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NATIONAL RESEARCH CENTRE

APPLIED SCIENCE AND TECHNOLOGY PROJECT
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Demonstration Subproject
(Academy of Scientific Research and Technology)

THE DEVELOPMENT AND APPLICATION OF BIOGAS TECHNOLOGY IN RURAL AREAS OF EGYPT

Eighth Progress Report (PR/8)
submitted to the JCC
by

Prof. Dr. M.M.El-Halwagi
Principal Investigator

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PROJECT TITLE

The Development and Application of Biogas Technology in Rural Areas of Egypt.

INTRODUCTION

This progress report covers the period from October 1982 to March 1983. Its basic purpose is to outline recent accomplishments as well as short-term future course of action. To have a rather self-sufficient document, complementary facets that have been covered in previous reports are also briefly presented. These include the project background, definition of the problem,goal and objectives, overall plans and past achievements. The last section of the report highlights the major conclusions and recommendations.

BACKGROUND

Renewable energy resurces, integrated rural development, food security, and pollution control are four priority areas in the National Research Centre (NRC) R & D program. Production of biogas through anaerobic digestion of farm wastes fits perfectly well within the framework of these four priority areas. After a preliminary preparation period, the NRC submitted to the Academy of Scientific Research and Technology (ASRT) a proposal for a multi-faceted, multidisciplinary R & D and demonstration project for the development and application of biogas technology in rural areas of Egypt. The ASRT approved the concept, and presented the proposal in the October 1978 JCC meeting whereby it was approved. A joint Egyptian - U.S. Panel was formed to elaborate a project design. As a result, a final project proposal was agreed upon, was submitted to the March 1979 JCC meeting and was given a full formal approval as a demonstration project.

PROBLEM

The burning of agricultural residues and dung cakes are estimated to provide about one half of the energy requirements of rural population. The open-fire type of devices used in this regard are quite inefficient and air polluting. Furthermore, the combustion of these biomass resources leads to a complete loss of their potential fertilization value if otherwise recycled to the land. In contrast, anaerobic digestion of these biomass residues and wastes would produce a clean gaseous fuel that would be utilized efficiently as an energy source, as well as a stabilized digested product that can be used as an excellent organic fertilizer. In addition, pollution and public health hazards associated with the handling and use of these residues and wastes are minimized to a great extent.

Though village-type biogas technology exhibited various degrees of success in such countries as China and India, there is no assurance of similar success if these technologies are applied in a different socio-economic environment. Rather, local endeavors are required to develop concurrently an adequate scientific and technical infrastructure, as well as the viable conditions that would ensure acceptance, adoption and propagation of appropriate technologies. The project was thus proposed to provide such requirements and so as to ensure logical and adequate sequence that can lay the foundation for subsequent viable implementation on the national scale.

GOAL AND OBJECTIVES

The goal of the project is to assess - through a comprehensi integrated and multidisciplinary R & D, technology transfer and field demonstration program - the feasibility of biogas technology for rural areas of Egypt.

Specific objectives include :

1- To carry through with a viable, creative and relatively successful village demonstration program,

2- To assess the biogas technology as a means for energy conservation, waste recycling, upgrading of soil fertility and pollution control, and

3- To propose - on the basis of the demonstration results and their evaluation - a logical national strategy and implementation program.

OVERALL PLANS AND PAST ACHIEVEMENTS

The overall plan encompasses the following major activities:

A- Fact Finding

* Study and assessment of potentially prospective technologies, and
* Survey the relevant socio-economic features of typical Egyptian villages.

B- Technology Demonstration

Transfer, adapt and develop appropriate village-type biogas technologies and demonstrate them in two types of villages representing the traditional and the new-planned villages.

C- Supportive Work

Carry out, through an interdisciplinary team, supportive research and development work and studies that are needed to accomplish program goals and thus the project objective.

D- Assessment of Feasibility

Evaluate the results of village demonstrations to assess socio-technico-economic feasibility.

As outlined in previous reports, the fact-finding phase has been finalized. Major portions of the R & D endeavours have been accomplished. Over the past two years, more emphasis has been placed on village demonstrations, being the central focus of the project. Family-size units have been first demonstrated in the NRC, then in Al-Manawat as a traditional village, followed by Omar Makram representing the new planned village. Both Indian and Chinese designs, as well as modifications introduced by the engineering team have been tested and successfully demonstrated.

