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Baseline Energy Audit Report
Varanasi
Brick Making Cluster

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1.0 Introduction

Under the 11th Five Year Plan, the Bureau of Energy Efficiency (BEE) had carried out diagnostic studies in 25 SME clusters and prepared cluster specific manuals covering energy efficiency, process and technology, best practices, case studies, etc. These clusters represents various energy intensive industry sub sectors like ceramic, textile, paper, sea food, rice mills etc. The studies have provided information on technology status, best operating practices, gaps in skills and knowledge, energy conservation opportunities, energy saving potential, etc. for each of the intervening sub-sector. Detailed project reports (DPRs) were also prepared for the identified technological options. In the 12th Five Year plan, BEE is implementing National Program on Energy Efficiency. The major activities covered under the program include:

i. Sector-specific approach for energy efficiency and technology up-gradation through facilitation of implementation of DPRs on energy efficient technologies
ii. Technical assistance and capacity building of stakeholders
iii. Energy mapping of SME

Varanasi brick cluster is one of the clusters covered under the study. Zig-zag technology is one of the technology options identified to enhance energy efficiency of brick making units in the cluster. The Energy and Resources Institute (TERI) has been entrusted by BEE in implementing natural draft zigzag firing technology in the identified units in the Varanasi brick cluster.

2.0 About Varanasi brick cluster

In Varanasi brick cluster, there are about 300 brick kiln units. Some of the major sub-clusters in Varanasi includes Mohan sarai, Munari, Raichandpur, Haruhua and Sarnath. Int Nirmata Parishad (INP) represents the cluster level industry association. The cluster predominantly uses hand-moulding for green brick making and Bull's Trench Kilns (BTKs) for brick firing. It is estimated that about 40 brick kiln units in the cluster have adopted zig-zag technology.

The details of brick making units participating in the project are provided in table 2.0.

Table 2.0: Contact details of brick making units

S. No.	Name of the brick kiln	Contact Person
1	M/ s Singh Int Bhatta, village Kharupur, Varanasi	Mr. Parikshit Singh
2	M/ s R.B. Company, village Bandaha, Varanasi	Mr. Ramashraya Singh
3	M/ s Khiladi IntBhatta, village ShainaKalan, Varanasi	Mr. MotiYadav
4	M/ s Swarup Int Udyog, village Cholapur, Varanasi	Mr. Rajesh Singh
5	M/ s Asim brick field, village Undi, Varanasi	Mr. Kamlesh Narayan Singh
6	M/ s Shyam Int Udyog, village Jaipar, Varanasi	Mr. Inder Pal Singh
7	M/ s Shail Int Bhatta, village Raichandpur, Varanasi	Mr. Chandershekhar Singh
8	M/ s Sahara Brick Industry, village Sultanpur, Varanasi	Mr. VirenderTiwari
9	M/ s Dilip Kumar, village Todarpur, Mohan sarai, Varanasi	Mr. Dilip Kumar Jethani
10	M/ s B.S. Enterprises, village GosainpurMahauan, Cholapur, Varanasi	Mr. AkshyawarYadav

3.0 Brick Kiln - 1

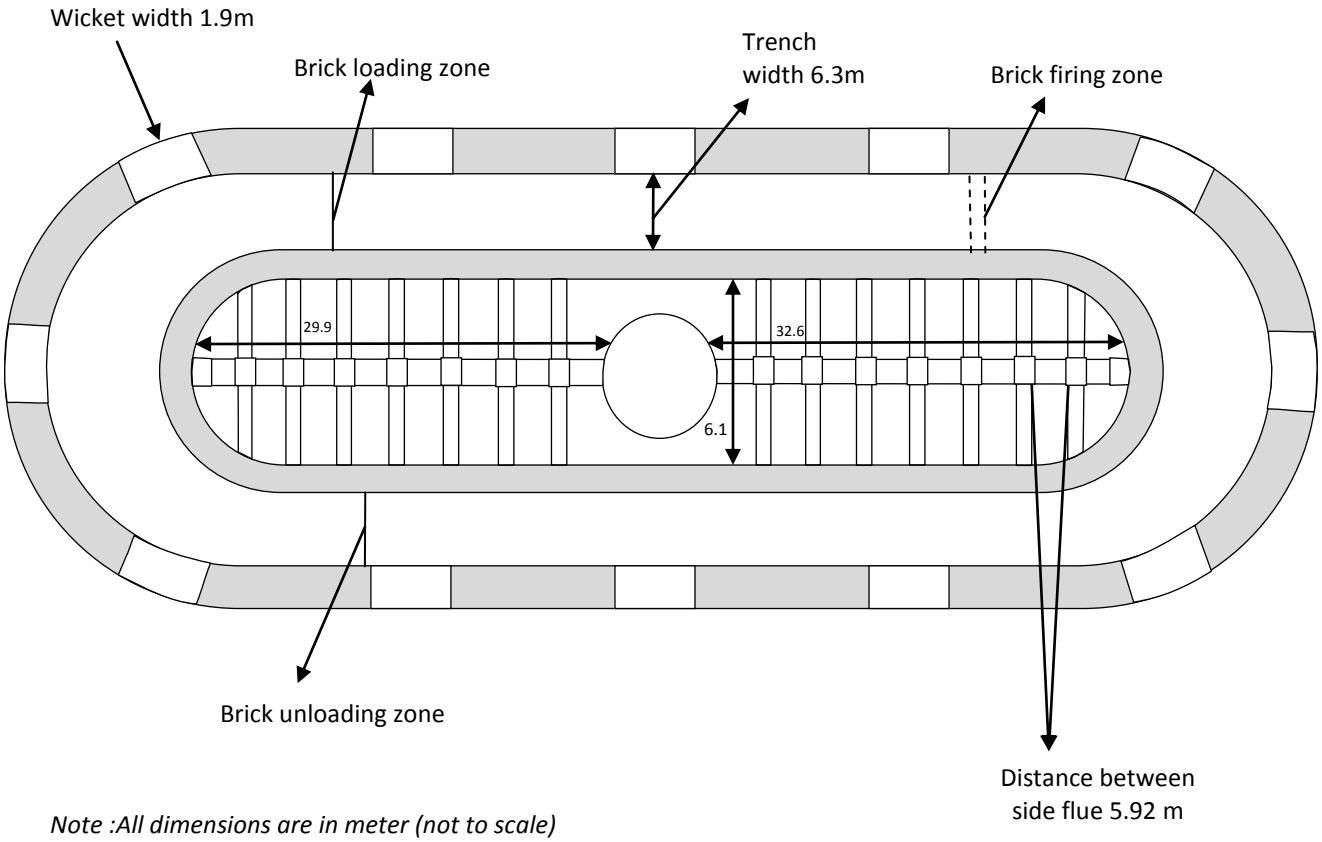
3.1 Basic information

Name of the kiln :	**M/s Singh Int Bhatta,**
Location of kiln :	Village Kharupur, Varanasi
Contact Person	Mr. Parikshit Singh
Contact No.	9793840001

3.2 Details of brick kiln

Type of brick kiln	**Oval shaped BTK**
Green brick molding process	Hand molding
Production Capacity	7 lakh per circuit
Size of trench	
- Width of trench	6.3 meter
- Height of trench	2.4 meter

3.3 Schematic diagram



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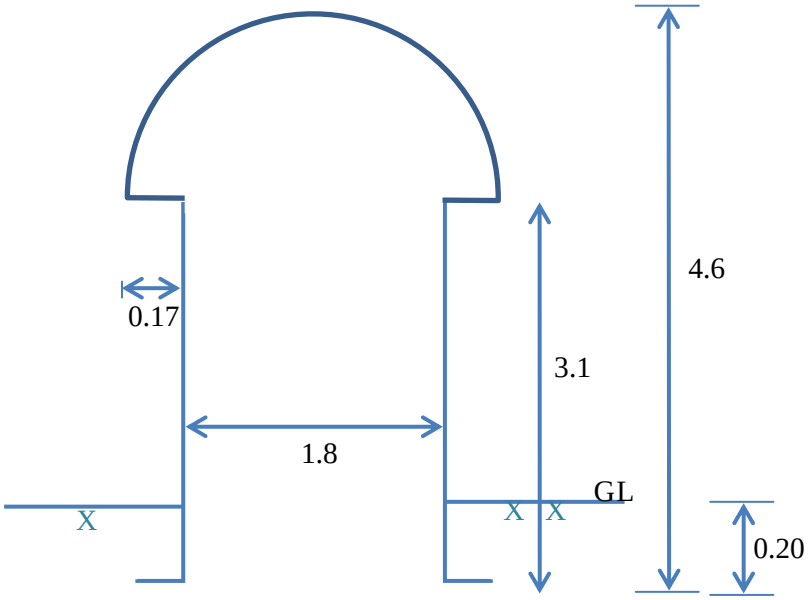


Side Flue

All dimensions are in feet (not to

3.4 Brick production

Number of rows in each line	**20**
Number of columns in each line	19
Number of bricks per line	3200
Number of lines fired per day	8 – 9
Average Size of green brick (mm)	236 x 113 x70
Average weight of green brick (kg)	3.0
Average Size of fired brick (mm)	236 x 111 x69
Average weight of fired brick (kg)	2.9

3.5 Kiln Parameters

Parameter	Range
Ambient temperature (°C)	37.5 – 40.4
Flue gas temperature (°C)	54.8 – 61.6
O_2 (%)	14.6 – 21.7
CO (ppm)	70 – 703
Firing Temperature(°C)	995 - 1038
Feed hole cover temperature (°C)	395 - 456
Kiln surface temperature	
Preheating zone (°C)	120 – 131.3
Firing zone (°C)	93.5 – 112.7
Cooling zone (°C)	67 - 86

