Proceedings of
Training Program on Biomass Gasification for Manufacturers, Technicians and LSPs (Local Service Providers) (17-19 May 2006 at RETREAT, Gual Pahari)

TERI has organized a Training Program on Biomass Gasification for Manufacturers, Technicians and LSPs (Local Service Providers) on 17-19 May 2006 at RETREAT, Gual Pahari (Haryana). This training program was organized as a part of TERI-SDC Partnership Project CoSMiLE (**Co**mpetence network for **S**mall and **Mi**cro **L**earning **E**nterprises) under the HID component of capacity building of gasifier manufacturers. The broad objective of the training program was to to build the supply chain as a part of mainstreaming gasifier promotion for thermal applications in SMiEs. It was the first among the series of such training programmes to be organized and is a starting point to train gasifier manufacturers and LSPs.. The total duration of the programme was for three days (Annexure A gives the training programme agenda) which was attended by 8 representatives of four gasifier manufacturers/LSPs (2 each) from Delhi, Haryana, Maharashtra and Rajasthan. Since this was the first programme of such kind, TERI technicians and researchers also participated in the program(Annexure B gives the list of participants).

Day-1:

Inaugural session

Welcome of participants

The programme started with welcome address by Mr Sunil Dhingra, Convenor of BETA (Biomass Energy Technology Applications) Group in which the participants were introduced to the objectives and importance of the training program.

Programme Introduction

The welcome address was continued with introduction to the overall objectives of the TERI-SDC Partnership and CoSMiLE. This made the participants understand about the CoSMiLE program, various phases of the programme over a decade and also made them aware about the other sectors which are being covered under broad project framework.

- Identification phase (1994-96)
- Action research phase (1997-2000)
- Pre-dissemination phase (2001-2004)
- Mainstreaming phase (2005-2008)

The presentation was concluded with major achievements and the challenges ahead for mainstreaming the developed technologies, This made the participants understand about the importance of capacity building to strengthen the supply chain mechanism.

Introduction of participants

This was followed by self intrdction of all participants, in which each participant briefed about their academic background, work experience and their specific experience in the gasifier field. The participants also shared their expectations from the training program.

Learning Session 1: Basics

Module-1: Energy Basics, (V V N Kishore, TERI)

In order to gradually warm up the participants the first topic of this training-cum-learning event was, understanding basic concepts of energy, which was taken by Dr V V N Kishore. Here effort was to clarify some of the basic concepts related to energy (sources/forms), work, power etc. What is meant by these technologies, terminologies, what are their measurement units, how they work, what are their advantages, limitation etc. Various measurement units were also explained along with their importance and how one unit can be converted to other.

At the end of the training session, participants were divided into three groups and quiz session was taken to assess effectiveness of learning from the session. The quiz also helped in involving all participants into learning environment, remove initial hesitation to pose query, make them attentive, remove the monotonousness and bring in energetic and enthusiastic environment.

Module II: Biomass Basics, (Ms Kusum Lata, TERI)

Ms Kusum Lata took the first post-lunch session to take forward the learning process from general energy related topic to more specific energy source under consideration i.e. biomass. Apart from explaining the difference between renewable and non-renewable energy sources, their respective positive points and shortcomings, the lecture covered the importance of biomass as energy source among renewable energy sources and its relevance to India, Details of photosynthesis was also explained and also how solar energy is converted and stored in biomass as chemical energy which in turn can be used on demand along with further advantages of biomass such as its carbon neutral ness etc. Participants were also then made aware about varieties of biomass resources, their properties etc. Throughout the session emphasis was given on biomass fuel characterization and to properties like moisture content, volatile matter content, ash content etc which are going to decide their suitability as fuel with specific reference to gasification.

At the end of the session interesting quiz was taken which helped participant to retaining interest in learning as well as helped to rethink and reiterate important learning.

Module III: Gasification Basics, (Sanjay Mande, TERI)

The final session of the day-1 was taken by Dr Sanjay Mande focusing on basics of gasification, which was the technology being promoted and for which ongoing training program was organized. The lecture started with basics of various thermo-chemical conversion technologies and combustion types i.e. combustion, pyrolysis and gasification. Slowly the presentation moved to biomass gasification, their types, merits, demerits and possible preferred application areas. Referring to previous lecture on fuel characterization, he tried to explain how ultimate analysis can help in estimating optimum air requirement and how share of volatile matter in fuel can help in assessing fuel's tar formation properties The presentation further explained. gasification reactions happening inside the gasifier reactor with specific reference to updraft and downdraft gasifiers.