RECENT ACCOMPLISHMENTS

In this section, achievements by the various groups over the report period are outlined with reference to plans.

1. Engineering group :

Planned work for this report period constituted further demonstration work, follow-up of operating digesters, and development work at the NRC extension site.

As to demonstration work, the team followed the recommendation of JCC evolving from the last meeting which emphasized the importance of demonstrating large-scale biogas digesters. A 50 cubic meter, tunnel-type digester was designed and constructed at Shubra Kass village near Tanta. It is attached to a poultry rearing operation typical of about 800 similar ones in the Shubra Kass area. The biogas project team provided, in full technical know-how and supervision, while VITA (Volunteers

In Technical Assistance) provided the actual costs. As of the time of preparing this report, the digester and its auxiliary systems are under start-up conditions. Preliminary tests indicated a leak proof liquid and gas system. Auxiliary components include a heating system for the digester contents as well as a gas-heating and lighting system for the chicks' rearing operation.

Follow-up of operating digesters involved three demonstration sites. The NRC extension area, Al-Manawat and Omar Makram villages. In these sites, 6 digesters are under continuous operation. All are technically viable, though two have floundered to a certain extent because of social or organizational issues. In this regard, the Chinese-type digester built at the Manawat village collective unit is still facing the problem of irregular feeding since nobody is willing to do that (apparently because it does not belong to anybody). The other case in point, is the Indian-type digester built at Omar Makram for two neighbouring families as a pilot-shared facility. Lack of cooperation (as we expected knowing the possessive characteristics of the Egyptian farmer) led to deliberate discontinuation of the digester operation. It took the team around two months to pacify the feud and get the two families back together with an agreement to do things in the spirit of matual cooperation. Yet it is early to arrive at any conclusions.

As to the technical performace data, regular monitoring is maintained. All the houses in Omar Makram have been provided with gas meters to keep a continuous record of gas consumption. Results are very much in agreement with those previously reported for the earlier units.

As to the development work that was supposed to take place at the NRC extension area, none was accomplished. The reason is that the biogas project has to move to another location since

the present location has to be allocated to the new Food Industries Pilot Plant. All the 3 biogas units established in that area are to be demolished, and we have to start from scratch once more. Nevertheless, a new plan has been made and the engineering group intends to start developing the site with much zeal and impetus with the experience we gained. We hope that within the coming year, a model demonstration and development site will be established.

2. Fertilizer Evaluation Group

The plans for this report period, as well as for the next 18 months, encompass :

(1) Field and green-house evaluation of accumulative/ residual effect of the digested slurry when used as organic fertilizer.

(2) Follow-up of the fermentation progress in the various operating demonstration digesters from the standpoint of potential ferilizing value.

Progress has been very close to plans. Work accomplished may be outlined as follows :

A) Field Experiments at Omar Makram : Three field experiments have been carried out at Omar Makram village to evaluate the accumulative/residual effect of the digesters slurry in comparison with farmyard manure and urea fertilizer. The fresh slurry was treated with silt, in the ratio of one to one, before, its incorporation into the soil. As first crops in this rotation, wheat was cultivated in one site and potatoes in the other one. The organic manures were added at the rates of 20 tons/feddan for wheat and 36 tons/feddan for potatoes. One farmer in the third site did not respond correctly to the recommeded design. The three sites will be put under different rotations using the same fertilization treatments.

1.2.

B) The Green House Experiment at the NRC : A green house controlled pot experiment using two types of soils representing the major groups of Egyptian soils were carried out. Wheat as a winter crop was cultivated in pots filled with 10 kg of clay or sand soils.

The fertilizer treatments were :

- Air dried biogas slurry,
- Slurry + silt,
- Composted slurry,
- Farmyard manure,
- Cow dung, and
- NPK

The organic manures were added 7 days before planting at the rate of 2% (20 ton/feddan) The NPK program was 200kg of urea and 100 kg of each of superphasphate and potassium sulphate/ feddan. Control with no fertilization was also included and all treatments were replicated four times.

Results of both field and green house experiments will be presented in the following reports.

3. Parasitology Group

Objectives for this report period, as well as for the remainder of the project time, included :

(1) Follow-up of operating village digester for the purpose of studying the effect of digestion on the viability of ova of parasitic worms and the protozoan oocysts that may be present.

