RT OF THE FIRST MEETING
OF
SULABH TECHNICAL ADVISORY GROUP
(APRIL 8-9, 1985)

**SULABH INSTITUTE
OF
TECHNICAL RESEARCH
AND
DEVELOPMENT
(SULABH INTERNATIONAL)
PATNA
INDIA**

REPORT OF THE FIRST MEETING OF SULABH TECHNICAL ADVISORY GROUP (APRIL 8-9, 1985)

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Introduction

The first meeting of the Sulabh Technical Advisory Group (STAG) was held on April 8-9, 1985 at Patna. It was a great pleasure to have a number of distinguished experts and almost all the STAG members in the meeting, scientists, engineers and other officers of the Sulabh Institute of Technical Research and Development (SITRD) and of the Sulabh International participated in the deliberations.

However, before describing the proceedings of the meeting, some background information about the endeavours of the Sulabh International, particularly SITRD and about the ongoing project of Sulabh Urja generation seems to be desirable.

The Sulabh International is involved in the areas of eco-development, low cost sanitation, bioenergy, pollution studies, social engineering and related aspects. The programmes include implementation of innovative design and management concepts, operation and maintenance of these systems and finally, man-power training for diffusion of the technology and the ideas. It has successfully designed a low cost water-seal pour flush pit privy known as 'Sulabh Shauchalaya'. Similarly, its endeavours have revolutionised the concepts of design, operation and maintenance of public conveniences in this country by evolving a practical, economically viable and efficient management system. Then Sulabh has gone a step ahead with the application of biogas technology for obtaining bioenergy (called 'Sulabh Urja') from the wastes of such public toilet complexes. On the social front the organisation is committed to the liberation and rehabilitation of the scavengers by converting the existing bucket privies into Sulabh Shauchalayas.

In the process of 'Sulabh Urja' generation, the human excreta from the Sulabh public toilet complex is channelled through covered drains into the inlet of the biogas plant where it is subjected to anaerobic digestion. The digester has been built underground with fixed dome and is oval shaped. Its capacity is 57 cubic meters biogas per day. A floating mild steel gas holder has been provided which acts as the gas storage space in addition to the space inside the fixed dome and also helps to regulate the pressure of the biogas when it is fed into the prime mover of the dual fuel genset. Before going into the floating gas holder, the biogas is passed through a slurry trap (for preventing any slurry which might accidentally find its way into the pipe line) and a copper foil scrubber (for removing the foul smelling and corrosive hydrogen sulphide gas from biogas). From the floating holder, the biogas is piped into the engine room and fed into dual fuel (diesel plus biogas) internal combustion engines coupled with alternators for generation of electricity which is used for street lighting.

Report and Recommendations

Mr. B.N. Ojha was in the chair. After the participants had introduced themselves and the agenda was placed before the meeting, Mr. Bindeshwar Pathak requested the gathering to suggest names of more experts in relevant areas who might be prospective STAG members. Twelve names were proposed in this connection (Appendix-III).

The meeting was divided into four sessions of two sittings each (Appendix-I), the description of which follows from the next page.

(A) General Topics of Biogas Technology

The technical discussions started with a brief description of the work being carried on by SITRD and the problems encountered so far. The biogas plant has been functioning continuously for the last three years, the problems faced being:—

(i) Occasional choking of the biogas plant (inlet, outlet and gas pipeline) and

(ii) Objectionable smell in the biogas, presumably of hydrogen sulphide.

As mentioned earlier, a slurry trap has been designed and it is functioning satisfactorily. For removal of hydrogen sulphide, a scrubber packed with copper foil has been provided, but it is too costly.

The salient points discussed in this session were — the role of stirring (mixing) of the digester contents, composition of the biogas, effect of temperature and pH, destruction of pathogens during anaerobic digestion, scrubbing of hydrogen sulphide and carbon dioxide present in the biogas etc. The first and the last named evoked much interest among the members and were discussed at length.