Throughout the presentation efforts were to reiterate and understand minimal basic concepts of gasifier reactions and making participant understand importance of various critical factors which can influence gasifier performance (gas quality etc) and more importantly why and how it happens. These included importance of fuel physical properties like bulk density, size (to minimize bridging tendencies), fuel moisture content (how excessive moisture can adversely hamper) etc. He also emphasized importance of gasifier reactor insulation (in maintaining high temperature for gasifier reaction to occur), supplying right amount of air (insufficient ~30% of what required for ideal complete-stoichiometric-combustion) etc. Participants were also made aware of effect of high ash content in some fuels, how then grate shaking becomes important to remove ash as well as minimizing clinker formation.

Due to lack of time quiz on this session was postponed to the next day.

At the end of the day all participants were asked to discuss day's learning among themselves and summarize their learning at the start of next day's programme.

Day-2:

Second day's activities started with recap of previous day's activities and participants feedback. Participants expressed their satisfaction of new learning experience of technologies they were either working on for past few years and some who are planning to take plunge in coming years. On behalf of participants Mr Aniruddha Kulkarni, 2M industries and Mr Gopu, Rolltech Engg summarized previous day's learnings from various sessions.

Quiz of module III: gasification basics (Dr Sanjay Mande, TERI)

Here efforts were more on recapitulating and re-emphasizing important learning concepts of gasifier among participants. The participants were found to be fully interactive and involved in the quiz session, which represented their level of enthusiasm and interest in the learning through this mode.

After completing the understanding of basic concept on the first day, the training programme focus was made more practical oriented from second day, with learning through hands on experience.

Learning Session II: Field Activity Related Issues

Module IV: Energy Demand Assessment (Mr Sunil Dhingra, TERI)

This session focused on explaining the methodology of assessing the energy demand of the user or target industry in the field. Mr Sunil Dhingra initiated this session with participatory approach and evolved what needs to be done in order to assess the user demand. Participants in turn gave several suggestions like understanding end use product, process, effectiveness of existing device, present fuel cost and its share in process, work environment and more important is how to convince user about economic viability of gasifier proposition etc. Summarising their emerged points, he gave brief presentation reaffirming the emerged points and adding some missed out point to complete the checklist. Two case studies on Plaster of Paris and *Namkeen* making further cleared many practical issues of the field assessment.

The session was continued by giving group exercises to the three teams on energy demand assessment of three different field sites

Energy Demand Assessment (Group Exercise)

After the first session on energy demand assessment participants were divided in three groups to carry out practical exercise of assessing the demand for end users. Three groups were given the task of carrying out energy demand assessment by themselves based on learning so far. The three tasks given two these three groups included:

Group-I: Large scale cooking at RETREAT Complex Canteen

Canteen of RETREAT complex uses LPG for cooking large number of participants of various programme. The task of the group was to collect the information so as to assess the energy demand to enable proposing to replace LPG by gasifier system.

Group-II: Autoclave at tissue culture pilot plant facility

Autoclave is being used at tissue culture pilot plant at Gual Pahari that produces steam. The task of the group was to collect the information so as to assess the energy demand of the

autoclave to enable proposing to replace electrical heater system for production of steam by gasifier system.

Group-III: Large scale cooking at Dhaba

There is *dhaba* located near Gual Pahari on Faridabad-Gurgaon road which lot of thermal energy for cooking food for people. The task of the group was to collect the information so as to assess the energy demand of the *dhaba* to enable proposing to replace some of the cooking system (consuming wood/kerosene/LPG) by gasifier system.

After the exercise is complete by onsite visit and collecting necessary information, and after doing calculation each group presented findings of the group exercise before dispersing for lunch. During presentation group representatives gave detailed information of how they approached the client and what information (and also what for) was asked/collected and also described how they used it to approximately assess the energy demand for the given application. The findings were discussed for some clarification and in some cases minor suggestions/corrections to improve effectiveness was given by the faculty.

