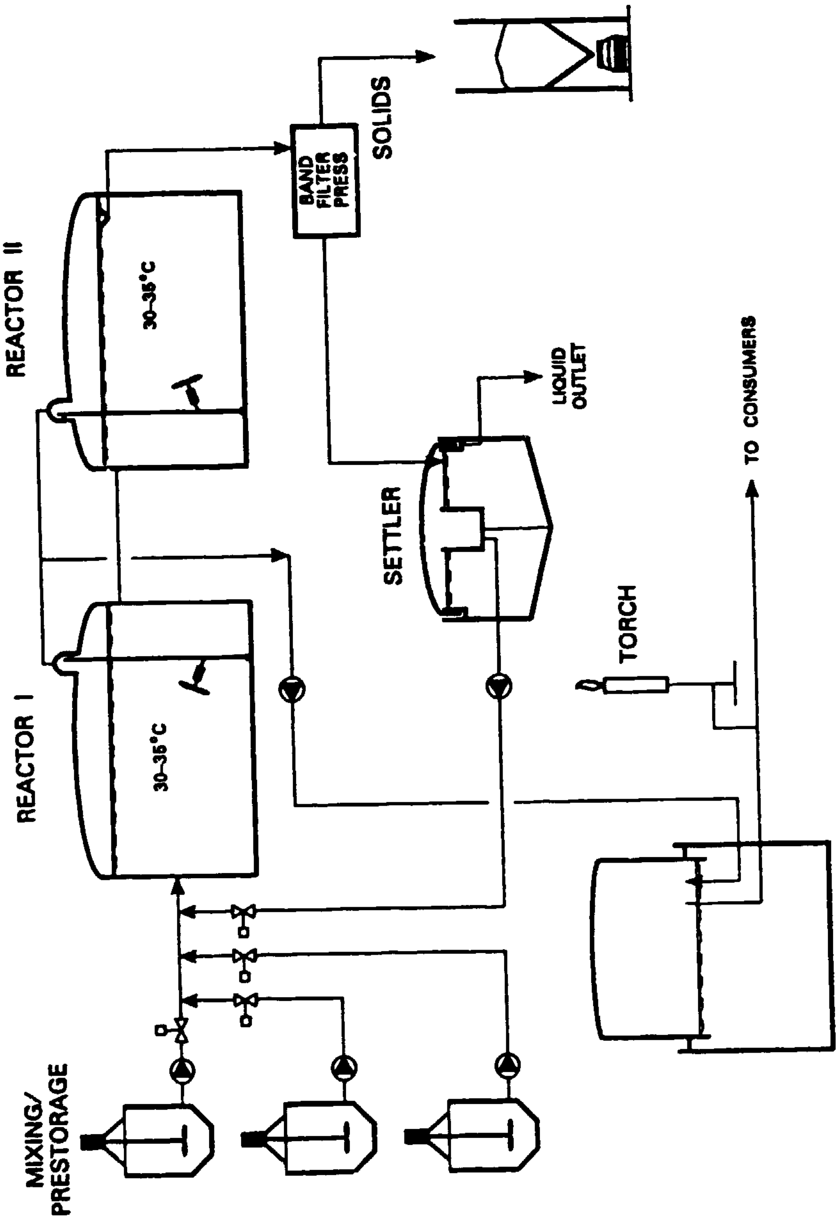

Figure I
Principle diagram for the biogas plant

4. Equipment Delivery and Installation

During the design, the German Subcontractor, the Chinese Counterpart and UNIDO have worked out a list of equipment to be imported for the demonstration plant in Daxing.

After an international tendering based on a list of equipment worked out by the German Subcontractor, the Chinese Counterpart and UNIDO, the French company CICS was chosen as supplier of the equipment.

Installation as well as operation manuals for the equipment should be delivered by the equipment supplier. These manuals together with the detailed design formed the basis for the Chinese Counterpart to install the equipment.

The Chinese Counterpart was solely responsible for checking the equipment after arrival to Beijing. Through this check it should be made clear that all listed equipment was delivered and that all parts of equipment were present together with manuals for installation and operation of the equipment.

After the installation, CBI should check the installation of the equipment and test the function as part of the overall testing of the functions prior to the starting up.

During the tests, it turned out that the gas system did not work due to the fact that the reactors were not gas tight. To solve this problem, CBI designed a gas evacuation system and delivered the necessary equipment.