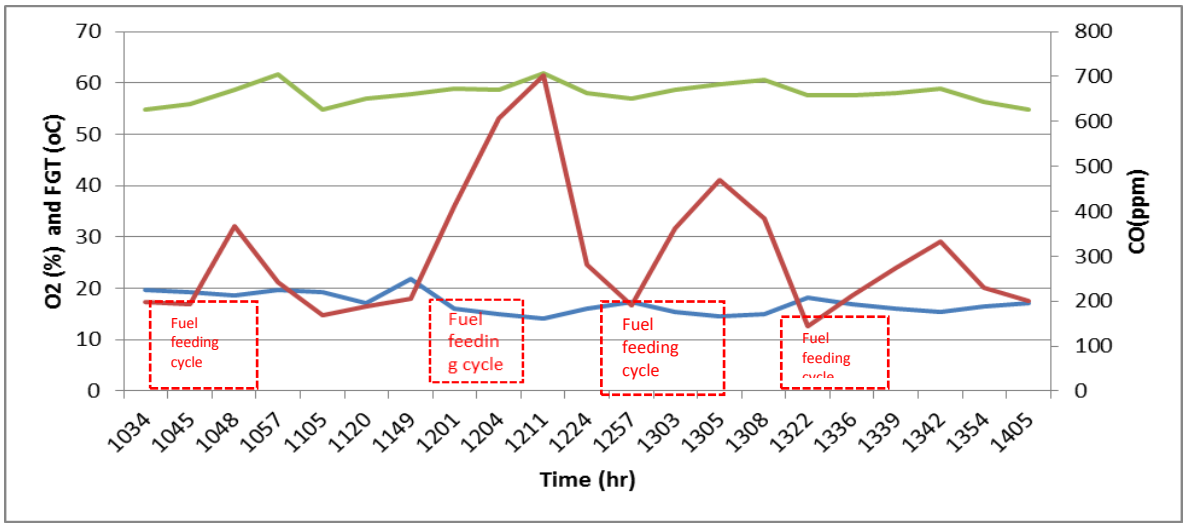


Figure 3.0: Variation of kiln parameters during kiln operation

3.6 Energy consumption

Type of fuel used	Coal
Coal consumption (kg/ day)	6552
Specific Energy Consumption (MJ/ kg-fired brick)	1.59

3.7 Energy balance

Component	Energy consumption (MJ/ton of fired clay)
Heat required for removal of mechanically held water in green bricks	29
Surface heat loss from kiln (top surface and side walls)	404
Other heat components*	1042
Heat loss in flue gases	77
Heat loss due to partial conversion to CO	18
Sensible heat loss in unloaded bricks	15
Total	1586

* Heat required for irreversible chemical reaction and losses such as trench bottom, periodic heating and cooling of kiln structure and due to un-burnt carbon in ash

3.8 Conclusion

The specific energy consumption (SEC) was observed to be high. Some of the factors that may attribute to high SEC level of the kiln include the following:

a) The kiln was not being operated efficiently. The kiln insulation was not proper. The temperature of the feedhole covers was in the range of 396 - 456°C. Similarly, thickness of rabbish at the kiln top was about 3.5 inches resulting in high top surface temperature in the pre-heating and firing zone in the range of 94 – 131°C.

b) Fuel feeding practices were observed to be poor. The fuel feeding frequency was about 55 minutes. Generally for coal fired BTKs the frequency of feeding should be about 30 minutes. The length of firing zone was too small as the firing was being carried out in two lines only against the conventional 3 lines. Similarly the length of cooling zone was very high. This might be one of the reasons for incomplete combustion of coal resulting in high percentage of un-burnt carbon in ash. The higher level of O_2 between two fuel feeding (14 to 21%) indicates either leakage in the kiln or less amount of fuel feedings resulting in higher fuel combustion.

c) Large variation of O_2 and CO level as shown in figure 3.0 indicates poor mixing of air with fuel and leakages in the kiln leading to high fuel consumption.

The acceptance letter from the unit owner regarding baseline energy audit is attached as Annexure 3.

4.0 Brick Kiln - 2

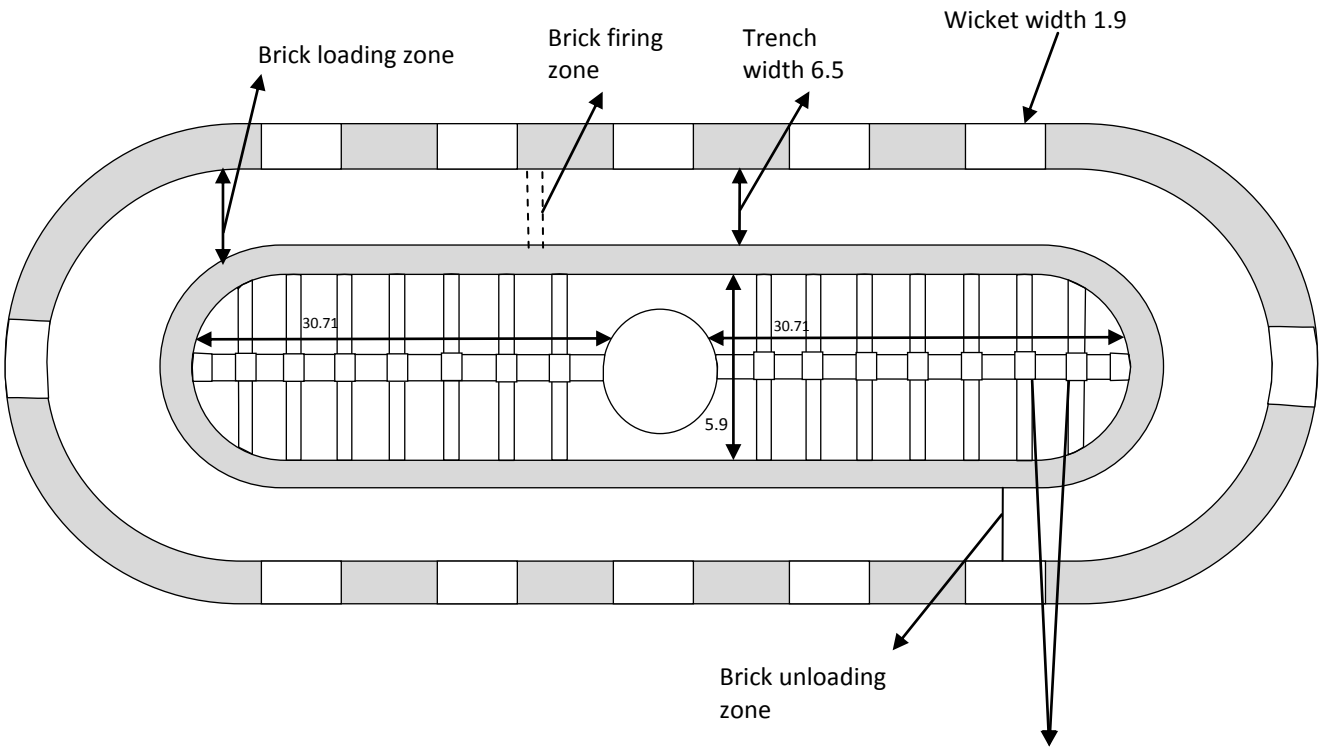
4.1 Basic information

Name of the kiln :	**M/s R.B. Company,**
Location of kiln :	Village Bandheya, Varanasi
Contact Person	Mr. Rameshwar Singh
Contact No.	9452731441

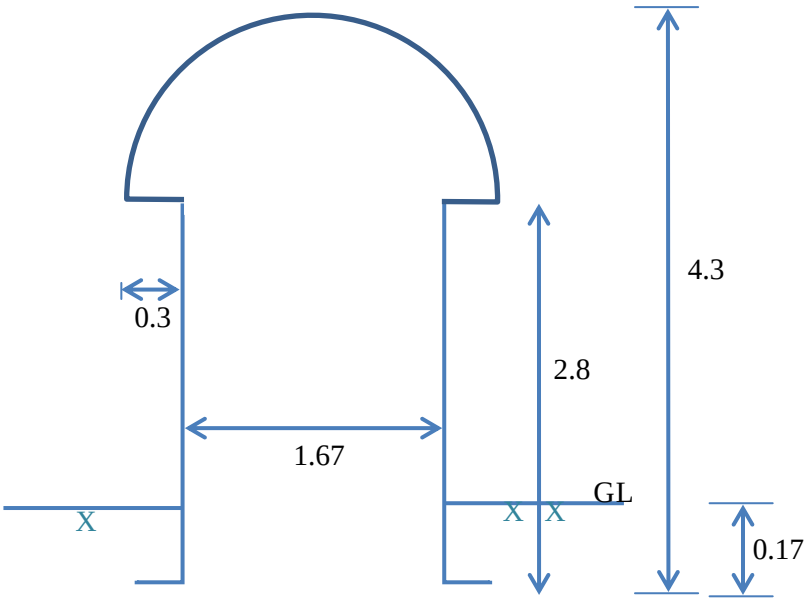
4.2 Details of brick kiln

Type of brick kiln	**Oval shaped BTK**
Green brick molding process	Hand molding
Production Capacity	7.5 lakh per circuit
Size of trench	
- Width of trench	6.5 meter
- Height of trench	2.5 meter

4.3 Schematic diagram



Note :All dimensions are in meter to scale)



Side Flue

All dimensions are in feet (not to

4.4 Brick production

Number of rows in each line	**21**
Number of columns in each line	19
Number of bricks per line	4000
Number of lines fired per day	7 - 8
Average Size of green brick (mm)	230 x 110 x 70
Average Weight of green brick (kg)	3.0
Average Size of fired brick (mm)	228 x 110 x 70
Average Weight of fired brick (kg)	3.0