(2) Conduct laboratory-controlled investigations to assess the effects of certain important variables and treatments. These include : temperature, time, disinfectants, and post-composting. The work is to be centered on

parasitic ova mainly ascarids, and protozoan oocysts, as well as pathogenic microorganisms, namely : Salmonella, Shigella and Clostridium spp.

Achievements, in general, have been quite close to plans. They may be summarized as follows :

A) Follow-up of field digesters

Key results may be outlined as follows :

1- Ascarid eggs were not existent in the samples obtained over this report period.

2- The anaerobic digestion process did not affect the viability of Eimeria oocysts under the prevailing operating conditions. The collected oocysts were subjected to sporulation for studying it infectivity.

3- Isolation and identification of the pathogenic micro-organisms showed that the presumptive strains of Salmonella spp. existed in the outlet slurry. The isolated strains were cultured for future identification by using the specific antisera.

4- No data were obtained on the isolation and identification of Clostridium spp. as the preparation of selective media and chemicals have only been accessible very recently.

B) Laboratory-controlled Investigations : These were confined to the assessment of the effects of time, temperature and disinfectants on the viability of ascarid eggs. Results indicated :

1- The temperature range 12-28°C has no effect on viablility. Temperatures outside this range are effective to various extents depending on the temperature level and retention time.

2- Cresol and phenol exhibited an ovicidal effect, but also a bactericidal effect as well.

4. The Pollution Control Group

The work of this group was confined to the follow-up of the occurence and survival rates of some entric micro-organisms in conjunction with the field demonstration digesters. Limitations were predominently caused by the inaccessibility of antigens and antisera, some of which have been recently procured.

Samples received from the different operating digesters were subjected to bacteriological examination. Results indicated very high percentage removal of total coliform, faecal coliform and faecal streptococci in the Indian-type digesters. In general percentage removal rates approaching 100% were realized. The Chinese-type digesters exhibited lower percentage removal rates, particularly for faecal streptococci which was in the range of 71 to 84%. This may be attributable to the existence of a certain degree of bypassing in the case of the Chinese design. More thorough examination of this aspect will be taken in the very near future.

In spite of the limited number of samples investigated, available data indicated the presence of Gram-negative non-lactose fermenting organisms, which are suspected to be of the Salmonellae group, in the digested slurry of both types of digesters (Indian as well as Chinese). This will be very thoroughly examined in the immediate future for positive verification.

5. The Fundamental Microbiology Group

The work of this group during this report period, centered on the assessment of immobilised trace metals for promoting anaerobic digesters of cow manure.

Three methods of immobilization were tried. Metal sulfides were immobilised in gelatin hardened (tanned) with formaldehyde. Gelatin was also hardened by glutaraldehyde. Several trials were done to obtain a suitable matrix that can withstand even mild shaking in the digester. None were successful. A trial was done using agar (2.5%) embedded in a sheet of open-cell polyurethane foam. A mixture of microelements soluble salts was included in the melted agar before embedding. This matrix proved to be mechnically suitable. The soluble salts were used to ensure diffusion-controlled release. The use of this device, however, did not show any appreciable effect on either the rate or the total yield of gas production. Further work will be pursued to elucidate this aspect.

6. The Biogas Central Services Laboratory

Phase I equipment were mostly installed in two adjacent laboratories prepared specifically for this purpose. The layouts of these two laboratories showing the placement of major pieces of equipment are depicted by Figure 1. The Biogas Central Services Laboratory constitute these two laboratories. They are fully staffed with trained personnel. Up till now, training was conducted locally. Plans include future advanced training of two laboratory supervisors in the U.S.A.

TRAINING

Training is proceeding according to plans. Two researchers from the pollution control and fertilizer evaluation groups received short-term training in the U.S.A. The project principal investigator attended a very important and relevant conference in U.S.A. During his trip, he met with the U.S.

panel members of the project. Progress and future plans were discussed at length. The idea of holding an international biogas technology conference in Egypt by the latter part of September 1984-which was proposed in the last progress report- was fully supported by the panel. Further collaborative actions in this regard will be taken in the near future. These will involve the project team members, the members of the U.S. panel, the ASRT, the NRC, the National Academy of Sciences and possibly some international organizations.

FUTURE COURSE OF ACTION

Over the coming six months, emphasis will be on the following activities :

1- Prepararion of the new biogas project site at the NRC extension area as a permanent center for development work, demonstration and training.