Churning arrangement has not so far been provided at any stage in the Sulabh biogas plant under deliberation. The excreta flows into the digester under gravity, carried by the water used for ablution, flushing and occasional cleaning. Opinion was divided among members regarding the desirability and extent of stirring and the position of the stirrer (mixing device). Some members felt that stirring was essential for efficient performance of the digester and that the biogas composition in this case showed a rather low percentage of methane gas (63%) possibly due to lack of sufficient stirring. The stirrer, according to them, should be positioned within the digester. Some of them opined that vigorous mixing was not needed but slow stirring, may be with the help of a screw pump, would certainly help. A few members, however, thought that in the continuous operation mode in the relatively small (in comparison to large batch digesters of sewage treatment plants) biogas plants, there was sufficient mixing caused by the feeding operation as well as displacement of slurry to bring about enough food-microbe contact. In this case a mechanical stirring device inside the digester would disturb the hydraulic retention time, so that it would be more desirable to mix the feed material thoroughly prior to its entry into the inlet chamber of the biogas plant.

Regarding the foul smell in the biogas, a member expressed his opinion that possibly the smell is predominantly due to hydrogen sulphide, but presence of some other volatile organic compounds (mercaptans, phosphorus compounds etc.) can not be ruled out. There was a lively discussion about the corrosive effects of hydrogen sulphide on internal combustion engines, where it is oxidised on combustion and ultimately converted into acids. Obviously, its elimination is desirable on grounds of the overall acceptability of the biogas and longevity of the gas pipeline and the engine. It was, however contended by one member that diesel oil also has sulphur whose fate on combustion is the same as that of hydrogen sulphide. To counter this the engine oil for diesel engines contains special detergent additives which should also be able to take care of the small percentage of hydrogen sulphide (about 0.32%). It was suggested that instead of copper foil, iron oxide or sodium carbonate may be used for scrubbing hydrogen sulphide. Some members felt that the carbon dioxide may also be removed for improving the calorific value of the biogas and to decrease the requirement of gas storage space.

(B) Design Aspects of biogas plant

In this session, the optimum design criteria for human excreta fed biogas plant was discussed in detail. It was felt that so far most of the information and data available on design aspects, was for cow dung fed biogas plants. Reported data on human excreta fed biogas plant is scanty. The members also felt that design considerations have largely been empirical rather than based on detailed scientific study.

The design aspects of anaerobic sewage sludge digesters and modern international trends were discussed. However, it was felt that for the smaller size biogas plants with a continuous mode of operation, some variations from the above might be more useful. Members were of the general opinion that the digester should be designed after considering all the important points such as the process mechanism from chemical, biochemical and microbiological view points, composition of the feed material, environmental conditions inside and outside the digester, materials for construction, economic considerations for construction and operation etc.

The diameter-height ratio of the digester was discussed extensively. It was suggested that depending upon the varying soil and ambient temperature conditions, the diameter to height ratio may vary from 1:1 to 1:2.5. It was reckoned that for smaller sizes, 1:1 ratio should be more suitable whereas for larger sizes, it could preferably be between 1:1.5 to 1:2.

Then the discussions turned to the inlet and the outlet of the biogas plant. It was decided that for upto 30-seated toilet complex, the diameter of the inlet pipe should be about 30 cm. if built of cement concrete and 25 cm. if built of plastics. An angle of 55° with vertical direction was suggested for the inlet pipe. The outlet opening could be rectangular of about 60 cm × 60 cm size. Since the middle 1/3rd portion (vertically) is the most active zone in the digester, it is highly desirable to have the inlet at the bottom of this zone. A free board of 30 cm. was thought to be necessary.

While discussing the digester shape, the prospects of egg-shaped digester was also considered. This type has recently been built in the U.S.A. and Europe. The members felt that although this was an interesting development, there would be certain problems if this design is adopted for constructing underground biogas plants, especially due to the buoyancy effect of ground water level. The RCC digester suggested by the Sulabh has the advantages of the egg-shaped digester without the adverse effect of buoyancy.

Regarding materials of construction to be used, it was felt that different types of materials should be tried keeping in view the important practical considerations, namely, cost of construction, durability, availability, corrosion etc. Some of the materials suggested were—reinforced brick work, reinforced cement concrete, ferro-cement, FRP (fibreglass reinforced plastic), high density polythene, steel etc. — to be used either alone or as composite material. Surface coatings for preventing corrosion were also discussed. It was also decided to compare the cost and the economics of a steel dome vis-a-vis an RCC dome.

Finally, a sub-committee was formed to finalise the design of the digester (Appendix-V).