4.5 Kiln Parameters

Parameter	Range
Ambient temperature (ºC)	42.3 – 52.4
Flue gas temperature (ºC)	59.1 – 94.7
O_2 (%)	11.9 – 18.1
CO (ppm)	202 - 2499
Firing Temperature (ºC)	920 - 955
Feed hole cover temperature (ºC)	283 - 330
Kiln surface temperature	
Preheating zone (ºC)	66
Firing zone (ºC)	83.6 – 84.7
Cooling zone (ºC)	119.2 – 134.4

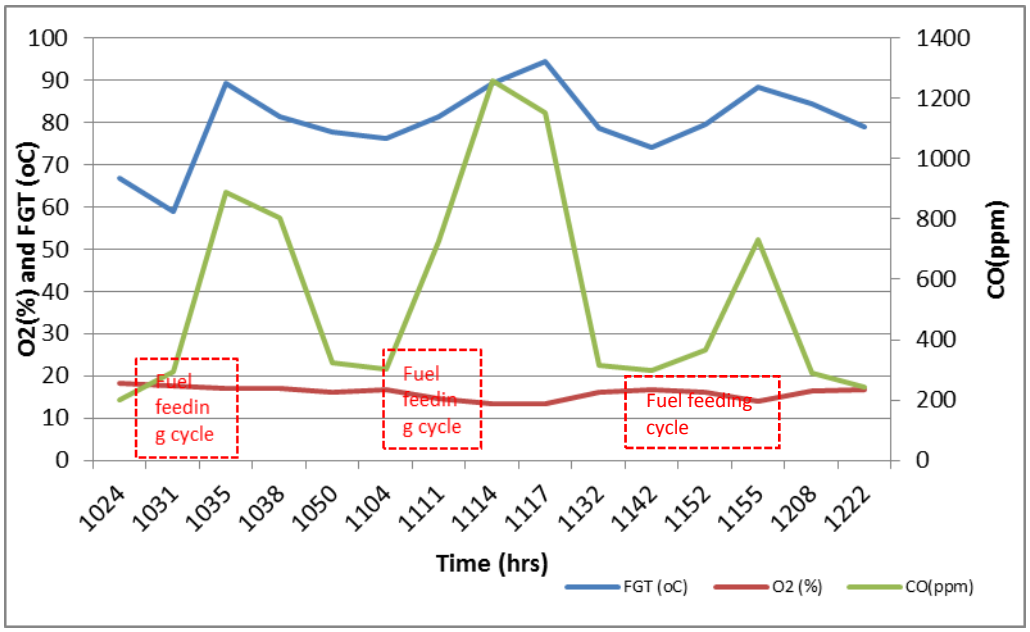


Figure 4.0: Variation in key parameters during kiln operation

4.6 Energy consumption

Type of fuel used	Coal
Coal consumption (kg/ day)	4400
Specific Energy Consumption (MJ/ kg-fired brick)	1.43

4.7 Energy balance

Component	Energy consumption (MJ/ton of fired clay)
Heat required for removal of mechanically held water in green bricks	146
Surface heat loss from kiln (top surface and side walls)	303
Other heat components*	892
Heat loss in flue gases	67
Heat loss due to partial conversion to CO	15
Sensible heat loss in unloaded bricks	11
Total	1434

* Heat required for irreversible chemical reaction and losses such as trench bottom, periodic heating and cooling of kiln structure and due to un-burnt carbon in ash

4.8 Conclusion

The specific energy consumption (SEC) was observed to be high. Some of the factors that may attribute to high SEC level of the kiln include the following:

a) The kiln was not being operated efficiently. The temperature of the feedhole covers was in the range of 283 - 330ºC. Fuel feeding practices were observed to be poor. The fuel feeding frequency was about 45 minutes. Generally for coal fired BTKs the frequency of feeding should be about 30 minutes. The length of firing zone was too small as the firing was being carried out in two lines only against the conventional 3 lines. Similarly the length of cooling zone and pre-heating zones were not proper. The higher level of O_2 between two fuel feeding (13 to 18%) indicates either leakage in the kiln or less amount of fuel feedings resulting in higher fuel combustion.

b) Large variation of O_2 and CO level as shown in figure 4.0 indicates poor mixing of air with fuel and leakages in the kiln leading to high fuel consumption.

The acceptance letter from the unit owner regarding baseline energy audit is attached as Annexure 4.

5.0 Brick kiln - 3

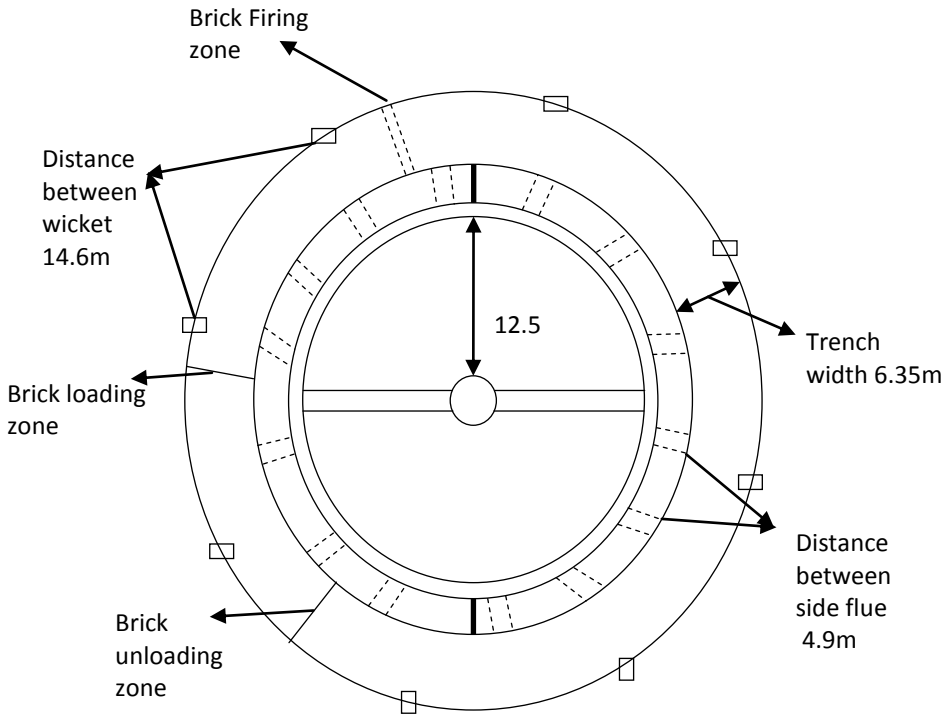
5.1 Basic information

Name of the kiln :	**M/s Khiladi Int Bhatta,**
Location of kiln :	Village Ravana Kalan, Munari , Varanasi
Contact Person	Mr. Moti Yadav
Contact No.	9451572064

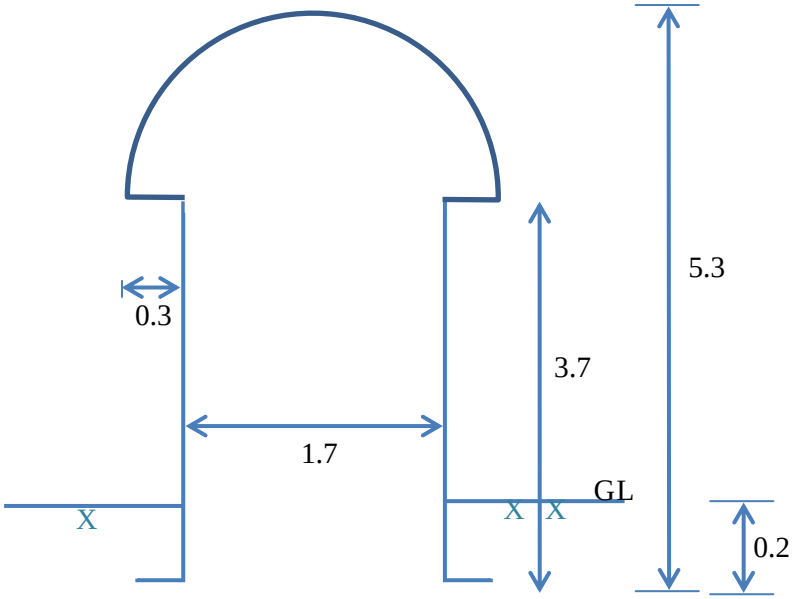
5.2 Details of brick kiln

Type of brick kiln	**Circular shaped BTK**
Green brick molding process	Hand molding
Production Capacity	5.0 lakh per circuit
Size of trench	
- Width of trench	6.3 meter
- Height of trench	2.2 meter

5.3 Schematic diagram



Note :All dimensions are in meter(not to scale)



Side Flue

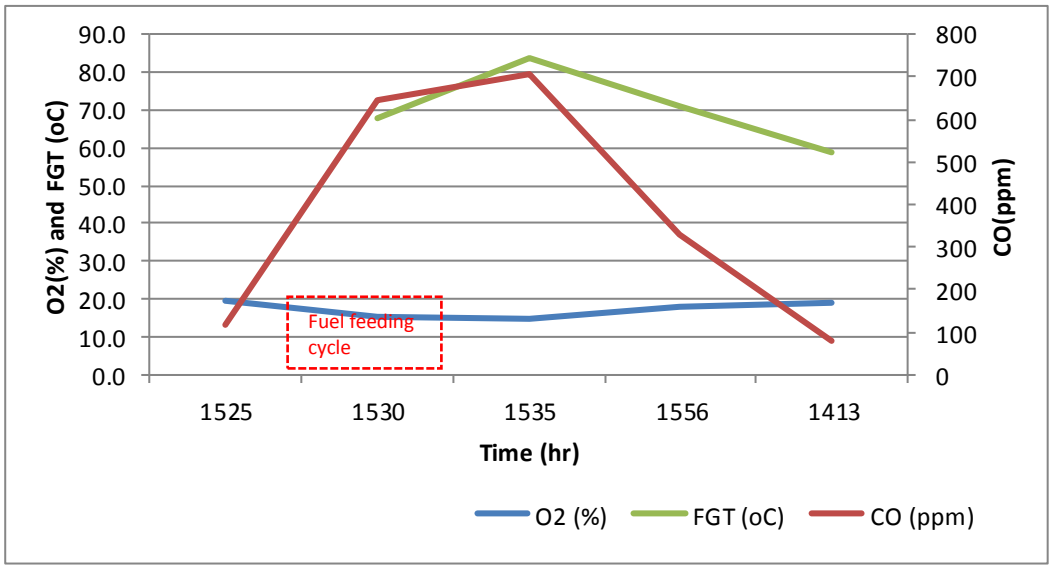
All dimensions are in feet (not to scale)