Furthermore, CBI has helped the Chinese Counterpart setting up a laboratory at the biogas plant in Daxing. The aim was to establish a laboratory in Daxing, which the staff of the biogas plant can use for analysing samples taken out for process control. The analysing equipment for the laboratory was purchased and delivered by CBI.

The following analyses are made possible at the biogas plant by use of the delivered equipment:

- Total solid
- Organic solid
- Chemical Oxygen Demand
- Alkalinity
- pH
- CH_4 and CO_2 content of the biogas

5. Task of the Project

In the contract between UNIDO and Carl Bro International a|s, the tasks of the project are listed as follows:

* Testing the installation prior to starting up of the biogas plant
* Starting up the biological process in the reactors using seed sludge from the biogas plant in operation
* Running the installation and optimizing the process conditions to maximum gas yield
* Training of two Chinese experts in Denmark
* Dissemination of the results from the project

Carrying out the work according to the Contract, CBI is obliged to have a briefing and debriefing meeting at the UNIDO office in Vienna, 4 missions to the project area, and participation in an international conference concerning biogas technology in developing countries.

Besides the missions to Vienna and the project area, CBI should be kept informed about the day to day situation at the plant in Daxing from the home base. CBI should in the periods between the missions give advice and guidance to the Chinese counterpart concerning the operation of the plant.

6. Status of the Daxing Biogas Station at the start of the Project

In General

In general, the plant was not completed at the time of the first mission. There were several outstanding problems, which meant that it was not possible to start up and run the plant as the conditions for this project said.

During the first mission, most of the problems were solved, and at the end of the mission it was possible to heat up one of the reactors in an attempt to start up the process. However, because of the fact that the treatment plant at the distillery was not working it was only possible to start the process up, and to keep it going until the start of the second mission.

The Design of the Plant

The total loading rate of the plant will according to information from BSERI at the time where the plant was started up be 70 m^3/day of liquid with a COD_{total} of approx. 20,000 mg/l.

This gives a hydraulic retention time of 40 days and an organic loading rate of approx. 1.75 kg COD/m^3 x day. The retention time is very short and the loading rate is very low.

A completely mixed reactor will normally run with approx. 20 days' retention time and a loading rate of 3-5 kg COD/m^3 x day. This means that it should be possible to run the plant with only one digester in operation.

As mentioned, the design was not completed and checked by the German Subcontractor, and for the part of design which has not been checked in Germany, it was noted that the installation of the plant did not fulfil normal safety precautions.

Especially the following could be mentioned:

* A service switch for the mixers in the reactors is missing.

* A service switch for the sludge recirculation pump is missing.

* A service switch for the feeding pumps in the system is missing.

Service switches are normally placed at the very spot of the installation and for mixers in the reactors just beside the manholes to make sure that the equipment can not be turned on while servicing or repair is going on.

The system does not even have separate switches for the different components in the switchboard.

We do not know whether the actual installation is made in accordance with the Chinese legislation, but for safety reasons, CBI has strongly recommended that the service switches were installed, which however never happened.

Constructions and Installations

It is obvious that the Chinese counterpart should have had much more help during the erection period.

The assistance could have ensured that mistakes, because of lacking information, misunderstandings or even the fact that technicians doing the installations did not understand the drawing or parts of them at all, would have been limited to an absolute minimum.

As an example of such a mistake it can be mentioned that the heating system was completed without using 40 shut-off valves purchased for the plant and shown on the drawings, because it was not understood why the valves should be there.

7. Fulfilment of the Obligations

According to the agreement with UNIDO's backstopping officer, the briefing took place in October 1992 by telephone. This form of briefing was acceptable to both UNIDO and CBI because the CBI team leader was the last one having been in Beijing and therefore the person best informed about the actual condition of the Daxing Biogas Station.

Beside the briefing and debriefing, CBI has performed 5 missions to the project area.

7.1 Testing the Installation prior to Starting up of the Biogas Plant

Tests of the following parts of the plant were carried out:

- Gas system
- Pumps
- Control system
- Heating system
- Mixers
- Treatment device
- Flare
- Miscellaneous

The results of the tests are described in Appendix D, which is a reprint of parts of Interim Reports I and II.

In general, it can be concluded the installations were functioning as planned. However, there were major changes in the heating system and in the gas system, which could only be solved after supply of extra equipment.

7.2 Starting up the biological Process in the Reactors using Seed Sludge from Biogas Plant in Operation

As the start-up of an anaerobic reactor is very dependent on the type of seed sludge you get, it was discussed which seed sludge BSERI could provide. Especially, a UASB reactor on a brewery was found of interest.