A suggestion was made for installing solar water heater at Adalatganj biogas plant cum public toilet complex for providing warm water to the toilet users during winter. Besides the comfort of the users, this arrangement would increase the temperature of the feed slightly, thereby increasing the production of biogas, especially during cold spells.

(C) Pollution and Environmental Aspects

The main theme of deliberation during this session was the pollution and environmental aspects connected with human excreta disposal. As outlined in the introduction, the Sulabh is presently interested in two modes of excreta disposal:

(i) Low cost hand flush water-seal sanitary latrine provided with twin leaching pits (for individual households) and

(ii) public toilet facility linked with human excreta fed biogas plant for disposal of excreta as well as generation of energy.

Members discussed about the pollution caused by the pathogenic load of human excreta which, if not treated properly, could contaminate surface and ground water and surface soil. Some surveys of old public latrines have been carried out by the UNDP and some studies have been made in the U.S.A. However, information regarding the survival of various pathogens and parasitic ova in different soils under different temperature conditions is not adequate yet. It was felt that an in-depth study backed by extensive monitoring work was required to establish the actual course of natural regeneration and destruction of pathogens. A detailed programme has to be chalked out starting with baseline monitoring studies including incidence of water borne diseases, in areas not having Sulabh Shauchalaya and preferably without faecal contamination, followed by construction of Sulabh Shauchalayas and Sulabh public toilets with biogas plant. Continued monitoring in the same area would show the difference, if any, depending upon the efficacy of the disposal method.

It was pointed out that uptil now most of the analyses were carried on by the MPN (most probable number) count method and that it would be highly desirable to use more reliable methods like the isotope tracer technique. Help in this connection could be obtained from the BARC (Bhabha Atomic Research Centre).

The performance of leaching pits was the next subject of discussion. Experiments at the CBRI (Central Building Research Institute), Roorkee, has shown that the leaching efficiency of the pits (bottom not sealed) having honey combed sides and those having continuous brick work did not differ much. The nature of the soil at the bottom of the pit was found to be much more important in influencing the leaching efficiency. The necessity of more field study was felt especially because most of the work in this area was concerned so far with the soakage pit of septic tank where 6-7 times more water is used and the function is also somewhat different. The study should be on long term basis to give an insight into the long term behaviour of the leaching pits with respect to leaching, digestion, solid storage, surcharging effect, destruction of pathogens etc.

Then the discussions veered round to the digestion and treatment through biogas plant. The members approved the Sulabh method of collecting the digested slurry in a large slurry pit built of masonry structure and their plan of building another slurry pit to make the alternate storage and drying of slurry possible. It was agreed that the effluent should be tested for pathogens before final discharge and some post-digestion treatment might be necessary in certain cases. The oxidation pond was suggested as one such measure, but it was also felt that in urban areas where the Sulabh public toilets are located, it will not be possible to acquire sufficient land for the purpose.

The following tentative programme of action in this connection was drawn up:

(i) Study of pollution in different environmental conditions like soil type, temperature, population density etc.

(ii) Careful selection of areas to obviate complications from other sources of pollution.

(iii) Some rural and some tribal areas should also be selected.

(iv) In every case, the study and monitoring should be started before construction of Sulabh Shauchalaya/Sulabh public toilet facility with biogas plant.

For consolidating this work, a sub-committee was formed (Appendix-VI).

D. Non-conventional Energy

The main theme of discussion was how to make non-conventional energy a viable alternative in a meaningful way especially for the rural and slum areas. For villages which are mostly located in remote areas or do not have adequate transportation facility, the decentralised energy generation systems should be more convenient and economic because for such cases, the distribution cost often outweights the generation cost. At the same time attempts should be made to tap all possible energy sources like biogas, solar energy, wind energy, energy plantation etc., so that the village may become self-sufficient in energy generation.

Biogas was identified as a priority source that could have very good potential in rural areas which has no dearth of organic waste materials like animal dung, agricultural wastes, water hyacinth etc. It was, however, felt that generation of biogas from human excreta may not be an attractive proposition at present due to psychological inhibitions about its use. The members agreed to a suggestion that a very pragmatic approach would be to try to set up dairy farms in villages which could supply plenty of cattle dung. All other available organic waste materials should be checked for their suitability for anaerobic digestion and biogas production. The most useful service to the villagers, especially to the women folk, would be to provide them with adequate cooking fuel. Biogas may play the most important role in this, but at the same time, the members felt that distribution cost may be a big deterrent due to the high capital investment in laying the gas pipeline. It was decided that techno-economic aspects of biogas distribution should be worked out with metal and HDPE pipeline. It was also felt that improvement in dual fuel (biogas plus diesel) engines to bring down the diesel consumption would be a good incentive for the villagers to use dual fuel prime movers either for agricultural/cottage industry purposes or even for electricity generation.

