Training Programme

On

"Cleaner Fired-Clay Brick Production Practices"

13 April 2016, Sri Ganganagar, Rajasthan, India

Organised by:

Greentech Knowledge Solutions Pvt. Ltd, New Delhi

In association with

Prayag Kiln Technologies, Varanasi

A report prepared by:

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An initiative supported by:

Climate and Clean Air Coalition (CCAC) and

International Centre for Integrated Mountain Development (ICIMOD)

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1 Introduction

1.1 Background

In most of the developing countries, bricks are mainly produced using traditional technologies and it has severe impacts on climate, agriculture and land use, and health. Efforts are being made in various regions towards improvements in firing technologies and processes and its adoption to make the brick production more energy and resource efficient and less polluting. Various studies have established that these improvements in technology and practices can reduce fuel consumption and pollutants emissions (including black carbon) significantly. The Brick Production Initiative (BPI) of the Climate and Clean Air Coalition (CCAC) is aimed at mitigating emission of black carbon and other pollutants from brick production through establishing networks of experts and facilitating implementation of actions on advancing science-based knowledge, policy development and implementation, and technology adoption. ICIMOD is coordinating this activity in Asia.

The training programmes are part of the 'Training and Technology Delivery' component of the brick initiative of CCAC which envisages establishment of several training and technology delivery nodes in South Asia and Latin America. These nodes can help in building capacities of key local actors (brick kiln entrepreneurs, policy makers/implementers and major consumers) through effective delivery of knowledge and cost-effective technological solutions which can lead to low emissions, better working conditions and minimized land degradation. The brick initiative aims to conduct 10-15 training programs in the South Asia region to educate the brick makers and other key stakeholders on cleaner brick-production technologies and practices by fine-tuning these as per the local requirements. In India, 5 training programs are to be organized and Greentech Knowledge Solutions Pvt Ltd (GKSPL) is the agency responsible for conducting the training programmes in India.

1.2 About the training programme

The third training programme in India was organised in April 2016 at Sri Ganganagar, located in the state of Rajasthan. Sri Ganganagar and the nearby regions, is a major brick producing cluster in Rajasthan with 700–1000 brick kiln units; and supplying bricks up to 300 km. All these units are using Fixed Chimney Bull's Trench Kiln (FCBTK) technology for firing of bricks and the main fuel being used are agricultural residue such as mustard stalk and guar stalk. Some of the kilns also use coal as supplementary fuel. The details of the existing production processes and practices is provided in Annexure-II.

The training programme was conducted in the form of smaller group meetings with the kiln owners at kiln sites in different clusters on 02 February and 12 April 2016, followed by a focused technical workshop organized on 13 April 2016 at Sri Ganganagar. These meetings were organized in 5 clusters in the nearby regions of Sri Ganganagar. The main objectives of these small group meetings were:

- To acquire first-hand information on the operating practices being practiced in this cluster for brick manufacturing, typical energy consumption, product quality and other process parameters such as firing temperatures, etc.;
- To explain the brick makers about the drawbacks in their existing technology and processes as well as the potential areas for improvements in their existing practices;
- To analyse the preliminary feasibility of shifting to more energy efficient natural draft zigzag kiln technology.

These meetings also helped in generating interest and mobilising them for the technical workshop.

Objective of the technical workshop

The technical workshop was organised on 13 April at Hotel Vikramidtya, Sri Ganganagar. The main objectives of the workshop were to make the brick makers aware about:

- the shortcomings of existing technology and practices, and its impacts on their profitability as well as on environment;
- the energy efficient and more profitable natural draught zigzag kiln technology;
- the possible areas improvements in their existing practices to improve efficiency; and
- the overall market and regulatory trends at both national and local level, and recommend them the way forward in the emerging context

The workshop also provided a platform to the participants to discuss about their issues and challenges with the experts.

1.3 About the participants

The project team got very good support from the local brick manufacturers association in organisation of the workshop and mobilisation of participants. The workshop was attended by close to 100 participants representing almost all the major brick manufacturing cluster around Sri Ganganagar. This also included representatives from most of sub-cluster level brick manufacturer's associations.