5.4 Brick production

Number of rows in each line	18
Number of columns in each line	22
Number of bricks per line	3300
Number of lines fired per day	8 - 9
Average Size of green brick (mm)	234 x 112 x 77
Average Weight of green brick (kg)	3.1
Average Size of fired brick (mm)	231 x 110 x 72
Average Weight of fired brick (kg)	2.9

5.5 Kiln Parameters

Parameter	Range
Ambient temperature (°C)	35 – 38.9
Flue gas temperature (°C)	47.5 – 50.2
O_2 (%)	17.2 – 18.3
CO(ppm)	115 - 331
Firing Temperature(°C)	975 - 998
Feed hole cover temperature (°C)	398 - 425
Kiln surface temperature	
Preheating zone (°C)	81.7 – 87.3
Firing zone (°C)	118.6 – 123.5
Cooling zone (°C)	135.1 – 137.9



5.6 Energy consumption

Type of fuel used	Coal
Coal consumption (kg/ day)	3960
Specific Energy Consumption (MJ/ kg-fired brick)	1.39

5.7 Energy balance

Component	Energy consumption (MJ/ton of fired clay)
Heat required for removal of mechanically held water in green bricks	113
Surface heat loss from kiln (top surface and side walls)	280
Other heat components*	892
Heat loss in flue gases	80
Heat loss due to partial conversion to CO	13
Sensible heat loss in unloaded bricks	16
Total	1393

* Heat required for irreversible chemical reaction and losses such as trench bottom, periodic heating and cooling of kiln structure and due to un-burnt carbon in ash

5.8 Conclusion

The specific energy consumption (SEC) was observed to be high. Some of the factors that may attribute to high SEC level of the kiln include the following:

a) The kiln was not being operated efficiently. The kiln insulation was not proper. The temperature of the feedhole covers was in the range of 398 - 425ºC. Fuel feeding practices were observed to be poor. The fuel feeding frequency was about 45 minutes. Generally for coal fired BTKs the frequency of feeding should be about 30 minutes. The length of firing zone was too small as the firing was being carried out in two lines only against the conventional 3 lines. Similarly the length of cooling zone was very high. This might be one of the reasons for incomplete combustion of coal resulting in high percentage of un-burnt carbon in ash. The higher level of O_2 between two fuel feeding (14 to 19%) indicates either leakage in the kiln or less amount of fuel feedings resulting in higher fuel combustion.

b) Large variation of O_2 and CO level as shown in figure 5.0 indicates poor mixing of air with fuel and leakages in the kiln leading to high fuel consumption.

The acceptance letter from the unit owner regarding baseline energy audit is attached as Annexure 5.

6.0 Brick kiln - 4

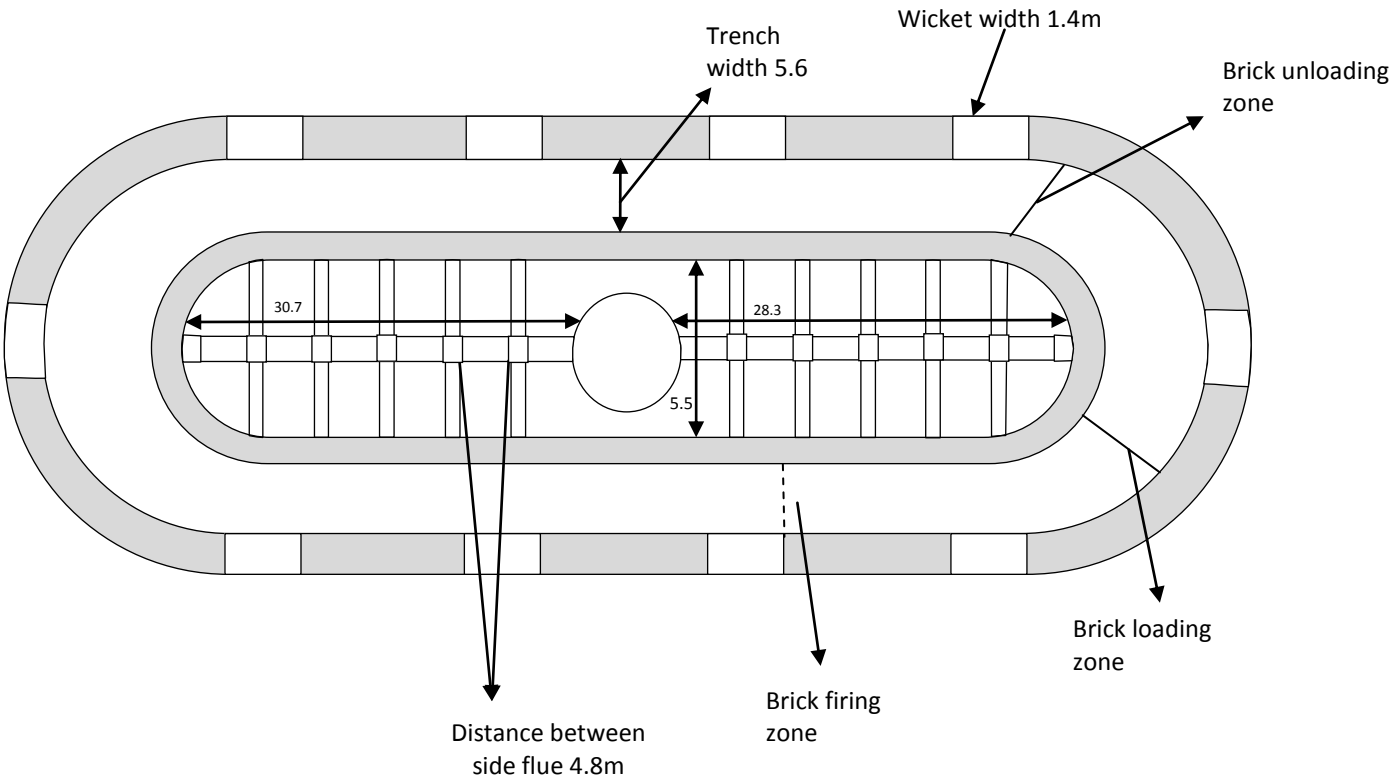
6.1 Basic information

Name of the kiln :	**M/s Swarup Int Udyog**
Location of kiln :	Village Gola Cholapur, Varanasi
Contact Person	Mr. Rajesh Singh
Contact No.	9415988553

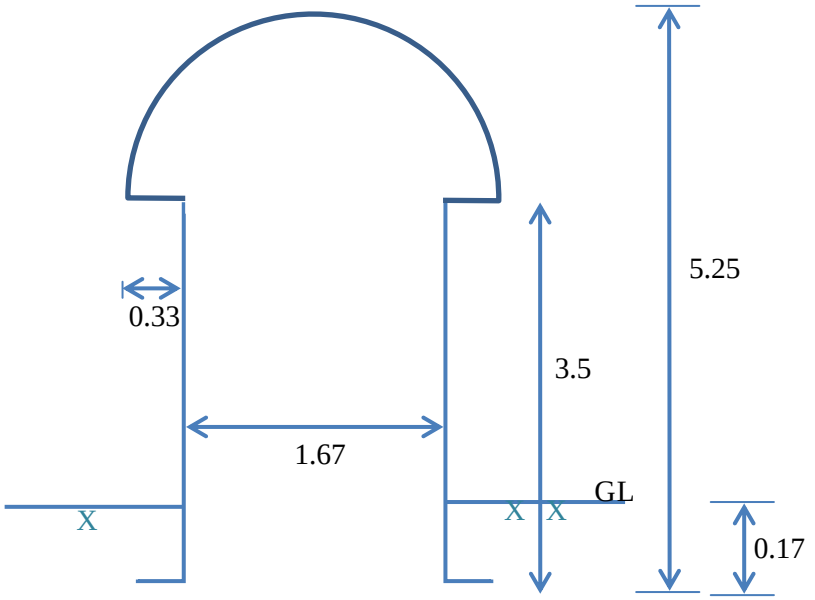
6.2 Details of brick kiln

Type of brick kiln	**Oval shaped BTK**
Green brick molding process	Hand molding
Production Capacity	6.0 lakh per circuit
Size of trench	
- Width of trench	5.6 meter
- Height of trench	2.3 meter

6.3 Schematic Diagram



Note : All dimensions are in meter (not to scale)



Side Flue

All dimensions are in feet (not to scale)

6.4 Brick production

Number of rows in each line	**20**
Number of columns in each line	17
Number of bricks per line	2500-3000
Number of lines fired per day	7 - 8
Average Size of green brick (mm)	232 x 109 x 70
Average Weight of green brick (kg)	3.0
Average Size of fired brick (mm)	231 x 109 x 70
Average Weight of fired brick (kg)	2.9

6.5 Kiln parameters

Parameter	Range
Ambient temperature (°C)	39.8 – 44.2
Flue gas temperature (°C)	80.9 – 134.3
O_2 (%)	18.3-19.5
CO (ppm)	216 - 264
Firing Temperature(°C)	989 - 1005
Feed hole cover temperature (°C)	405 - 428
Kiln surface temperature	
Preheating zone (°C)	131.8 – 143.3
Firing zone (°C)	122.5 – 156.8
Cooling zone (°C)	95.4 – 96.8