Some members urged the Sulabh International to select a few sample villages and regularised slums for an integrated energy planning combined with low-cost sanitation facility. In this connection, a few Calcutta slums (with the help of the CMDA), Delhi slums (with the help of the DDA & DMC), village Bawan (Distt. Hardoi, U.P.) etc. were suggested as prospective areas for the project implementation.

A sub-committee was constituted for pursuing this work (Appendix-V).

Before closing the 2-days meeting, Mr. Bindeshwar Pathak, Chairman, Sulabh International, thanked all the participants for their keen interest and valuable suggestions.

APPENDIX-I

AGENDA

1. Detailed discussion regarding optimisation and standardisation of human excreta fed biogas plant.
2. Scrubbing of undesirable components of biogas (e.g. hydrogen sulphide gas).
3. Microbiological studies.
4. Anti-corrosive and leak proof surface coating for digester, pipelines etc.
5. Methodology for studies regarding possibility of ground water pollution from Sulabh Shauchalaya and effluent slurry of biogas plant.
6. Economics of human excreta and water hyacinth fed biogas plants and
7. Adoption of sample villages for improved sanitation and integrated energy systems.

PROGRAMME

8.4.1985	Ist and 2nd sitting	General Topics of Biogas Technology
	3rd and 4th sitting	Design Aspects of Biogas Plant
9.4.1985	5th and 6th sitting	Pollution and Environmental Aspects
	7th and 8th sitting	Non-conventional Energy.

APPENDIX-II

The following persons attended the Technical Advisory Group meeting:

S.No.	Name
1.	Dr. K.P. GUPTA
2.	Mr. R.P. Gupta
3.	Mr. M.M. Hoda
4.	Mr. Jainarain
5.	Mr. M.N. Jain
6.	Dr. J. Jha
7.	Mr. S.N. Jha
8.	Mr. P.K. Mukherjee
9.	Prof. K.J. Nath
10.	Mr. B.N. Ojha
11.	Mr. B. Pathak
12.	Mr. J.N. Panday
13.	Dr. T. Prasad
14.	Mr. P. Ram
15.	Dr. B.P. Sinha
16.	Mr. L.K. Sinha
17.	Dr. S.P. Sinha
18.	Mr. K.K. Singh
19.	Mr. N. Verma

Scientists, engineers and other officers of the Sulabh Institute of Technical Research and Development and of the Sulabh International attended the meeting and participated in the discussions.

APPENDIX—III

PROPOSED STAG MEMBERS

1. Dr. S.D. Badrinath,
   National Environmental Engineering Research Institute,
   Nehru Marg,
   Nagpur-20.

2. Dr. Indira Chakravarty,
   Head, Deptt. of Biochemistry and Nutrition,
   All India Institute of Hygiene and Public Health,
   110, C.R. Avenue,
   Calcutta-73.

3. Prof. Mrs. T.R. Doctor,
   S.M.V. College of Science and Commerce,
   Bombay.

4. Prof. A.K. Dutta,
   B.E. College, Howrah,
   (At present Q.I.P. Fellow, I.I.T. Kanpur).

5. Dr. T.K. Ghose,
   Biochemical Engineering Research Centre,
   I.I.T.,
   New Delhi-110 016.

6. Dr. S.H. Godbole,
   Director,
   Maharashtra Association for Cultivation of Science,
   Pune-411 004.

7. Dr. G. Guruswamy,
   Professor of Public Health Engineering,
   Centre for Environmental Studies,
   College of Engineering,
   Anna University,
   Madras-600 025.

