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December 1988

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INDUSTRIAL BIOGAS TECHNOLOGY DEMONSTRATION PLANT

US/CPR/81/171

Republic of China

Expert Report*

Prepared for the Government of China
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. Soren Kraemer,
Consultant in Anaerobic Digestion
Carl Bro International, Denmark

Backstopping Officer: R.O. Williams, Chemical Industries Branch

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Vienna

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Anaerobic Waste Water Treatment Plant for Daxing Distillary

US/CPR/81/171

Report by Søren Kræmer, Carl Bro International, Denmark.

Introduction

The project "Industrial Biogas Technology Demonstration Plant and Experimental Station at Daxing" was started as a UNIDO financed project in 1982. In 1986 the first phase of the project was completed by the German Contractor and the second phase was prepared.

However some disagreements between the German Contractor and the Chinese Counterpart showed up and delayed the project. With the overall task to clear-up these disagreements I visited Beijing in September 1988. On my way to Beijing I went to UNIDO's office in Vienna for a briefing.

During the first days of the stay in Beijing, it appeared that the question of which technology to be implemented in the full-scale plant may be the minor problem of the Chinese counterpart's problems. A major problem seemed to be that the people involved in the technical side of the project were not confident with this form of contracting, sharing activities and responsibilities (more or less a joint-venture) and at the same time having a claim of guarantee from the Chinese counterpart, Beijing Municipality.

After this appearance, I decided to enlarge the task of the visit with a description of activities, responsibilities, and guarantee which, from my point of view, should be added to the Terms of Reference (TOR) and/or contract.

2. Meetings with the Chinese Counterpart

When I arrived in Beijing, the Chinese counterpart presented a programme for the first 3 days of work.

The first meeting of importance was arranged at the Daxing Distillery and was attended by the technical staff of Beijing Solar Energy Research Institute, the Project Manager (both technical and political), a Ministry of Foreign Economic Relations and Trade (MOFERT) representative, and the General Manager of Daxing Distillery.

This meeting was held in order to give a general introduction to the project, the Chinese counterpart, and the test facilities at Daxing.

Many political statements were also made, and as a final point the meeting asked for UNIDO's attitude to the project in general and to the Chinese wish of getting the project restarted as soon as possible and if necessary a change of subcontractor.

To this, I could only say that as far as I knew UNIDO quite agreed with the Chinese counterpart concerning the time schedule for phase II, and hopefully the outstandings could be cleared up during my visit so that a restart within this year should be possible. Concerning change of subcontractor I said that such an act would only cause further delay, and therefore I appealed that, during my stay, the Chinese counterpart would consider whether this should be necessary or not.

After this first meeting, a number of more informal meetings were held discussing:

- the work of phase I
- the co-operation with the German subcontractor
- the substrate to be treated at the full-scale plant
- the Chinese counterpart's purpose of this project
- possible technology for the full-scale plant
- activities for the two parties in phase II
- responsibilities and guarantee of operation performances
- laboratory and pilot test facilities

Besides these meetings, I went through the TOR in detail together with the Chinese counterpart for two reasons. Firstly, I wanted to be sure that the decision-makers were aware of the paper in all details, and secondly, I was anxious that the Chinese counterpart had failed to comment on the TOR as he was very uncertain of the importance of such a paper.

All the meetings were attended by both technicians and the project management, and furthermore Mr. Zhong from the Beijing Peoples Government participated. The meetings were frank and my relationship with the Chinese counterpart was very good.

In appendix I the namecards of the people met are shown, and in appendix II a brief report is shown concerning phase I, substrate and technology for phase II which the Chinese counterpart agreed upon point by point during the stay.

3. The Chinese Counterpart

During my visit I had the opportunity to see some of BSERI's activities, and it is my opinion that, concerning anaerobic digestion, the Chinese counterpart, represented, by BSERI is well prepared for the actual project. Concluded upon our discussion, I must say that they are also realistic in their evaluation of the technological possibilities for the full-scale plant.