2- Completion of the installation and testing of all the ancillary facilities of the recently constructed 50 cu.m. unit at Shubra Kass. Its steady-state operation will be thoroughly monitored in order to assess its actual performance.

3- Continuation of the follow-up of all operating demonstration digesters. Due regard will be given to the technical as well as the socio-economic factors. It is planned that, following the coming U.S.panel meeting with the biogas project team, a joint short-term sociological evaluation will be conducted with the help of Dr.H.Capener(who is one of the three U.S. panel members and professor of rural sociology). Another all-rounded technical evlauation is anticipated with the help of Dr.T.Prakasam, another member of the U.S.panel.

4- Continuation of the strengtheing of the biogas Central Services Laboratory capabilities, material and human-wise.

5- Continuation of the supporting research activities of the various groups very much along the same lines of work reported

for the past five months period. It is hoped, however, that more concrete findings and achievements will be established.

CONCLUSIONS AND RECOMMENDATIONS

1. The progress has been fairly close to plans.

2. The most recent large-scale field demonstration is believed to be a break-through, and it is hoped that its actual performance will confirm this expectation.

3. The technical performance of the family-size demonstration units was quite good.

Socio-economic impacts are in general favourable.

4. Special attention will be given to the development work aiming at alleviating certain shortcomings of the demonstrated systems. In particular, the low gas productivity during the cold winter season and the desirability of using agricultural residues to supplement the digesters feed materials, are two aspects that should be addressed.

5. In-depth reviews of the techno-socio-economic viability of the prospective biogas technologies under the range of prevailing conditions in rural areas of Egypt will be augmented. The purpose is to approach the final goal of the project in assessing feasibilities and defining the prospective viability limits and requirements.

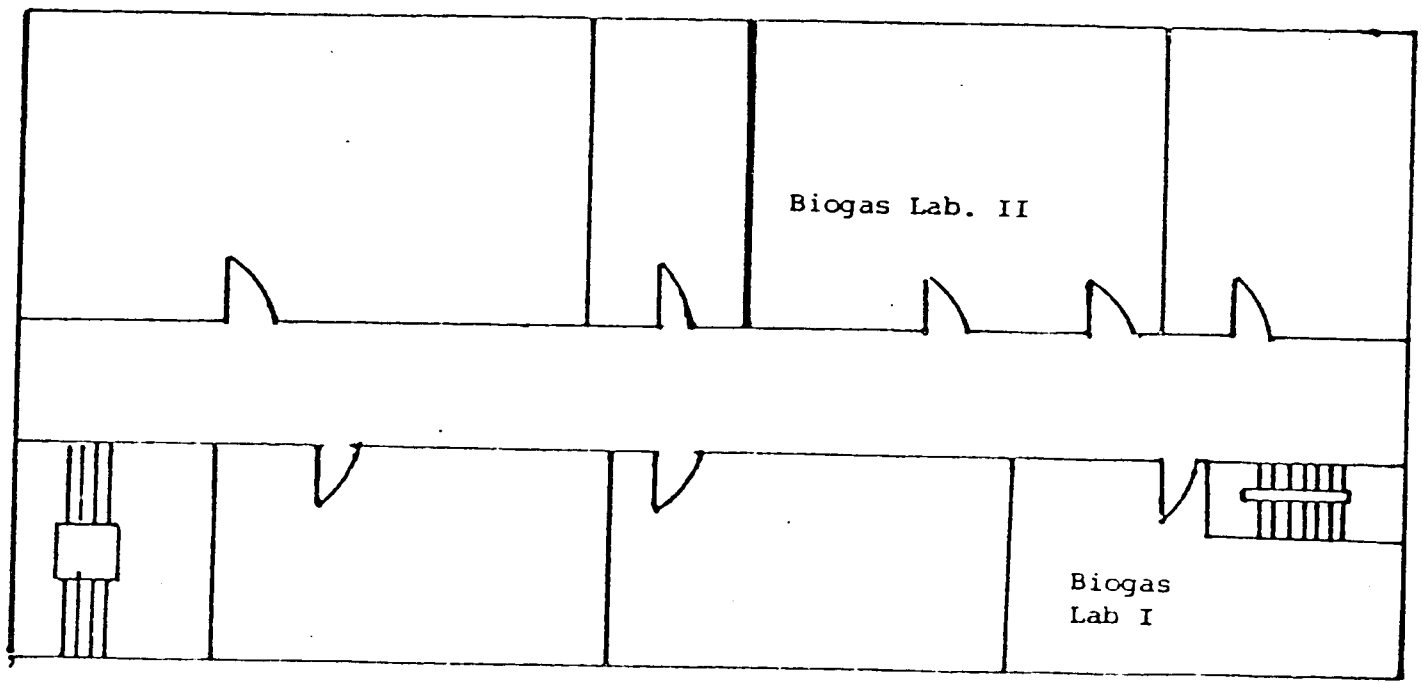

Fig. (1A) - The Location of two biogas central services laboratories in the upper floor of the Pilot Plant Laboratory, NRC