1.4 Organising team

The training programme was organised by Greentech Knowledge Solutions Pvt. Ltd (GKSPL), in association with Prayag Kiln Technologies (PKT), a clay-products manufacturing enterprise and technology provider based in Varanasi. The organising team comprised of

1. Dr Sameer Maithel, Director, Greentech Knowledge Solutions Pvt. Ltd., New Delhi
2. Mr O P Badlani, Chairman, Prayag Clay Products Pvt. Ltd., Varanasi
3. Mr Sonal Kumar, Greentech Knowledge Solutions Pvt. Ltd., New Delhi
4. Mr Ananthakrishnan Ravi, Greentech Knowledge Solutions Pvt Ltd., New Delhi
5. Mr Sandeep Ahuja, Prayag Clay Products Pvt. Ltd., Varanasi

Collectively, the team has the experience of successfully conducting several training programmes in the past for the brick industry sector in India and other countries.

1.5 Agenda of the technical workshop

Date: April 13, 2016; **Venue**: Hotel Vikramaditya, Suratgarh Hanumangarh Bypass, Sri Ganganagar

10:00 - 10:30	**Registration**
10:30 - 11:15	**Inaugural Session:** – Welcome remarks by Mr Premchand Agrawal, President, Sri Ganganagar Brick Kiln Association – Background and purpose of the programme: Mr O P Badlani, Prayag Kiln Technologies – Special remarks: Mr.Vishal Agarawal, Bureau of Energy Efficiency, Govt. of India – Remarks by Mr Pradeep Periwal, President, Abohar Brick Kiln Association – Remarks by Chief Guest, Mr Ajay Chandak, Chairman, Sri Ganganagar Municipal Council
11:15 - 12:30	**Session – I: Improvement opportunities in the existing brick production practices in the region** – Basics of brick firing and combustion process in the kiln – Existing brick firing practices in the region – Possible improvement options Experts: Mr O P Badlani & Dr Sameer Maithel
12:30 - 14:15	**Session II: Introduction to Natural Draught Zigzag Kiln – an efficient kiln technology** – Operation and shortcomings of FCBTK (Air Pollution, Fuel Loss, Poor Product Quality) – Introduction to Natural Draught Zigzag Kiln technology – Advantages of natural draught zigzag kiln technology (fuel savings, better product quality, improvement in profitability, reduction in stack emissions) – Retrofitting of existing kilns to natural draught zigzag kiln Experts: Mr O P Badlani & Dr Sameer Maithel
14:15 - 15:00	**Q&A and Discussion on way forward**
15:00 - 16:00	**Lunch**
Post-Lunch	**Small group meetings with brick makers**

2 Proceedings of the technical workshop

2.1 Inaugural session

The technical workshop started with the welcome address by Mr Premchand Agrawal, President Sri Ganganagar Brick Kiln Association. He introduced the guests to the participants and welcomed the participants who had come from different tehsils of the district.

Mr O P Badlani, Chairman, Prayag Kiln Technologies, welcomed all the participants, experts and guests. He emphasised on the need to change and evolve with growing times and acknowledged that such programmes not only educate the brick makers about cleaner brick production practices but also provides a platform/opportunity to brick makers for cross-sharing of knowledge and experiences.

Mr Vishal Agarawal, Bureau of Energy Efficiency, Govt. of India explained about the roles and initiatives of BEE towards promoting energy efficiency and technology upgradation in MSMEs. He also mentioned that BEE would like to provide technical support to the early adopters of energy efficient technologies.

Dr Sameer Maithel, Director, Greentech Knowledge Solutions, talked about context and relevance of the technical workshop. He described the issues and challenges being faced by the brick industry and what should be the way forward. He also provided the overview of the technical workshop.

Mr Ajay Chandak, Chairman, Sri Ganganagar Municipal Council, who himself is a brick entrepreneur welcomed the initiative of training program and promised that the local brick entrepreneurs will support the transition from conventional manufacturing methods to energy efficient technologies.

Mr Pradeep Periwal, president of Abohar Brick Kiln Association emphasized on the need to move to energy efficient brick kiln technologies. He appreciated the efforts taken up the organizations involved in conducting this workshop.