On the technical side also the Beijing Institute of Civil Engineering and Architecture is represented. As to detailed design I am not able to pass an opinion, as I did not see any examples of the work of this institute.

As the decision-makers of the counterpart are representatives of Beijing Municipality, political opinions and objectives often overrule the voice of the technicians resulting in a situation of uncertainty. BSERI does not believe that its knowledge of process and technics is good enough to ensure the political objectives of the Chinese counterpart.

As to the management of phase II, it seems that the Chinese counterpart is going into such a contract for the first time. Furthermore, a contract like this is rather complicated as the Chinese counterpart acts both as the client and at the same time as contractor in a kind of joint-venture with the German subcontractor.

I think that UNIDO should consider a third part in this project who should be independent of BSERI and the German subcontractor, and have experience within the actual technical fields and within contracting and project management in international joint-venture projects.

4. Evaluation of Phase I

During phase I, 5 pilot scale digesters of different types were erected and operated for 1 1/2 years to find out which type of digester and which technology are most reliable under the actual circumstances.

To evaluate the pilot tests it is very important to know the technical design and to know how the digesters were operated.

During my stay, I visited the pilot test plant and discussed both the operation and the results of phase I.

The technical design had major failures at all 5 tests digesters. In the following these failures are briefly described as background for the evaluation of the results.

Digester I is a completely stirred reactor (CSTR), or at least it should have been.

The fact is that stirring has been insufficient, shown by a very big temperature gradient (10^{0}C) from the top to the bottom. The problem could easily have been solved by placing the internal heating tubes in the bottom instead of in the top or by mixing more frequently.

Furthermore, a trace study carried out by BSERI indicated a short circuit which should have been avoided or reduced by moving the outlet pipe from the bottom to the top of the digester.

Digester II is quite similar to digester I, and the problems were the same. Digester I and II should have been operated in series but the connecting pipe was blocked, and the two step digestion was never tested.

Digester II was equipped with an external settlement system and a recycling of sludge. My guess is, however, that the main part of the sludge recycled consists of inorganic material and heavy digestible material such as shells from the grain used in the distillery, and that the recycling was without any effect on the process in the digester.

I dare this guess because the outlet was taken from the lowest point of the digester and you know that the settlements in the digester is heavy inactive material, which in the actual situation was recycled again and again.

The outlet should have been lifted from the the bottom and even an overflow would have been better.

Digester III was designed to be a two-step in one digester system with an internal pretreatment chamber.

However, this pretreatment chamber was fixed to the top of the digester and not to the bottom, and as raw material pumped into a digester system has a higher density than the material already in the digester, caused by different temperatures and a gas expansion of material processed, the raw cold material goes directly through the pretreatment chamber to the digester, and you get a very inefficient digester.

A pretreatment chamber fixed to the bottom would have worked.

Digester IV has no important design failures but the operation of the filter failed completely. A fixed filter is used for waste water types where the COD is very digestible, resulting in a low hydraulic retention time, to prevent a wash-out of the active sludge. By fixing the bacteria in the digester you gain a high number of bacteria which is not dependent on the relation between hydraulic retention time and bacteria growth ratio.

In order to bring feeding material to the bacteria fixed in the digester the waste water has to be circulated continuously through the tank, and that was where the pilot test failed. There was no recirculation except for external heating which gave a far from sufficient circulation, and for long periods it was stopped as there was no call for heat.

Digester V should have been a UASB digester, but the granulars were never formed.

To operate a UASB and other types of more or less fluidized digesters it is of overall importance to keep a constant flow in the digester, not only constant over the time but also over the cross-section.

In the actual pilot test, the inlet holes in the bottom of the digester blocked, causing flow problems in the digester.

Some of all these design and operational failures were discussed by the contractor and the Chinese counterpart but it seems that nothing was done to improve the tests.