Finally, it was decided to base the start up on the following seed sludge:

Seed sludge from fig farm digester

Most of the sludge (100 m^3) was planned to come from a pig farm digester close to the airport.

Receiving the first sludge on November 30, 1992, the sludge did not fulfil the requirements and therefore only approx. 30 m^3 were received altogether from the pig farm.

There was too little biological activity in the sludge, the sludge was too thin, and there were stones and other impurities in it.

Seed sludge from a brewery UASB reactor

From one of the breweries in the Beijing area, we succeeded in having 20 m^3 of sludge from a UASB reactor.

The sludge was tested in the laboratory and found extremely active, and thereby very good as a seed sludge.

All the seed sludge was pumped into the southern reactor, which was the reactor chosen for the process start-up.

During the tests of the installations, it was made evident that it would not be possible to put the plant into operation during the first mission, the start up of the process took place in the spring 1993 after the technical alternations were made.

During the second mission, a plan for the start-up was prepared together with BSERI. The plan took into account the actual possibilities of supplying feed material from the distillery.

At the end of the missions 2, 3, and 4, new plans were prepared, every time with the aim of reaching the maximum loading of the plant in the shortest possible time.

However, mainly for the reason that it was not possible to have enough feed material from the distillery, the plans were never followed in the periods between the missions.

As an example, the plan prepared after the 4th mission is shown beneath.

Plan for Feeding in Week 38-43 1993

The following plan for the loading of the biogas plant with a combination of waste from the distillery and industrial waste was discussed and agreed upon.

The feeding of the plant (both reactors) has to be as shown in Table 4.1.

The plan for running-in the second reactor has to be taken into account, too.

Expected COD values for the feeding material are:

- distillery waste:	5 kg/ton
- bleaching clay:	500 kg/ton
- oil sludge:	750 kg/ton
- jam waste:	350 kg/ton (20% VS and presumed 1.5 kg COD/kg VS)

The plan starts at the beginning of the week 38, because appointments with the waste producing companies have to be made first.

If the COD in the inlet material is varying more than 10% from the expected values, the feeding rate has to be adjusted (relatively).

The important figure is the total load. If it is not possible to get one type of waste, another type should be added to keep up the loading rate.

Week No	Feeding rate **distillery waste** kg COD/day	Feeding rate **bleaching clay** kg COD/day	Feeding rate **oil sludge** kg COD/day	Feeding rate **jam waste** kg COD/day	Total load kg COD/day	Expected gas prod. m^3/day
38	150 30 t/d	50 0.1 t/d	40 0.05 t/d	0	240	120
39	225 45 t/d	100 0.2 t/d	75 0.1 t/d	35 0.1 t/d	435	200
40	300 60 t/d	150 0.3 t/d	150 0.2 t/d	70 0.2 t/d	670	335
41	450 90 t/d	200 0.4 t/d	300 0.4 t/d	105 0.3 t/d	1,055	525
42	450 90 t/d	250 0.5 t/d	450 0.6 t/d	140 0.4 t/d	1,290	650
43	450 90 t/d	250 0.5 t/d	550 0.75 t/d	175 0.5 t/d	1,425	700

Beside the loading of the reactors, the plan gives guidance to the staff for other things such as how to ensure correct mixing of the different types of waste into, how to feed the reactors, and how to operate the mixers in the reactors.

8. Running the Installation and optimizing the Process Conditions to Maximum Gas Yield

In general, the process is working satisfactorily. However, the loading rate has never reached a normal level for the type of reactor, which means that the process has never worked at an optimal loading rate and gas production.

The reason for this situation was that the plant never received enough liquid from the distillery. During the whole project period it was discussed to introduce industrial waste of different types. However, only a few of the identified waste types could be used with the actual prestorage and feeding system.

Based on the investigations and tests performed, the biogas plant in Daxing could be used to demonstrate industrial solid waste treatment.

Looking into the future, there is no doubt that solid waste treatment will be an issue which the authorities of Beijing will have to face. The Daxing Biogas Plant will give an important information and basis for decision of whether to introduce biogas plants for solid waste treatment in a broader scope or not.

Industrial Waste identified in the Daxing Area

Three different types of waste have been identified, which are suitable for the biogas plant.

1. Bleaching Clay

   A waste product from vegetable oil production. This is a product that the factories will find no other use for.