2.2 Technical Session–I: Improvement opportunities in the existing brick production practices in the region

The first technical session was focused on working principles and operation of Fixed Chimney Bull's Trench Kiln (FCBTK) and its shortcomings such as higher fuel consumption, lower percentage of good quality bricks and higher pollutant emissions. The session was conducted by Dr Sameer Maithel. The session started with description of principles of brick firing process; various fuels used in brick kilns and their characteristics; and principles of combustion. An animation on working and operation of a FCBTK was shown to the participants. With the help of this animation, the scientific phenomena happening in the kiln during firing and the causes of incomplete combustion, poor product quality and high emissions in a FCBTK, were explained to the participants.

This session also focused on the drawbacks of the existing kiln construction and operating practices being practices in the cluster. Some of the main points of concern that were highlighted are incomplete combustion because of the existing fuel feeding practices and its impact on fuel consumption and stack emissions; leakages through the flue gas duct systems; leakages and heat loss through the wicket gates; heat loss from un-insulated fuel feed hole covers; etc. Mr O P Badlani elaborated on the measures for improvements in the existing practices with the help of sketches and videos. He also explained about the importance of making the kiln leak proof and recommended measures that can be taken while construction and operation of the kiln to prevent air leakage.

2.3 Technical Session–II: Introduction to natural draught zigzag firing concept

This session started with the introduction to the natural draught zigzag firing concept and explanation of its advantages over FCBTK in terms of better product quality, less fuel consumption and low emissions. This was also explained with the help of an animation on principles and working of natural draught zigzag kiln technology which also illustrates the main differences between a FCBTK and a natural draught zigzag kiln. This was followed by the description of the brick settings in zigzag kilns to guide the air flow in one/two or three streams of zigzag flow depending upon the production capacity and dimensions of the kiln. The participants were also explained about the characteristics of fuel best suited for firing in different chambers, the ideal fuel mix and the ideal fuel feeding practice that should be adopted for complete combustion of fuel and uniform temperature distribution in the kiln.

This session also focused on construction of a new natural draught zigzag kiln or retrofitting of an existing FCBTK to natural draught zigzag kiln, and best practices in operation of a natural draught zigzag kiln. They were explained about the overall design of the kiln; various critical parameters that should be considered during the kiln design such as production capacity, trench width, chimney dimensions, flue gas duct dimensions, etc.; and estimate of materials required for construction of a new kiln. Depending upon the condition of an existing FCBTK, it can also be retrofitted to a zigzag kiln and the cost can be reduced significantly. Later on, the steps and processes involved in the retrofitting of an existing FCBTK to natural draught zigzag kiln and the associated financial and environmental benefits were explained with the help of drawings and photographs of various stages of retrofitting process. The session was conducted by Mr. O. P. Badlani.

2.4 Q&A and Discussion

This session started with questions and concerns of the participants which were answered by the expert team and officials from Bureau of Energy Efficiency. The main concerns of the brick makers and discussions were primarily related to

- the suitability of mustard/guar stalk as a fuel for the natural draught zigzag kilns
- the low profitability of the enterprises in Sri-Ganganagar brick kiln cluster
- steps involved and processes in shifting to zigzag kiln technology and operation of zigzag kilns.

Mr Premchand Agrawal, President, Sri Ganganagar Brick Kiln Association, in his concluding remarks, applauded the team for successfully organising the technical workshop and encouraged the participants to shift to cleaner brick production technologies in theirs as well as in national interest.

3 Photographs of the technical workshop

Figure 1: Dignitaries on the dais in the inaugural session

Figure 2: Mr Vishal Agarawal, Bureau of Energy Efficiency addressing the participants

Figure 3: Mr Premchand Agrawal, President Sri Ganganagar Brick Kiln Association welcoming the participants

Figure 4: A view of participants in the inaugural session

Figure 5: Dr. Sameer Maithel explaining the working principles and operation of FCBTK and its drawbacks

Figure 6: Mr. O.P. Badlani introducing the natural draught zigzag firing concept

Figure 7: View of chief-guest seated along with the participants

Figure 8: Q&A Discussion session

Figure 9: Discussion at the kiln site during the visit on 12th April 2016

Figure 10: Emissions due to existing mustard stalk feeding system

Figure 11: Discussions on shortcomings of existing practices at the kiln site during the visit on 02 February 2016

Figure 12: A view of the discussions during small group meetings on kiln site in various clusters on 02 February 2016