The results given by the contractor in his latest progress report in fact show that none of the digesters have been in optimal operation. The contractor concludes that 500 l of biogas can be produced per kg COD reduced. This is a more or less general figure which is not specific for the type of digester but for the type of waste water. So the actual result could have been achieved from laboratory tests. The results from pilot tests should have been specific figures for max. COD load, gas production rate, and COD reduction.

As these figures are missing for all digester types, I must conclude that the results can not be used for comparing the different digester designs.

Lab. tests carried out by the BSERI since 1986, however, show that a loading rate of 18-20 kg COD/m^3 x day is possible for 2 stage systems and fixed filter. Compared with results from full-scale plants operated on distillery waste water, this is a much more realistic figure than what was actually gained in the pilot tests.

5. The Full-scale Plant

As the full-scale plant is going to be a demonstration project, the Chinese counterpart wants to implement the most suitable technology for the actual substrate and operational situation. He also stresses that the operation must be very reliable and that no circumstances which can be foreseen such as varying waste water flow and COD load, cut off power supply etc. may cause a serious process problem.

Besides waste water the distillery produce a considerable amount of organic solid waste. This waste has a very high content of cellulosis and therefore the digestability is very low.

Tests in laboratory carried out by BSERI show a gas production of app. 0.05 m3/kg of solid waste added to the digestion with retention time of app. 2 months.

Discussions with the Chinese counterpart concerning possible methods of disposing the solid waste conclude that biological digestion of the solid residue after a pretreatment to dissolve digestible solids is not to be carried out in this project.

The Chinese counterpart and the contractor must discuss furtner the possibility of drying and burning the solid residue in the coal fired heating system of the distillery of other disposal methods.

The actual substrate to be treated will consist of waste water from the distillery and the dissolution from pretreatment of solid waste.

In appendix III the results of lab. tests at BSERI are shown.

Besides the digestion the full-scale plant must comprise a pretreatment of the solid waste to extract the digestible organics. Furthermore, the solids must be disposed e.g. by dewatering, drying, and burning.

Taking into consideration that the waste water is very digestible and in fact could be treated in advanced systems such as UASB but on the other hand thay it must be a very reliable process, I will recommend the anaerobic fixed filter.

A fixed filter is a high rate digester, which can be exposed to varying in process parameters without causing a break down. E.g. the temperature and the flow can be varied, and you are even able to close it down for a period without causing problems as long as anaerobic conditions are kept in the tank.

However, to me it seems to be of great importance that the two parties agree upon the choice of technology for the full-scale plant, as both parts have to be confident with the actual technology.

6. Terms of Reference/Contract

In the following, I try to give a description which will amend the TOR and /or the contract to straighten out responsibilities in such a way that both subcontractor and Chinese counterpart know exactly what is required.

1. The German contractor is responsible for the detailed design carried out both by his own staff and by the Chinese counterpart.

   The two parties have to agree upon the overall design of the plant and work together in Germany in such a way that the final work, detailing the plant, can be carried out partly in China and partly in Germany according to an agreement about how to divide the work.

   As the contractor is responsible for the detailed designing, the Chinese team has to provide the contractor with all necessary details and calculations of their work at the end of the detailed design phase.

2. The plant is to be erected by local entrepreneurs and the Chinese team is responsible for building the plant and installing the equipment.

In this part of the project, the German contractor is only acting as supplier of the equipment to be imported. The contractor is responsible only for the quality and the function of the equipment supplied.

The contractor is supervising the work of construction and installation of equipment to ensure that the work is carried out as described in the detailed design.

If changes in the project is necessary, the Chinese counterpart must have a signed confirmation by the contractor before changing the plant.

If the German subcontractor, during his supervision, finds that the plant is not carried out as described, he must react immediately by contacting both the Chinese counterpart and UNIDO.

3. Responsibilities for the operation and performances of the plant must be divided between the two parties in such a way that failures and performances not keeping up to the guarantee agreed upon by the two parties, is related to the part responsible for the part which failed.