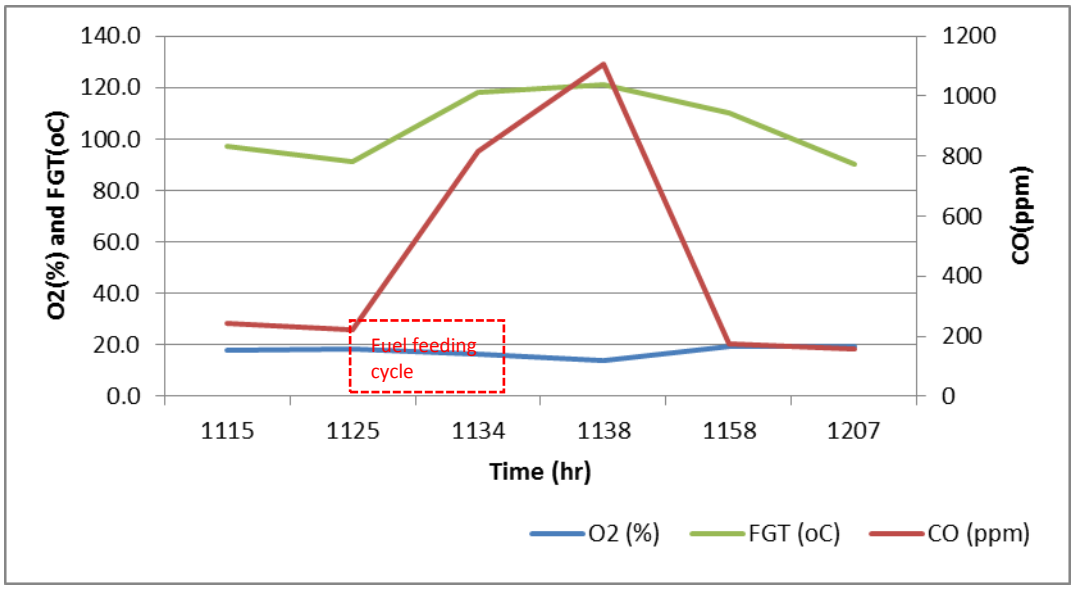


Figure 6.0 Variation in key parameters during kiln operation

6.6 Energy consumption

Type of fuel used	Coal
Coal consumption (kg/ day)	3290
Specific Energy Consumption (MJ/ kg-fired brick)	1.64

6.7 Energy balance

Component	Energy consumption (MJ/ton of fired clay)
Heat required for removal of mechanically held water in green bricks	59
Surface heat loss from kiln (top surface and side walls)	260
Other heat components*	1094
Heat loss in flue gases	189
Heat loss due to partial conversion to CO	24
Sensible heat loss in unloaded bricks	11
Total	1635

* Heat required for irreversible chemical reaction and losses such as trench bottom, periodic heating and cooling of kiln structure and due to un-burnt carbon in ash

6.8 Conclusion

The specific energy consumption (SEC) was observed to be high. Some of the factors that may attribute to high SEC level of the kiln include the following:

a) The kiln was not being operated efficiently as there was problem of green brick availability. The kiln walls were poorly maintained and the kiln insulation was not proper. The temperature of the feedhole covers was more than 400ºC and temperature at the outside of the wicket was about 91ºC, which were quite high.

b) Fuel feeding practices were observed to be poor. The fuel feeding frequency was more than 60 minutes. Generally for coal fired BTKs the frequency of feeding should be about 30 minutes. The length of firing zone was too small as the firing was being carried out in one line only against the conventional 3 lines. Similarly the length of cooling zone was very high. This might be one of the reasons for incomplete combustion of coal resulting in high percentage of un-burnt carbon in ash. The higher level of O_2 between two fuel feeding (14 to 19%) indicates either leakage in the kiln or less amount of fuel feedings resulting in higher fuel combustion.

c) Large variation of O_2 and CO level as shown in figure 6.0 indicates poor mixing of air with fuel and leakages in the kiln leading to high fuel consumption.

The acceptance letter from the unit owner regarding baseline energy audit is attached as Annexure 6.

7.0 Brick Kiln - 5

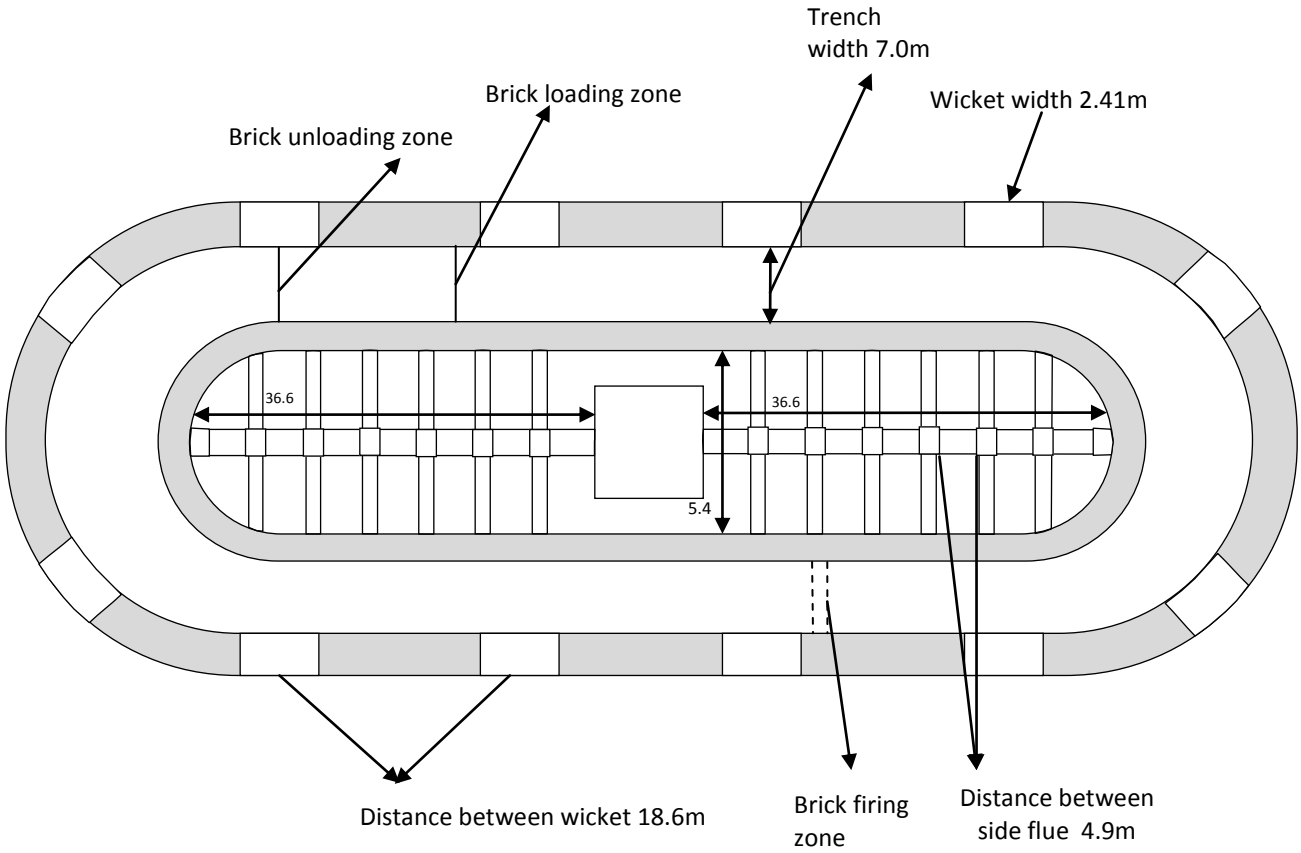
7.1 Basic information

Name of the kiln :	**M/s Asim Brick Field**
Location of kiln :	Village Undi, Varanasi
Contact Person	Mr. Kamlesh Narayan Singh
Contact No.	9415227670

7.2 Details of brick kiln

Type of brick kiln	**Oval shaped BTK (using ID fan with Chimney)**
Green brick molding process	Hand molding
Production Capacity (lakh per circuit)	9.0
Size of trench	
- Width of trench	7.0 meter
- Height of trench	2.3 meter

7.3 Schematic diagram



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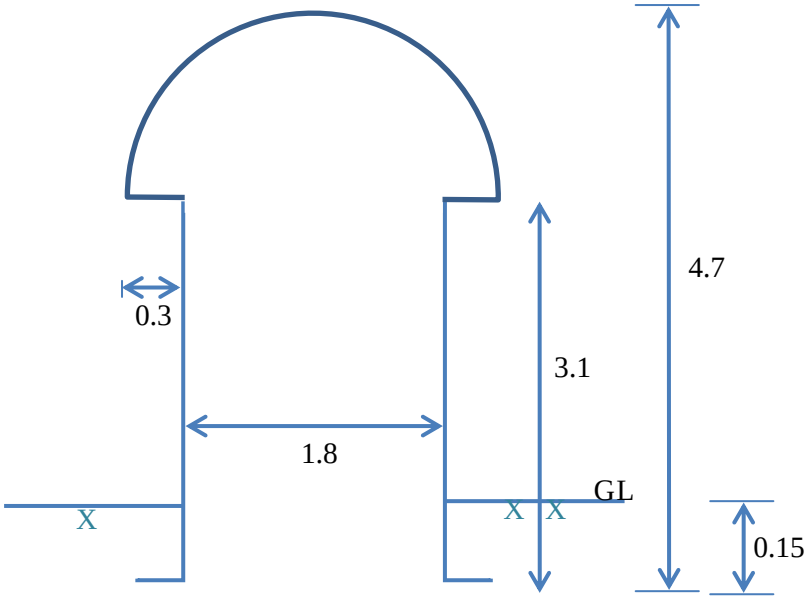


Side Flue

All dimensions are in feet (not to scale)