Scale 1 : 200

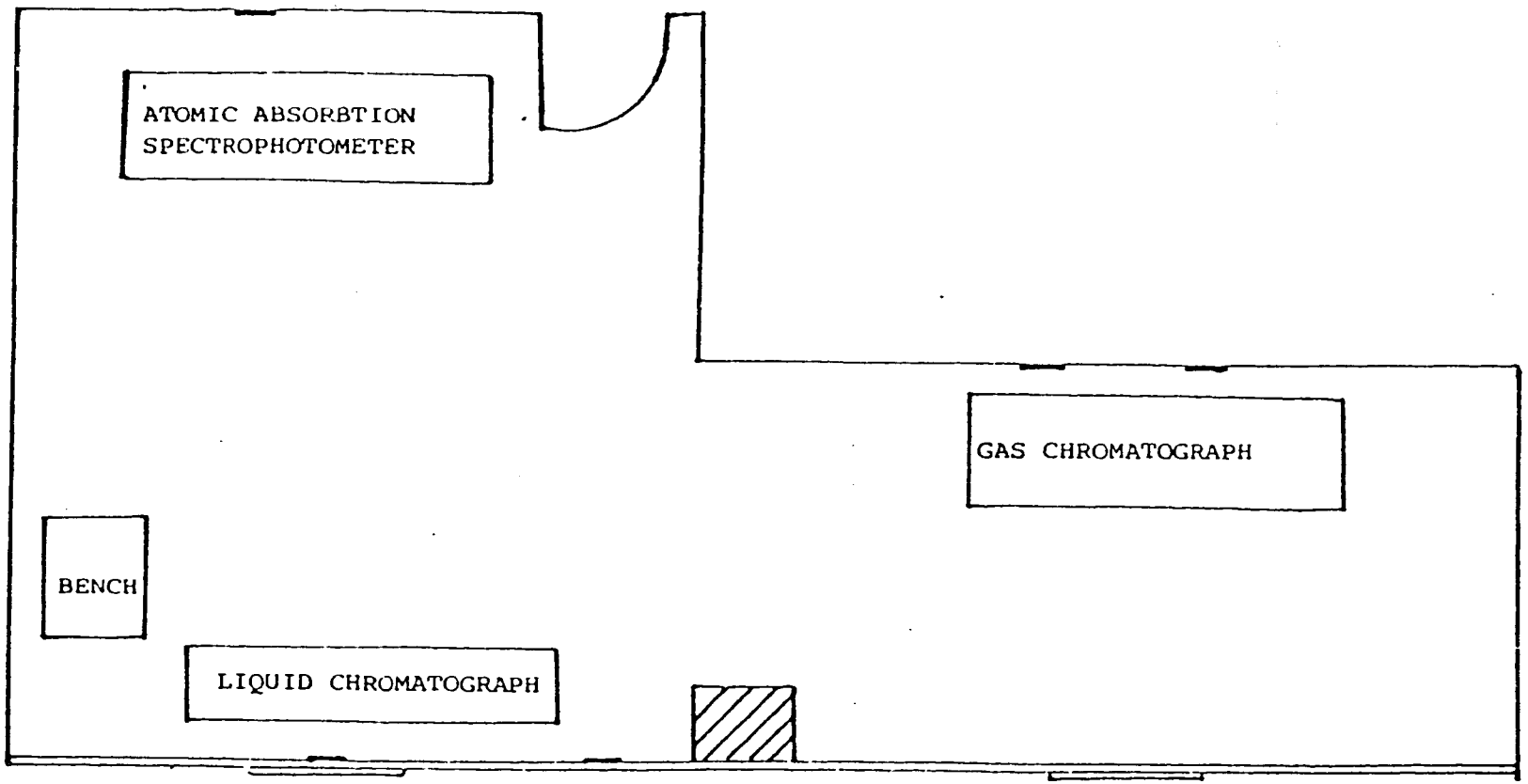

Fig. (1B) - Layout of Biogas Central Services Lab. I

Scale 2 cm = 1 meter (1:50)