   Problems which are caused by a design failure, are the responsibility of the contractor, and he shall, if possible, improve the operation of the plant.

   If obstacles or problems arise, caused by the construction and installation work, the contractor is only to be made responsible for these if they are caused by failures or bad performances of equipment delivered by the contractor.

   Problems of this kind must result in an immediate action by the contractor to improve the plant.

   Only the Chinese team will be responsible for running the plant. The contractor is obliged to supervise the Chinese team and to work out operation manual and routine together with the Chinese team during the training in Europe.

   In the contract (or in the guarantee) a third part must be defined to decide in case of disagreements between the parties concerning responsibilities and performances.

4. As guarantee of plant performances is a very important issue, the TOR/contract must outline the main content of the guarantee such as

   - what is to be guaranteed
   - what are the provisions for the guarantee
   - what happens if the guarantee is not fulfilled
   - in case of disagreements, who is the independent third part

This paper should also give the budget for the follow-up work and state who is responsible for this budget.

7. Activities for the two Parties

From my point of view, it is very important to describe the activities in the initial phase of the detailed design to avoid misunderstandings which may finally cause a delay of the project.

The activities must of course be worked out in close relation to responsibilities described above.

The description is related to the schedule of activities and timing in phase II of the project presented in Terms of Reference.

Before activity B1:

The Chinese counterpart is gathering all necessary information of importance for the detailed design, such as:

- legislation and standards
- site investigations comprising soil investigation for foundation, plan for interconnecting pipes, and outlet pipe
- drawings of a site plan showing existing buildings, if not submitted to the contractor already
- calculations of the amount of waste water from the distillery and from pretreatment of solid waste. Calculations must show both maximum flow per hour, day and the variation over the year.
- heat requirements for the distillery to be substituted by biogas. Variances for the day, week, and year.
- The attitude of the Chinese counterpart to technology, design parameters, and other relations which must be decided in B 1.

The contractor draws up a time and activity schedule for B 1 based on the activities described for B 1.

B 1:

The Chinese counterpart sends a team of experts to the contractor. In the team must be both technicians and decision-makers with the necessary knowledge of anaerobic digestion. During the visit in Europe, the general design must be worked out and agreed upon.

The following activities are included:

- the final discussion and decision concerning technology and lay out for the plant
- drawing up of flow diagram in principle
- dimensioning of all components in the plant such as volume of tanks, flow rate, and effect of pumps.
- drawing up of site plan for the actual plant showing position of all major components.
- overall description of the control system for the plant
- description of the working routine for operational staff
- agreement of who is going to do the detailed design of what
- drawing up of a list of drawings to be worked out by each of the two parties in B 2
- agreement upon standard of drawings and specifications
- agreement of exact position and dimension of all interconnection pipelines
- all necessary information concerning technical performances and cost of equipment produced in China to draw up a draft paper describing the equipment to be imported, and the equipment supplied by the Chinese counterpart.

B 2:

The final detailed design is worked out. All necessary permission to establish and run the plant is provided by the Chinese counterpart.

The activities of the contractor include:

- work out of drawings according to list drawn up in B 1.
- specifications of all components in the part of the plant detailed by the contractor

The activities of the Chinese counterpart include:

- work out of drawings according to list drawn up in B 1.
- specifications for all components and constructions in the part of the plant detailed by the Chinese team.
- providing all necessary permission to establish and run the plant.

At the end of B 2, the contractor must go through all drawings and specifications together with the Chinese counterpart to ensure that the work of the two parties fit perfect together.

The draft description of equipment delivery is reviewed and finally confirmed by the two parties.

Also at the end of B 2 a detailed time schedule for construction of the plant is worked out and agreed upon.

B 3:

All material and equipment are ordered by the two parties to be delivered according to the time schedule agreed upon.

B 4:

The operational staff goes to Europe for training.