Annexure – I: List of participants of the technical workshop

Sr.no	Name	Organization	Contact no.
1	Satish Nagpal	Maruti Int Udyog	9928465477
2	Bhussha chalane	Maruti Int Udyog	9875254651
3	Rajkumar Verma	Kavita Int Udyog	9667230814
4	Raj Kumar	Brar Int Udyog	9549527000
5	Bhairam	Chaudhary Brick	8094284946
6	Mahender Pal	SKR Int Udyog	9694797897
7	Gaurav Tayal	Laxmi Int Udhyog	9982611612
8	Vishal Chalana	Shree Ganesh Int Udhyog	8741084666
9	Virender Dhamija	Shree Ganesh Int Udhyog	9982307963
10	Vikas Jalotra	Shree Ganesh Int Udhyog	9828532408
11	Rajesh Jalotra	Jalotra Int Udyog	9828532408
12	Vishvakarma		9829684876
13	Vishwa Bandhu	Vishwa Int Udyog	9772750376
14	Pradeep Kumar Periwal	Periwal Brick Kiln	9417414121, 9876514121
15	Somesh	Bajaj Brick	9417127116
16	Gopal Periwal	Periwal Brick Kiln	9779800885
17	Subash Chand	Shyam Kiln company	9414246338
18	Dinesh Goyal	Kalp Brick Padampur	9413769280
19	Om Prakash	Shree Ram	7597482786
20	Pawan Kumar	Malethiya Int	9414210206
21	Jagdish	Sandhya Brick	9828120127
22	Pawan	Gurunanak Brick co.	9414092269
23	Chiranji Lal	Pawan Bricks	9414092268
24	Jeet Ram	Namdev Int udyog	8696085805
25	Santram Yadav	Jai Ambey Int Udyog	9875255579
26	Saurabh	GIU	9672955303
27	Gurvinder		9417331012
28		Malethiya Int	9414948808
29	Gopal	Maruti Int Udyog	9829061541
30	Ajay Sihah	Ganesh Int Udyog	9829692309
31	Shourabh	Ganesh Int Udyog	
32	Sunil Bhatia	Ganesh Kiln co.	9414873790
33	Satpal Garg	Aggarwal Int Udyog	9772721350
34	Deepanshu Singhal	Shri Ramdev Bricks	8290858400
35	Manjeet Sekham	sekham Int Udyog	9414368001
36	Radheyshyam	Chugh Int Udyog	9414087384
37	Rakesh	Rakesh Brick	9829076365
38		Goyal Brick	9461261606
39	Sadu B N		9413290338

40	Sahu	Vinayak Brick	9414323166
41	Rajbir Sihag	Jagdamba Bricks	9828411159
42	Parminder Singh	Kalgidhar Bricks	9414481714
43	Tara Singh	Kalgidhar Bricks	9460787121
44	Bhupender Suthar	YES	9413377016
45	Moti Lal		9887865170
46	Nandlal	Shree Ram Int Udyog	9414512409
47	Harish	Aggarwal Bricks	9414949043
48	Dinesh Balana	Balana Bricks	9549565800
49	Manish Arora		9414507357
50	Maniram Poonia		9829358387
51	P D Midha	PDM Int Udyog	9828709902
52	Bhanu Prakash		9414456555
53	SNO SDS		9414512496
54		GIC Int Udyog	9772671372
55		Dada Bricks	9414514717
56	Madan Lal		9928284265
57	Shivchand		9785524038

Annexure – II: Details of existing production process and practices in Sri Ganganagar brick kiln cluster

During the visit to the kilns, the team closely observed the key features and operating practices of the kilns and also measured the main parameters such as weight and dimensions of the bricks; temperatures in firing zone; temperatures of fuel feed hole covers and at the kiln top surface; flue gas temperature; temperature of outer surface of wicket gates. The main observations are as below:

Moulding and drying of bricks: – The moulding of bricks are done manually and the green bricks are dried in open sun. – Weight of dried green bricks = 3.2-3.5 kg	
Loading of bricks in the kiln: – The dried green bricks are transported into the kiln with the help of hand cart or small tractors. – The bricks are loaded into the kiln for firing in column-blade setting (straight line firing).	
Fuels: – Agriculture residue such as mustard stalk (GCV = 3300 kCal/kg[1]) and guar stalk (GCV=3750 kcal/kg[2]) are used as fuel. – Imported coal from USA (GCV = 6500-7000 kcal/kg[3]) is used as supplementary fuel in few kilns.	