7.4 Brick production

Number of rows in each line	**20**
Number of columns in each line	20
Number of bricks per line	3300
Number of lines fired per day	8-10
Average Size of green brick (mm)	226 x 111 x 72
Average Weight of green brick (kg)	3.0
Average Size of fired brick (mm)	225 x 109 x 71
Average Weight of fired brick (kg)	2.9

7.5 Kiln parameters

Parameter	Range
Ambient temperature (°C)	31.1 – 32.2
Flue gas temperature (°C)	45.8 – 53.9
O_2 (%)	15.3 – 17.2
CO (ppm)	426 - 1576
Firing temperature(°C)	919 - 973
Feed hole cover temperature (°C)	156 - 245
Kiln surface temperature	
Preheating zone (°C)	58 – 76.3
Firing zone (°C)	86.2 – 104.3
Cooling zone (°C)	105 – 144.8

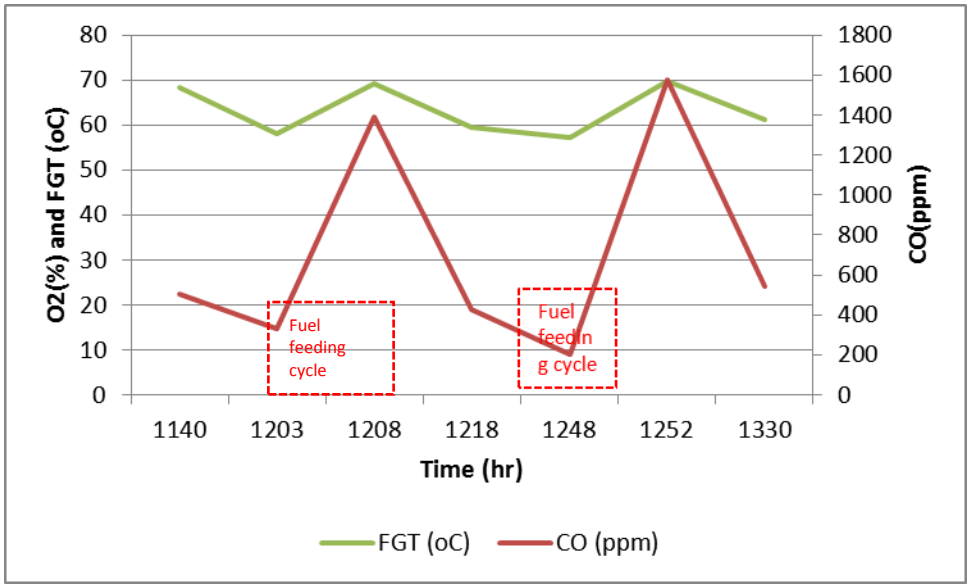


Figure 7.0: Variation in key parameters during kiln operation

7.6 Energy consumption

Type of fuel used	Coal and Sawdust
Coal consumption (kg/ day)	4015
Specific Energy Consumption (MJ/ kg-fired brick)	1.36

7.7 Energy balance

Component	Energy consumption (MJ/ton of fired clay)
Heat required for removal of mechanically held water in green bricks	145
Surface heat loss from kiln (top surface and side walls)	228
Other heat components*	894
Heat loss in flue gases	54
Heat loss due to partial conversion to CO	20
Sensible heat loss in unloaded bricks	19
Total	1360

* Heat required for irreversible chemical reaction and losses such as trench bottom, periodic heating and cooling of kiln structure and due to un-burnt carbon in ash

7.8 Conclusion

The specific energy consumption (SEC) was observed to be high. Some of the factors that may attribute to high SEC level of the kiln include the following:

a) The kiln insulation was not proper. The temperature of the feedhole covers was in the range of 156 - 245ºC and temperature at the outside of the wicket was about 64ºC, which were quite high. However, the kiln was using shunt system for side flue operation..

b) Fuel feeding practices were observed to be poor. The fuel feeding frequency was about 50 minutes. Generally for coal fired BTKs the frequency of feeding should be about 30 minutes. The length of firing zone was too small as the firing was being carried out in two lines only against the conventional 3 lines. Similarly the length of cooling zone was very high. This might be one of the reasons for incomplete combustion of coal resulting in high percentage of un-burnt carbon in ash. The higher level of O_2 between two fuel feeding (14 to 18%) indicates either leakage in the kiln or less amount of fuel feedings resulting in higher fuel combustion.

c) Large variation of O_2 and CO level as shown in figure 7.0 indicates poor mixing of air with fuel and leakages in the kiln leading to high fuel consumption.

The acceptance letter from the unit owner regarding baseline energy audit is attached as Annexure 7.

8.0 Brick kiln - 6

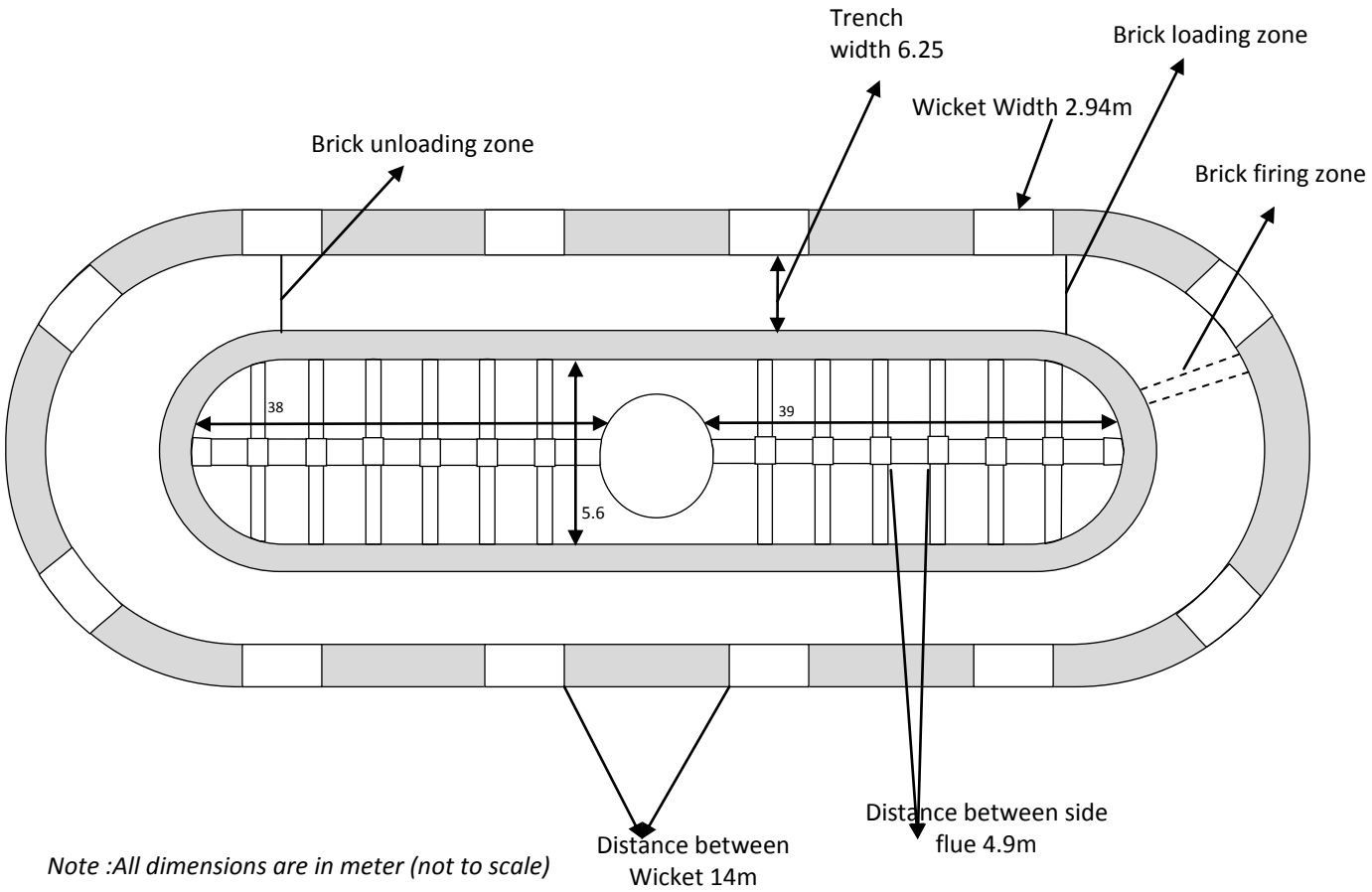
8.1 Basic information

Name of the kiln :	**M/s Shyam Int Udyog**
Location of kiln :	Village Jaipar, Varanasi
Contact Person	Mr. Inder Pal Singh
Contact No.	8808070622

8.2 Details of brick kiln

Type of brick kiln	**Oval shaped BTK**
Green brick molding process	Hand molding
Production Capacity	8.5 lakh per circuit
Size of trench	
- Width of trench	6.25 meter
- Height of trench	2.6 meter

8.3 Schematic diagram



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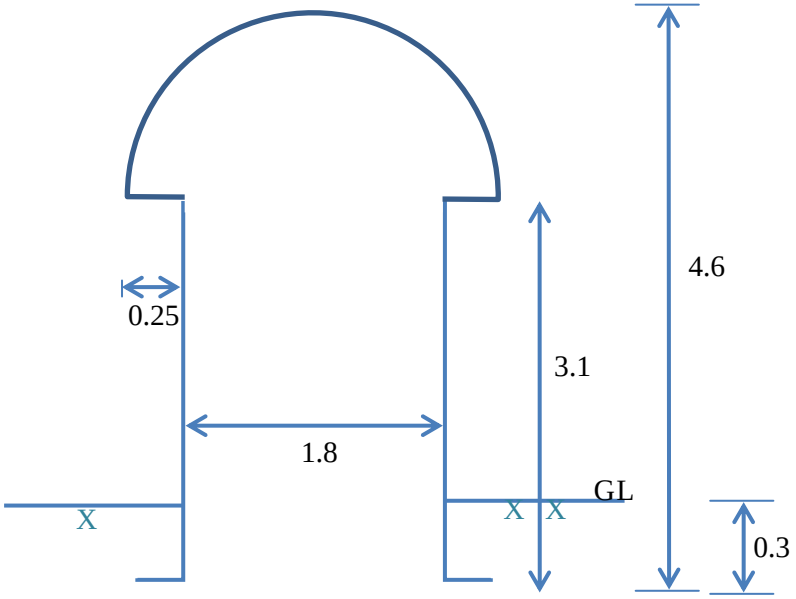