The Chinese engineers must during the training have experience with the operation of the actual type of plant by means of a stay at a similar plant together with the operational staff of the plant and personnel of the contractor.

During the stay, a detailed operational manual is worked out describing all activities and routines for daily, weekly, and monthly work to run the plant.

This manual must also describe service and maintenance to be carried out preventing operational problems, and a list of necessary spare parts.

Together with the progress report no. 2, the contractor draws up a schedule for the supervision of the construction and installation of equipment in accordance with the time schedule worked out in B 2.

8. Comments to TOR Made by the Chinese Counterpart

All the comments made by the Chinese counterpart are expressed below to reflect the general attitude of the Chinese counterpart despite the fact that some of them are of less importance or of no importance at all.

To 1.02 and 1.03, 2.04, and 2.05:

To strengthen BSERI and to enable BSERI to carry out future projects, a test laboratory and pilot installation are needed.

The test facility in Daxing is more or less useless, but BSERI does not know exactly which type of equipment to install for a test station.

To 3.01:

Yes, the tests were carried out but the results were very poor, and the preliminary design based on these tests is not qualified.

Furthermore, figures for solid waste from the distillery are not 70 tons/day as given in the last progress report but app. 30 tons/day.

To 4.03.3

Table 1 should give a more detailed description of the activities B1-B4. The Chinese counterpart fear that they have to do all design work themselves. This fear is based on experience that they have gained in phase I.

Table II should be discussed and agreed upon during the training visit in Europe.

To 4.03.4:

Power generation is out of the question, as biogas can be used for heat production at the distillery. And the Chinese counterpart do not wish to introduce more complicated equipment than absolutely necessary.

The Chinese counterpart is not confident with neither the contractor's work nor with the technology to be employed for pretreatment and digestion, and he fears that decisions have to be made where he needs qualified helpfrom UNIDO concerning technology .

To 4.03.6:

Approval of the detailed design by UNIDO and Chinese authorities should be given before ordering and construction work is started.

1-2 months should be put in the time schedule for the approval and for the final discussion and decision of which equipment to be imported. As the contractor probably does not know which machinery and equipment are available in China, the Chinese counterpart must agree upon the specification.

To 4.04.1:

The most important activities in Europe are not generation of fabrication and construction drawings, but working out in cooperation the general design and dimensioning of machinery and equipment according to list of activities in chapter 7 above.

The main plan, Table 2, does not assign responsibilities as said in TOR.

To 4.03.3:

To the second line should be added, ...responsible for "the detailed design and therefore also for:"

To 4.04.4:

"The travel and subsistence costs of the Chinese trainees will be borne by UNIDO". The same should be defined for the design team going to Europe.

To 4.06.1:

A visit to China before the design team goes to Europe, is not needed. The discussion of TOR can take place in Europe.

The contractor should submit a plan of the time to be used for the specified activities in Table 1.

To 4.08.1:

The chinese counterpart wants UNIDO to approve the general design reported in "Progress report no. 1".

To Table 1:

According to the comment above and the reported discussions of activities from B1-B4, the Table 1 should be revised as follows:

Step no.	Month no.	Activity
B 1a	0-1.5	General design
B 1b	2	Approval by UNIDO
B 2a	3-5.5	Detailed design carried out partly in China and partly in Germany
B 2b	6	Approval by Chinese authorities and UNIDO
B 3	7-8	Ordering
B 4	7	Training in operation
B 5	8-14	Construction of the plant

The time for the construction works, 7 months, is sufficient if the work gets started in June of July. If it is started later than July, problems keeping up to the time schedule will occur.

9. Discussions concerning Test Facilities

To enable BSERI to carry out future projects without technical assistance, they certainly need both lab. equipment and a more operational pilot facility.

During our discussions, they claimed that a very advanced digester system working sterile and computer controlled was what they needed. The system like the one they asked for is used by industries and few private laboratories for fundamental research such as bacteria screening and growth.