8. Mr. Arbind Pandeya,
   Khadi Prayog Samiti,
   Ahmedabad.

9. Mr. Mohan Parikh,
   Krishi Yantra Vidyalaya,
   Bardoli,
   Gujarat.

10. Mr. Ishwar Bhai Patel,
    Safai Vidyalaya,
    Harijan Ashram,
    Ahmedabad-380 013.

11. Mr. Jash Bhai Patel,
    Gujarat.

12. Mr. M.K. Roy,
    Dy. Chief Inspector of Factories (Chemical),
    Bailey Road,
    Patna.

APPENDIX-IV

CURRENT LIST OF STAG MEMBERS

1. Mr. Preetam Singh Bajwa,
   P.S. Bajwa and Sons Pvt. Ltd.,
   Chandigarh.

2. Mr. H.U. Bijlani,
   Founder President,
   All India Housing Development Association,
   HUDCO House, Lodi Road,
   New Delhi-110 003.

3. Dr. Indira Chakravarty,
   Head, Deptt. of Biochemistry and Nutrition,
   All India Institute of Hygiene and Public Health,
   110, Chittaranjan Avenue,
   Calcutta-700 073.

4. Mr. N. Das,
   Chief Engineer,
   Public Health Engineering Department,
   Patna.

5. Mr. R.L. Dewan,
   Former Director,
   Irrigation Research,
   Officers' Flat No. 77/40,
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6. Director (or his nominee),
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   Nehru Marg,
   Nagpur-20.

7. Dr. S.H. Godbole,
   Director,
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8. Dr. K.P. Gupta,
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9. Dr. R. Guruswamy,
   Prof. of Public Health Engineering, Centre for Environmental Studies,
   College of Engineering,
   Anna University,
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10. Mr. M.M. Hoda,
    Director (Communication),
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    Lucknow-226 001.

11. Mr. M. Ibrahim,
    Director,
    Biogas International and Consultant,
    India Development Group,
    Gandhi Bhawan,
    Lucknow-226 001.

12. Mr. Jainarain,
    Consultant,
    Deptt. of Non-conventional Energy Sources,
    Ministry of Energy,
    Block No. 14, C.G.O. Complex,
    Lodi Road,
    New Delhi-110 003.

13. Mr. Mallinath Jain,
    Short Term Consultant to the Ministry of Environment,
    Govt of India,
    (on matters relating to the pollution of River Ganga),
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    New Delhi-110 002.

14. Dr. Janardan Jha,
    Director,
    Bihar Institute of Technology,
    Sindri (Dhanbad).

15. Mr. S.N. Jha,
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Sulabh Institute of Technical Research and Development,
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16. Dr. N.B. Mazumdar,
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17. Mr. N. Mishra,
Executive Chairman,
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18. Mr. P.K. Mukherjee,
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19. Prof. K.J. Nath,
Professor of Environmental Sanitation &
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20. Mr. S.K. Neogi,
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21. Mr. B.N. Ojha,
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22. Mr. J.N. Pandey, IFS (Retd.),
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23. Mr. B. Pathak,
Chairman,
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24. Dr. T. Prasad,
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25. Mr. P. Ram,
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26. Mr. E.F.N. Ribeiro,
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30. Mr. Basawan Sinha,
Engineer-in-Chief,
Technical Examiners' Cell,
Cabinet Secretariat (Vigilance),
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31. Dr. B.P. Sinha,
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33. Mr. R.R.V.P. Sinha,
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35. Mr. K.K. Singh,
Principal Scientific Officer,
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36. Mr. K.M. Srivastava, IAS,
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37. Mr. Narendra Verma,
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38. Dr. S.S. Yadav,
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APPENDIX-V

MEMBERS OF STAG SUB-COMMITTEE ON NON-CONVENTIONAL ENERGY SOURCES

1. Mr. M.M. Hoda,
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2. Mr. Jainarayan,
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3. Dr. B.P. Sinha (Co-ordinator),
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   Sulabh Institute of Technical Research and Development,
   Adalatganj,
   Patna-800 001.

4. Mr. K.K. Singh,
   Principal Scientific Officer,
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5. Mr. L.K. Sinha,
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6. Mr. N. Verma,
   Scientist-Coordinator,
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   Central Building Research Institute,
   Roorkee-247 667

APPENDIX-VI

MEMBERS OF STAG SUB-COMMITTEE ON POLLUTION AND ENVIRONMENTAL STUDIES

1. Prof. Indira Chakravarty,
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2. Dr. K.P. Gupta,
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4. Prof. K.J. Nath,
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