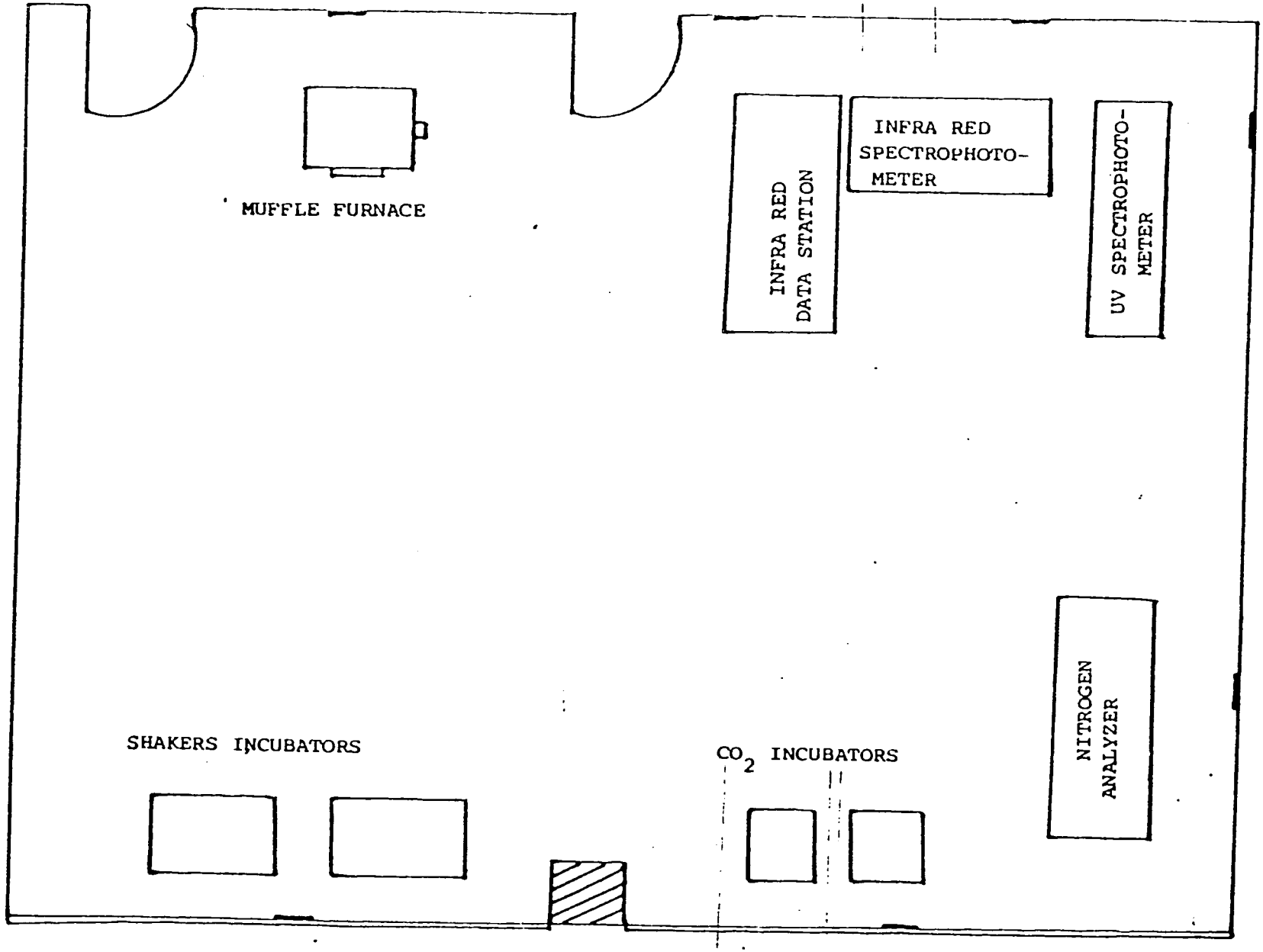

FIG. (1C) - Layout of Biogas Central Services Lab. II

Scale 2 cm = 1 meter (1:50)