Module V: Gasifier Critical Dimensions (Dr V V N Kishore, TERI)

After lunch Dr Kishore gave brief presentation to all participants basically to reiterate which are critical dimensions of the gasifier viz. reactor diameter, air nozzle (no and diameter), distance between air nozzle and grate. He also emphasized importance of these dimensions and need to stick to these dimensions as per detailed technical drawings, specification given and requested not to tamper with these critical dimensions to ensure any adverse effect on gasifier performance. He also highlighted importance of gasifier insulation and its material selection, thickness and proper curing during casting.

Module VI: Blowers and Burners (Mr P Raman, TERI)

The module covered some issues which need to be given due attention while designing or selecting practically important gasifier system components namely air blowers and producer gas burners. Introduction to various types of blowers available

in the market and their selection criteria for given application were important segment of this presentation. He then explained the critical issues behind designing of producer gas burner due to presence of slow (CO) and fast (H_2) burning gases in producer gas. He emphasized the need for maintaining proper air fuel ratio as well as proper mixing of air and gas in burner and its uniform distribution within burner to enhance its effectiveness

Module VII: QAQC in Manufacturing (Mr B R B Mathur, Consultant)

Mr BRB Mathur gave brief presentation highlighting importance of quality. How it can be achieved through small things right from purchase of raw material till production of finished goods. He gave information about how quality can be assured by following proper process, selecting and procuring proper bought out items. Then he gave example of welding, how to do it properly and more importantly how to check quality. What are different ways to check quality norms?

After the presentation al the participants were taken to TERI's gasifier section where live demonstration was given on how to check quality of welding joints using simple dye penetration test method. Here detailed information on how to perform the quality check was given along with practical training. Participants asked series of queries about utility of this technique, circumstances where it can be applied and where it cannot be, etc which faculty responded to participants satisfaction.

Home activity

The day's program ended with seeking feedback from participants on day's proceedings. At the end all participants were asked to discuss learning so far form training programme and how it will be used further.

Day-3:

Last day (Day-3) started with presentation by participants on learning (Mr Aniruddha Kulkarni and Mr Gopu) they had so far. Other participants also added their views to supplement them.

Module VIII: Material selection, operation - troubleshooting (Mr P Raman, TERI)

Mr Raman then gave brief presentation on material selection for various components of gasifier system. He also explained about best practices of gasifier operation, which included how to start, and shut down the system and more importantly he emphasized on several common DONTs. He then gave brief information on routine maintenance for keeping system performing good and also gave information various trouble-shooting measures.

At the end of his presentation he gave schematic diagram of updraft gasifier system (10-20 kg/hr capacity) which was later used for exercise on bill of matrrial preparation.

After this session the participants were divided into two groups for parallel sessions. Participants who are more involved in marketing and decision-making formed the Group-1 and those dealing with field activities formed the Group-2.

Module IX: Bill of Material (Parallel Session-1)

This group worked on exercise of preparing bill of material for the updraft gasifier system comprising of blower, gasifier, duct and burner for thermal application. The schematic diagram given at the end of morning session was used here as basis. Participants represented by four different manufacturer groups worked separately here so as to evolve four bill of material. Participants were asked to list different types of material required, their prices in order to arrive at bill of material. In addition to this costing involving other costs (fabrication, installation, commissioning, profit, royalty, QAQC implementation etc) were added to arrive at common costing of gasifier system.

After the completion of the exercise each group presented the bill of material and pricing prepared by them. On comparison lot of variation was found and through discussions the costing was made more uniform and acceptable to all.

Module X: Gasifier Operation Training (Parallel Seesion-2)

While first group was working on exercise of bill of material the other group was taken to gasifier demonstration section. One updraft gasifier (similar to one for which schematic diagram was given in the morning) was got fabricated for this purpose. Participants of this group were further sub-divided into two smaller groups. Then they were given on hand training on gasifier operation (one on silk down draft gasifier system and other on new updraft gasifier system) by rotation on both updraft and down draft gasifier.

Mr M L Sharma (one of the senior TERI technicians) observed the participants work and later given his feedback on how participants operated the system and what can be done for further improvement through these observed mistakes/shortcomings.