   Initial tests have been performed with bleaching clay in Daxing.

2. Industrial Waste (with no or very little fibres)

   This is a type of waste which can derive from different industries. In Daxing, oil sludge from a vegetable oil factory has been tested as an example.

3. Fibre-rich Waste

   The originally planned waste from the distillery would be categorized as fibre-rich waste. But also fruit and vegetable waste, slaughter-house waste, the organic part of waste from households, manure, and other kinds of organic waste are identified in Daxing.

To reach an optimal composition of the waste for an anaerobic digestion, you will have to balance the different types of waste. The amount of bleaching cla[illegible] hould be added to a minimum of 5%, but never exceed 20% of the total inpu[illegible] material. The amount of industrial waste could form up to 40% of the total input. Left is the fibre-rich waste which should form at least 40% of the total input.

The treatment capacity of the plant in Daxing will be approximately 10 tonnes of waste per day.

Gas Production and Biogas Utilization

Treating industrial waste, the biogas plant can produce 2-3,000 m^3/d of biogas.

To reach this gas production, approximately 10 tonnes of waste will be needed per day. Whether it will be possible to collect that much waste can not be said at the moment. However, based on the waste already identified, a production of 1,500 m^3/day can be expected.

9. Training in Denmark

This chapter has been written by the Mrs He and Mr Lee at the end of the training course in Denmark.

From February 16, 1993 to February 27, 1993 we visited Denmark to take the training of approaching industry (household) wastes and R & D work in the field of anaerobic digestion. During our stay we were involved in the following activities:

1. Visit to Technical University of Denmark (February 17 - February 19)

1.1 We attended the lecture on anaerobic degradation. Ms B. Ahring gave us an introduction of anaerobic microbial process and some important parameters for monitoring the process.

1.2 Practical exercise in the laboratory.

1.2.1 With the help of a scientist in the laboratory, we set up a 1-litre UASB reactor including influent storage, pumps for feeding and recycling, biogas bag, effluent bottle and necessary tube. Then we started the reactor with the granular from another UASB reactor. Meanwhile we did some analysis for influent (waste water from sugar plant) such as TS, TSS, VS, VSS, VFA, COD and reducing sugar. On the second and third day, we continued the measurement of CH, COD and VFA for effluent. The scientist showed us the way to use the data to evaluate the process.

1.2.2 Under the guidance of a scientist in the laboratory, we went through activity test. Granular was taken from a UASB reactor and the whole process was going on. Besides, we were shown by the scientist the method of making CH/substrate curve versus time and the calculation of immediate activity of granular on a specific substrate.

This test is a quick and practical way to measure activity of inoculum. It is useful for choosing seed sludge and monitoring anaerobic process.

The use of immune probe on granular sample was also shown.

2. Visit to Vegger Biogas Plant (February 23)

We visited the whole biogas plant, including the laboratory. The co-digestion using manure, HSW and different kinds of industry waste is very effective. We discussed a bit with the scientist there about the process control, particularly the control of VFA.

We got the impression after the visit that the cooperation between Technical University and Vegger Biogas Plant is very successful and using such a biogas plant as a test plant is practically feasible.

3. Visit to Aalborg Municipality (February 22 - February 24)

People told us the programme for HSW and the plan to increase, recycle and to reduce incineration and landfilling. They also gave us some introduction to the law and regulations within this field. They showed us the station for sorting HSW. What impressed us most is the effective organization of the collecting, sorting and treating system.

4. Visit to Danish Technological Institute (February 24)

Scientists in the institute showed us some activities there, such as biomass fermentation, biological control of insect and fungi, chemical analysis of different sample.

5. Visit to Carl Bro (February 25 - February 26)

5.1 Visit to the Biogas Plant in Helsingør

After the visit to the biogas plant in Helsingør, we discussed with the scientist in Carl Bro about the plant. He showed us the way of doing the feasibility study, preliminary design and detailed design.

5.2 The scientist showed us the whole process of doing feasibility study for the project in Toftlund. He gave us an introduction to the survey of biomass amount, storage and transportation facility. He also gave us the introduction of the comparison of different process and economic analysis.

The discussion in Carl Bro is very helpful for us to approach a new project.

10. The Arusha Conference

To present the results of this and other projects in China, the team leader and Mrs He from BSERI participated in a conference in Arusha, Tanzania. The title of the conference was Small and Medium Size Biogas Plants for Developing Countries.

A poster presenting the Chinese projects and the costs of Mrs He's participation were covered by the project.