[1]Biomass fuel supply study for Rajasthan, May 2015, Rajasthan Renewable Energy Corporation Ltd. http://viainfotech.biz/Biomass/theme5/document/Reports/Rajasthan%20biomass%20fuel%20supply%20study%202015%20(1).pdf

[2]*Ibid.*

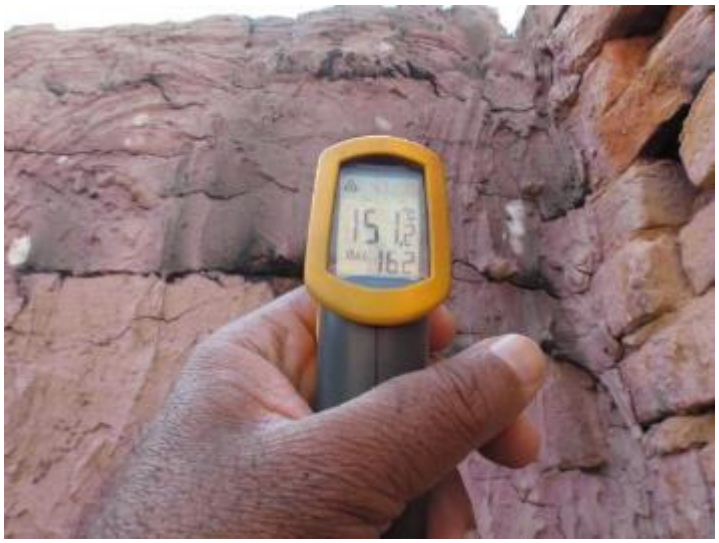
[3]As stated by the brick manufacturers who have got this fuel tested.

Firing practice:

- Bricks are fired in Fixed Chimney Bull's Trench Kiln (FCBTK)
- Fuel is fed through feed holes provided at the top of the kiln
- Fuel is fed in only one line at a time (length of firing zone: 2-3 feet)
- Usually 8-10 lines are fired in a day i.e. firing time for one line is 2.5-3 hours.
- Around 100 kg of coal and 500 kg of guar stalk is fed in one line. The whole amount of fuel required for firing one line is fed altogether in 30-40 minutes and then it is left for burning for 2-2.5 hours. Then the fire is proceeded to next line.
- Firing temperature: 950-1050 ^{0}C. The average temperatures measured at the top and bottom of the kilns in the firing zone are 1040 ^{0}C and 1010 ^{0}C respectively.
- Usually large, un-insulated fuel feed hole covers (metallic tawa) are being used. Temperature of feed hole cover is around 400-500 ^{0}C
- The temperature at kiln top surface in the firing zone is around 150-200 ^{0}C.
- In few of the kilns unburnt fuel at the bottom of the kiln is observed which indicates incomplete combustion of fuel.
- Around 60-80 % of the product are of class 1 or 1.5 which are considered good in the market. The remaining bricks are of class 2 and breakages or wastage.

Flue gas duct system:

- Majority of the kilns do not have shunt systems. Also, in the kilns where shunts are being used, the shunts are not insulated and are usually very heavy. At one of the kiln prefabricated light weight shunt made up of fiber is being used.
- The kiln is directly connected to central main duct through side ducts and these side ducts are usually closed by a 4.5-inch-thick brick wall with thin plaster of mud on the inner side.
- The flow of flue gases from the kiln to the central duct is controlled with the help of a metallic sheet (door) which is adjusted from the top of the kiln. To prevent leakages through these gates, clothes are used which is not effective as desired.

Wicket gates: – The wicket gates are closed with 18-22 inch wall with thin plaster of mud from outside. – The temperatures on outside surface of the wicket gates close to the firing zone is observed to be around 150-200 ^{0}C. – Leakage of air through wicket gates was also observed.	
Flue gas emission: – There is large amount of soot particles (including unburnt fuel particles) in the flue gases exiting from the kiln as evident from the black colour of smoke during fuel feeding. – The chimneys are of square as well as circular shape. The height of the chimney is around 110-120 feet. Except in 1 or 2 kilns, port hole and platform are provided on the chimney for the purpose of monitoring of flue gases.