Afterwards the participants of this group went to same three sites on which they did energy demand assessment, took the user to these gasifiers and tried to convince them about the benefits of gasifier operation through actual demonstration.

Module XI: Field experience sharing (TERI technicians)

After lunch the session was devoted to share wide diverse unique experience of TERI technicians with participants during the decade of field based work on gasifier system demonstration and promotion.

Mr M L Sharma, Mr L B Thakur shared their varied valuable experiences with the participants. Emphasis here againwas what type of problems, situations come across while dealing with field activities and how tackle them tactfully. Effort was also to enrich knowledge of participants with new approaches methods, which one might need to adopt while convincing user, operators and others in the field.

Module XII: Tools/monograms for quick estimation (Dr Sanjay Mande, TERI)

In the last technical session Dr Mande gave some quick useful tools in the form of graphical monograms. This included simple graphical representation useful to convert various temperature, energy units. Some more useful handy monograms for quick (though might be approximate) estimation of gasifier size for replacing fossil fuel or wood fuel based system with gasifier based systems. He also showed monogram under preparation (draft version) which can be easily used to do calculations on quick water boiling test and fuel consumption test to workout graphically usefully and input power of existing system which can quickly give operating efficiency levels. This also can then be used for quick estimation of gasifier capacity required.

Feedback session

In the concluding session feedback form was given to all participants to seek their opinion about usefulness of various sessions and to know their satisfaction as well as their future aspirations from similar programs in future. They were also asked to give suggestions to present program structure as well as new program needs for mainstreaming gasifier systems in the field.

Training programme concluded with formal vote of thanks by Mr Sunil Dhingra.

Annex A

Training Program on Biomass Gasification for Manufacturers, Technicians and LSP (Local Service Providers)

Date : 17-19 May 2006
Venue : RETREAT, Gual Pahari

Programme Agenda

Day-1 : Wednesday 17 May 2006

10.00 – 10.30	Registration
10.30 – 10.45	Welcome address
10.45 – 11.00	Self introduction by participants
11.00 – 11.30	Introduction to Program and CoSMiLE
11.30 – 13.00	Energy – Basics
	LUNCH
14.00 – 15.30	Biomass - Basics
15.30 – 17.00	Biomass gasification – basics

Day-2 : Thursday 18 May 2006

09.30 – 10.00	Recap of yesterdays activities
10.00 – 11.30	Energy Demand Assessment - presentation
11.30 – 13.00	Energy Demand Assessment – group field exercise
	LUNCH
14.00 – 14.30	Gasifier critical dimensions
14.30 – 15.00	Air blowers and gas burners
15.00 – 16.00	QAQC in manufacturing – presentation
16.00 – 17.00	QAQC in manufacturing – practical demonstration

Day-3 : Friday 19 May 2006

09.30 – 10.00	Recap of yesterdays activities
10.00 – 11.00	Material selection, O&M, trouble shooting
11.00 – 13.00	Parallel Sessions
	(a) Gasifier demonstration, Practical training-learning
	(b) Preparation of bill of material
	LUNCH
14.00 – 15.00	Field experience sharing by TERI technicians
15.00 – 15.30	Tools/monograms for quick estimation
15.30 – 16.30	Feedback and concluding session

Annex B

List of Participants

2M Industries, Mumbai
- Aniruddha Kulkarni
- Prabhakar Kulkarni

Chanderpur Works, Yamunanagar
- Harmani Bhardwaj
- Dilshad Ali

Rolltech Engineering, New Delhi
- S Gopu
- Harbhajan Singh
- Om Prakash

Navjyot Enterprises, Sirohi
- Raj Pal Singh

LSP, Jaipur
- Jitendra Singh

TERI Technicians
- E Joseph
- L B Thakur
- M L Sharma
- Rajkumar

TERI Research Staff
- Gaurav Mishra
- N K Ram
- Mohit Pushp

Research Student
- Om Prakash Chaturvedi

Faculty
- B R B Mathur, Consultant
- V V N Kishore, TERI
- Sunil Dhingra, TERI
- P Raman, TERI
- Sanjay Mande, TERI
- Kusum Lata, TERI