11. Conclusion and Recommendations for the Operation of the Plant in the Future

The general conclusion is that the plant never reached the performance expected during the project. Therefore the plant never proved whether the design is suitable for the actual type of waste/waste water.

There seems, however, not to be any doubt that the plant is operational on the type of waste water it was designed for.

As the reactors of the plant are of the completely mixed type, it is possible to treat nearly all types of waste in the plant. During the final mission on this project is was discussed to rebuild the plant for reception and treatment of industrial waste and the organic part of household waste.

Changing the type of waste to be treated means that both reception of waste and outlet of digested material must be changed. Part of the preparatory work for this will take place during the undergoing activities of this project. However, new installations if needed and the refurbishment of the existing installation can not take place under the existing programme because the available budget does not allow new investments.

It is recommended to prolong the ongoing project activities for another year, and to carry out the following activities split up into two phases.

First Phase: Reorganization and Refurbishment

The following activities should be included in the first phase of the project:

1. Transportation of the waste must be arranged and managed, and new types of waste must be identified.

   Mr Li and BSERI should ensure the contacts to industries. UNIDO should assist in putting up the final agreements with the industries.

   To transport 10 tonnes of waste to the plant every day, and to make sure that the fertilizer product produced is brought to the farmers, a small truck with containers would be appropriate.

2. The reception of different types of waste needs an area where waste can be unloaded and stored.

   Pre-storage must be provided for the solid waste in the industries and at the plant to such an extent that transportation can take place in full truck loads.

   The existing pre-storage tank will be used to mix the waste. The tank must be equipped with a mixer and a new pump with higher capacity than the existing.

Two new mixing/pre-storage tanks must be provided for industrial waste. Both tanks must be approximately 10 m^3 and equipped with mixers and pumps feeding the waste to the reactors.

Existing pumps delivered for the pilot-scale tests are tested and if possible repaired for this purpose.

The new tanks can be situated between the biogas reactors and the existing gas storage.

3. A crusher will be convenient for pre-treatment, as it will allow the plant to take a broader scope of waste.

   Sorted household waste will normally have to be crushed before it is dissolved into liquid and fed to the reactors. However, if the sorting can ensure that no big items are delivered with the waste, this can also be done by a macerator placed just in front of the feeding pump.

4. The band filter press presently installed in the treatment at the distillery must be moved to the biogas plant and installed at the outlet flow.

   Digested slurry from the reactors will hereafter pass the band filter press before it goes to the settler.

   Dependent on the discharge standards for wastewater, the final effluent treatment must be decided. Besides the existing settling tank, effluent treatment in the form of COD removal may be necessary.

5. The solid residue from the band filter press must be used as fertilizer. An area must be made available for this product to be stored until the farmers collect it.

   Or the plant will have to take care of the transport of this waste to the farmers. The plant taking the fertilizer to the farmers may be more expensive, however it may also be more reliable.

6. Diversifying and extending the use of biogas to other users, including households and if possible also to be used as fuel for vehicles.

   It is extremely important to get the best use of the biogas and to get the highest income from the gas sale. Therefore the gas use must be diversified.

   A newly established medicine production on the same site as the biogas plant itself is one of the obvious users. The only need is a little piping and a meter registering the heat sold.

   The new apartments being planned in the area at the moment should be prepared for installation of biogas for kitchen use.

On a longer term, UNIDO and the project authorities in Beijing should discuss the possibility of having a small fleet of gas driven cars. In the first place only for demonstration.

7. Involvement of the project authorities in the management of the project. Day-to-day management of the plant will be carried out on the site. However, the NPD must be more active in budgeting, negotiation of agreements, and making general and overall decisions for the project.

   UNIDO and the NPD will have regular meetings (at least once a month) preparing status for the project, discussing coming activities and changes of the project.

8. Optimization of the operation parameters to an optimal biogas production.

9. Preparation of documentation for the operation to be used in phase 2.

Second Phase: Link to other Biogas Programmes

As soon as the biogas plant has been refurbished and the process works carried out as expected, contacts should be taken to other programmes. In the first place, an effort will have to be made convincing others that the plant is now on the right track, by inviting representatives for other programmes and projects to visit the plant, and by distributing information of the results. A seminar introducing the biogas process as a waste management tool in China may be a possibility in this phase.

Formal contacts will hereafter be taken by Beijing Municipal Government and UNIDO with the aim of arranging for the project to be included into the existing programmes.