To give the Chinese team the necessary knowledge of which tests are carried out and the build up of test facilities; I think they should pay a visit to one or two test laboratories in Europe during their stay.

I could also suggest a visit to a pilot plant in Munich treating solid waste with high cellulosis content.

For design of the test facility, I suggest the following:

1. The Chinese team visit Munich and i.e. one or two test facilities in Europe (Copenhagen)

2. The Chinese counterpart prepares a draft plan for the test facility.

3. The plan is discussed and evaluated by a UNIDO consultant.

4. The Chinese counterpart and UNIDO agree upon the plan, time schedule, and budget for the project.

Namecards:

Middle pt Beijing Standard (u) 8/4

The Planning Committee of Beijing People's Government,
Director of Science, Education,
Culture and Health Dept

ZHONG JIA LU

Engineer

Vice—Chairman, Society of Architerture,
Chinese Medical Association, Beijing Branch
Vice—Chairman of The Beijing Hospital
Waste Water Treatment Association

No.2 Zheng yi Road — Tel. 5121133—2005
Beijing China — 540776—2205

Mr. Zhong is from Beijing Municipality. He is project manager for Beijing Municipality and the real decision-maker. He attended all meetings and discussions during my stay.

Mr. Zhong is on the team which is going to Europe for detailed design.

The Academy of Science And Technology
of Beijing Chief Engineer
Beijing Municipal People's Government
Professional Adviser

HU YOUDAO

Senior Engineer

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Telex, 22555 BCDST CN

Mr. Hu is the manager of the project. He has been involved in phase 1 and been to Europe for training in this phase.

Midday pü Beijing Stad duck 8/6

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Mr. Jiang is the director of BSERI and the one having the responsibilities for process issues in connection with the project.

Beijing Solar Energy Research Institute
Biomass Energy Department

HE SHAO QI Director
Engineer

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Mrs. He is the head of BSERI's department for anaerobic digestion. She speaks English very well and knows much about biogas. She is on the team going to Europe for detailed design.

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LU WEI
Engineer

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Mr. Ku is a BSERI staff working with anaerobic digestion. He has been involved in phase I.

Middag p? Beijing Steakdack 8/9.

Deputy president, Beijing Hospital Wastewater & Solid Wastes Treatment & Disposal Association

Vice Chairman, Water Supply and Sewage Discipline commission of Beijing Institute of Civil Engineering & Architecture

Member, Consultative Committee of Hospital Sewage Disposal of Public Health Ministry

Senior Engineer

Xiao Zhenghui

Mr. Xiao is representing the institute which takes care of the technical design. He is the one designing the pilot test plant in Daxing. He is on the team going to Europe for detailed design. He attended all discussions during my stay.

Middag p? Beijing Steakdack 8/9

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Mr. Meng attended some meetings but he never took active part in the meetings. He was once assisted by Mrs. Yang.

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Mr. Yao a MOFERT programme officer, participated together with an assistant in the first meeting in Daxing.

The People's Government of DaXing County,
Beijing Municipality.

County magistrate
LIU ZHEN SHAN

Add, Huang Cun Beijing
Tel, 350175-326
308

Mr. Lin hosted the dinner in Daxing after our meeting there.

Evaluation of Technology for Daxing Distillery Waste Water Treatment Plant

The evaluation of the background for the full-scale plant and of the most suitable technology for this plant is based on discussions with the Chinese counterpart concerning pilot test in phase 1 of the project, the worldwide development in the field of industrial waste water treatment and the actual situation at Daxing distillery. Also a visit to the distillery and the pilot test plant is a part of the background.

1. Evaluation of "Phase 1", Design and Results

In phase 1, 5 different types of digester design were tested on the Daxing Distillery waste water.

Designing the digesters and the necessary installations such as heating system, recirculation of waste water and sludge, insufficient attention was paid to the importance of having very stable and comparable operation conditions in such a test.