Side Flue

All dimensions are in feet (not to scale)

8.4 Brick production

Number of rows in each line	**22**
Number of columns in each line	20
Number of bricks per line	3200
Number of lines fired per day	8-10
Average Size of green brick (mm)	232 x 110 x 69
Average Weight of green brick (kg)	3.0
Average Size of fired brick (mm)	230 x 110 x 68
Average Weight of fired brick (kg)	2.9

8.5 Kiln Parameters

Parameter	Range
Ambient temperature (°C)	32.8 - 36.6
Flue gas temperature (°C)	60.5 – 96.6
O_2 (%)	14.8 – 19.4
CO(ppm)	58 - 985
Firing Temperature(°C)	903 - 935
Feed hole cover temperature (°C)	375 - 397
Kiln surface temperature	
Preheating zone (°C)	115.9 – 120.5
Firing zone (°C)	133.8 - 169
Cooling zone (°C)	151.2 – 179.9

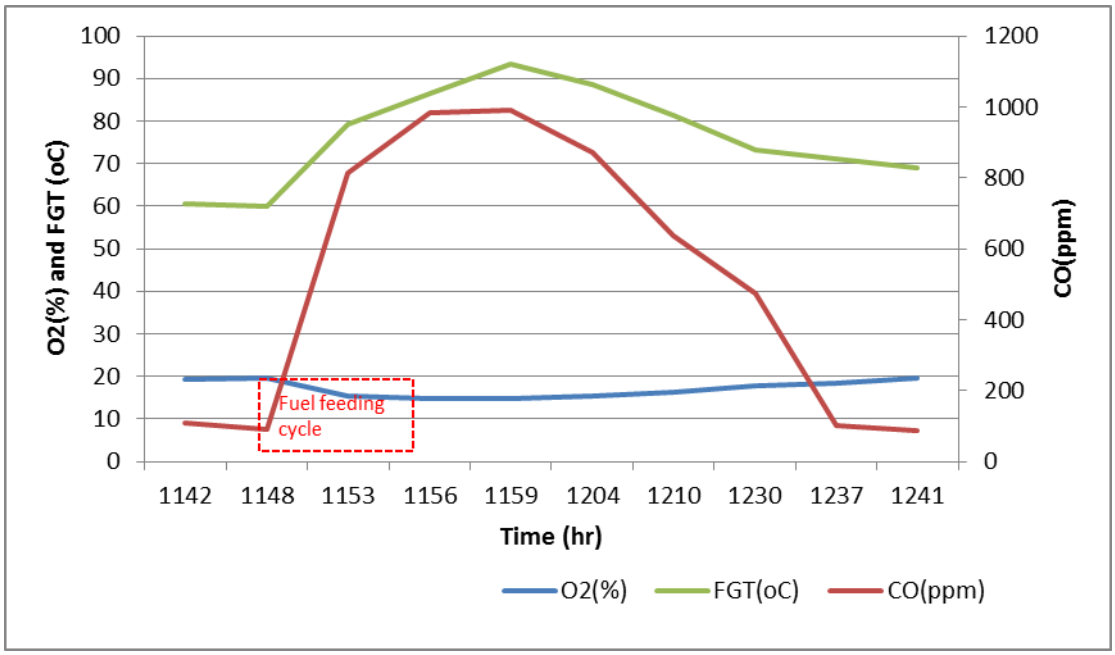


Figure 8.0: Variation in key parameters during kiln operation

8.6 Energy consumption

Type of fuel used	Coal
Coal consumption (kg/ day)	2709
Specific Energy Consumption (MJ/ kg-fired brick)	1.57

8.7 Energy balance

Component	Energy consumption (MJ/ton of fired clay)
Heat required for removal of mechanically held water in green bricks	177
Surface heat loss from kiln (top surface and side walls)	324
Other heat components*	911
Heat loss in flue gases	121
Heat loss due to partial conversion to CO	22
Sensible heat loss in unloaded bricks	21
Total	1573

* Heat required for irreversible chemical reaction and losses such as trench bottom, periodic heating and cooling of kiln structure and due to un-burnt carbon in ash

8.8 Conclusion

The specific energy consumption (SEC) was observed to be high. Some of the factors that may attribute to high SEC level of the kiln include the following:

a) The kiln was not being operated efficiently. The kiln insulation was not proper. The temperature of the top surface was in the range of 130 – 180ºC. The temperature of the feedhole covers was in the range of 375 - 397ºC and temperature at the outside of the wicket (about 74 feet from firing zone in the cooling zone) was about 80ºC, which was quite high.

b) Fuel feeding practices were observed to be poor. The fuel feeding frequency was about 45 minutes. Generally for coal fired BTKs the frequency of feeding should be about 30 minutes. The length of firing zone was too small as the firing was being carried out in two lines only against the conventional 3 lines. Similarly the length of cooling zone was very high. This might be one of the reasons for incomplete combustion of coal resulting in high percentage of un-burnt carbon in ash. The higher level of O_2 between two fuel feeding (14 to 19%) indicates either leakage in the kiln or less amount of fuel feedings resulting in higher fuel combustion.

c) Large variation of O_2 and CO level as shown in figure 8.0 indicates poor mixing of air with fuel and leakages in the kiln leading to high fuel consumption.

The acceptance letter from the unit owner regarding baseline energy audit is attached as Annexure 8.

9.0 Brick Kiln - 7

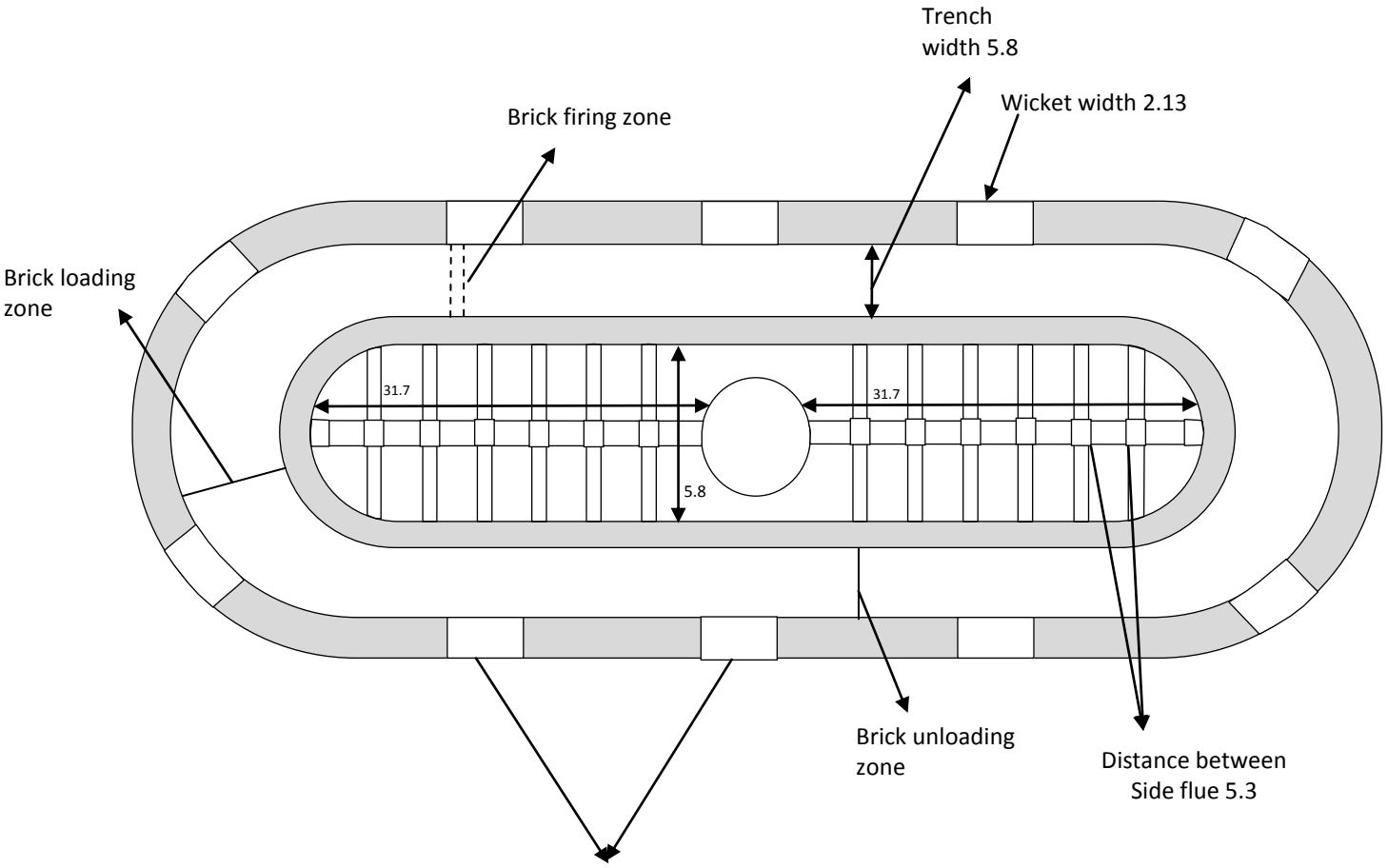
9.1 Basic information

Name of the kiln :	**M/s Shail Int Bhatta**
Location of kiln :	Village Raichandpur, Varanasi
Contact Person	Mr. Chandershekhar Singh
Contact No.	9918400421