During the tests technical problems appeared for all digesters.

To optimize and compare the results, changes in both design and operation routine were necessary after the start-up-period.

However, no or absolutely insufficient changes were carried out.

The Chinese counterpart carried out tests for app. 1.5 years according to instructions from the German contractor. All results and data were reported monthly to the contractor.

The results are presented in the 5th Progress Report by the contractor.

Because of failures in design and insufficient follow-up, the results from this period of 1.5 years are not comparable for any of the 5 digesters neither to the other digesters in the test nor the results from similar waste water treatment plants.

The contractor concluded in his progress report that gas production of 500 l per kg COD reduced is the main result of the test.

The tests should however have shown the optimum loading rate, COD reduction rate and gas production as these figures are the ones to use in the comparison of digester designs.

So the output of phase 1 is the analysis of the waste water and the knowledge that the actual waste water is very digestible.

2. Substrate to Be Treated in Full-scale Plant

Besides waste water the distillery produce a considerable amount of organic solid waste. This waste has a very high content of cellulosis, and therefore the digestability is very low.

Tests in laboratory carried out by BSERI show a gas production of app 0.05 m3/kg of solid waste added to the digestion with retention time of app. 2 months.

Discussions with the Chinese counterpart concerning possible methods of disposing the solid waste conclude that biological digestion of the solid residue after a pretreatment to dissolve digestible solids is not to be carried out in this project.

The Chinese counterpart and the contractor must discuss further the possibility of drying and burning the solid residue in coal fired heating system of the distillery of other disposal methods.

The actual substrate to be treated will consist of waste water from the distillery and the dissolution from pretreatment of solid waste.

3. Full-scale Demonstration Plant

The Chinese counterpart stresses that the plant must be based on the most suitable technology for the actual substrate and site. He also stresses that the operation of the plant must be very reliable as a very big attention is paid to this demonstration plant and failures in design and operation must by any cause be avoided.

Concerning actual technology the Chinese counterpart wishes to introduce advanced technology to improve the possibilities for a lift in development within this field in China.

For the actual substrate you can base the full-scale plant on a mixed digester, an activated sludge digester or a fixed filter. You might even consider using more advanced technology, but this must be based on fundamental knowledge and tests in laboratory and pilot scale.

For the actual substrate a fixed filter is considered the most advanced technology and the final discussion between the contractor and the Chinese counterpart should be founded on this technology.

Design parameters for the plant should be agreed upon by both parts and the waste water outlet from the treatment plant must keep the standards defined in legislation concerning nutrients, suspended solids, heavy metal a.o. In the design work both parts must be aware of other legislation, which might influence design parameters or constructions.

The full-scale plant should comprise:

- interconnecting pipings
- transport system for solid material
- pretreatment of solid separation to minimize the amount of suspended solid in the substrate.
- solid-liquid separation to minimize the substrate and if necessary after treatment to keep standards.
- treatment of solid residue (i.e. drying and burning).
- anaerobic fixed filter to treat the substrate and if necessary after treatment to keep standards.
- buffer storage tanks for waste water.
- gas storage to adjust gas production to the needs of the distillery.
- boiler station to produce heat for the distillery.
- all necessary equipment, installations, and control system to ensure a reliable operation.

Content and Property of Raw Material

	Waste water	Distillery	Elution (2:1)
Ts %	2.1 - 4.3	40	3.1
VS %	1.6 - 3.7	34	2.4
COD (g/l)	30 - 55		36 - 52
BOD_5 (g/l)	20 - 36		22 - 31
N (mg/l)	500 - 700	1.8%	1160 - 1235
P (mg/l)	300 - 550		580 - 700
C (%)		45	
Cellulose (%)		45	
Saccharide (%)		7.1	
Starch (%)		3.5	
Gas production potential	226mlCH_4/gCOD	129mlCH_4/gTS	33omlCH_4/gCOD