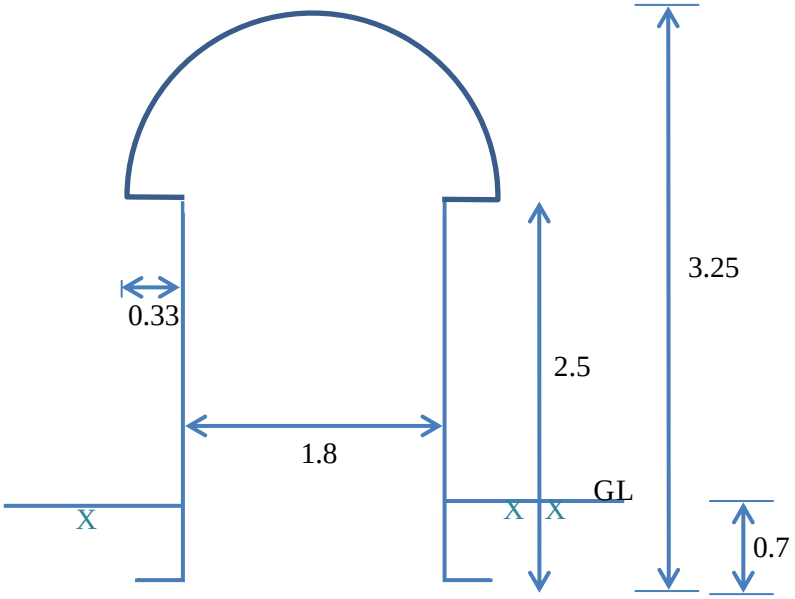
9.2 Details of brick kiln

Type of brick kiln	**Oval shaped BTK**
Production Capacity (lakh per circuit)	6.25
Size of trench	
- Width of trench (m)	5.8
- Height of trench(m)	2.5
Type of fuel used	Coal

9.3 Schematic diagram



Note :All dimensions are in meter(not in scale)



Side Flue

All dimensions are in feet (not to scale)

9.4 Brick production

Number of rows in each line	**22**
Number of columns in each line	17
Number of bricks per line	3000
Number of lines fired per day	7 - 8
Average Size of green brick (mm)	237 x 112 x 75
Average Weight of green brick (kg)	3.0
Average Size of fired brick (mm)	237 x 112 x 74
Average Weight of fired brick (kg)	2.9

9.5 Kiln parameters

Parameter	Range
Ambient temperature (°C)	32.2 – 37.3
Flue gas temperature (°C)	86.8 - 131
O_2 (%)	14.1 – 18.7
CO (ppm)	186 - 2280
Firing Temperature(°C)	946 - 1069
Feed hole cover temperature (°C)	310 - 324
Kiln surface temperature	
Preheating zone (°C)	59.8 – 63.8
Firing zone (°C)	97.8 – 102.5
Cooling zone (°C)	98.7 – 102.9

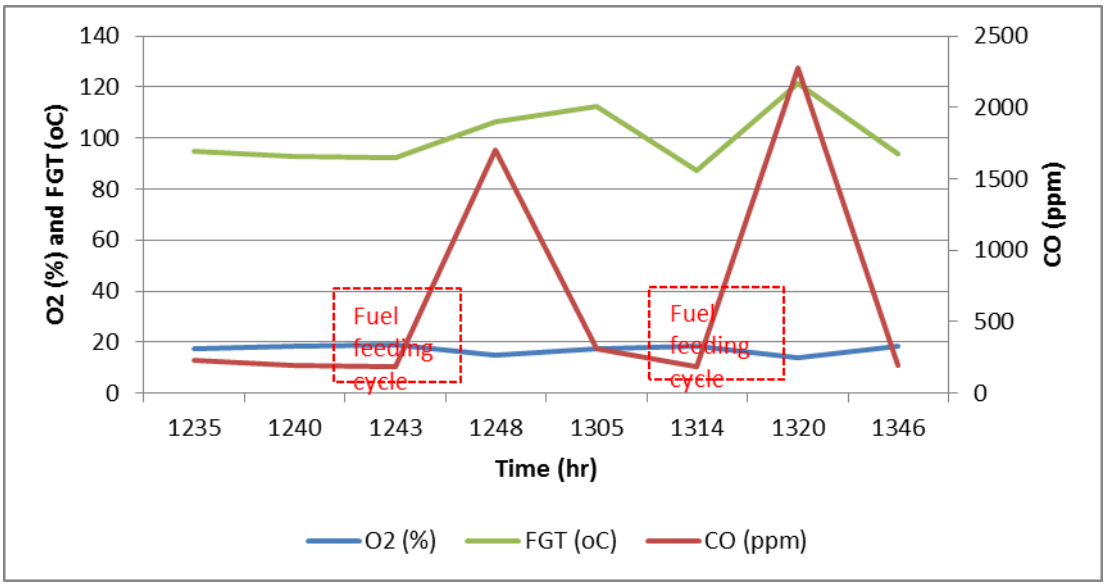


Figure 9.0: Variation of key parameters during kiln operation

9.6 Energy consumption

Type of fuel used	Coal
Coal consumption (kg/ day)	3480
Specific Energy Consumption (MJ/ kg-fired brick)	1.33

9.7 Energy balance

Component	Energy consumption (MJ/ton of fired clay)
Heat required for removal of mechanically held water in green bricks	117
Surface heat loss from kiln (top surface and side walls)	225
Other heat components*	799
Heat loss in flue gases	147
Heat loss due to partial conversion to CO	27
Sensible heat loss in unloaded bricks	19
Total	1332

* Heat required for irreversible chemical reaction and losses such as trench bottom, periodic heating and cooling of kiln structure and due to un-burnt carbon in ash

9.8 Conclusion

Compare to other brick kilns monitored in the region, this kiln is being operated efficiently. The shunt system is being used in the kiln and the fuel feeding frequency was also about 30 minutes. Some of the factors that may attribute to high SEC level of the kiln include the following:

a) The length of cooling zone was relatively more and the temperature of the kiln surface was higher and was in the range of 65 to 103^0C.
b) The length of firing zone was too small as the firing was being carried out in two lines only against the conventional 3 lines. Similarly the length of cooling zone was very high. This might be one of the reasons for incomplete combustion of coal resulting in high percentage of un-burnt carbon in ash. The higher level of O_2 between two fuel feeding (14 to 18%) indicates either leakage in the kiln or less amount of fuel feedings resulting in higher fuel combustion.
c) Large variation of O_2 and CO level as shown in figure 9.0 indicates poor mixing of air with fuel and leakages in the kiln leading to high fuel consumption.

The acceptance letter from the unit owner regarding baseline energy audit is attached as Annexure 9.

10.0 Brick kiln - 8

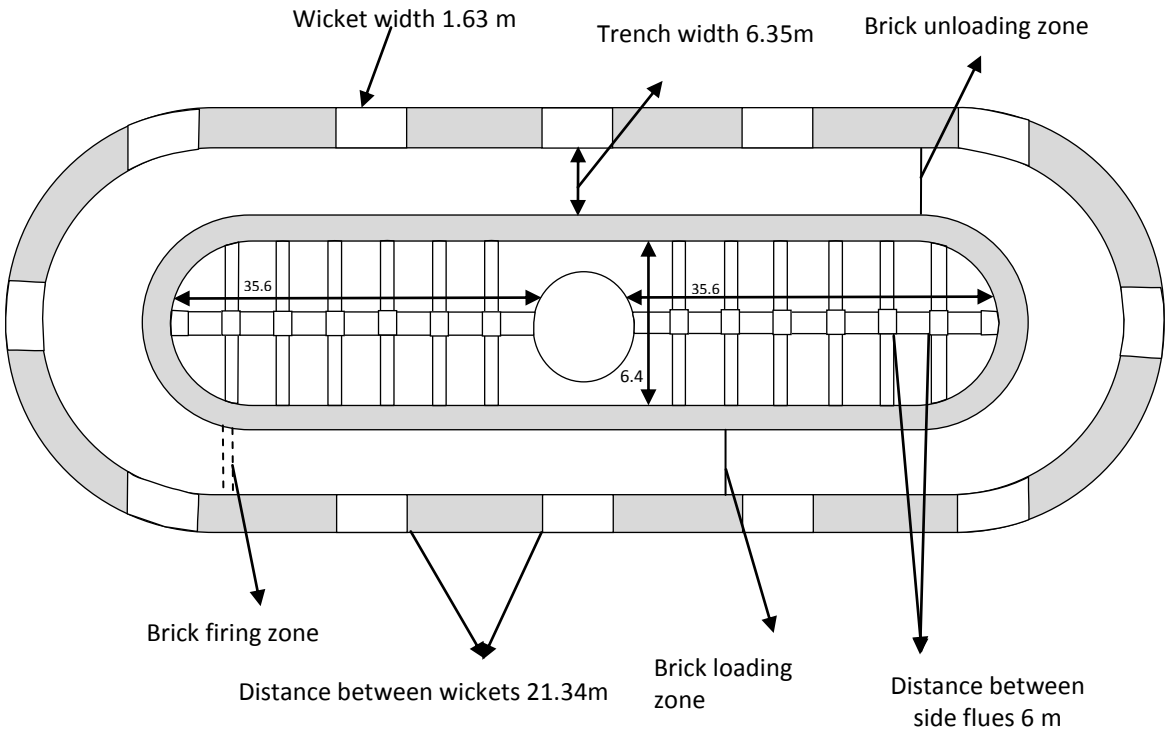
10.1 Basic information

Name of the kiln	**M/s Sahara Brick Industry**
Location of kiln	Village Sultanpur, Sarnath, Varanasi
Contact Person	Mr. VirenderTiwari
Contact No.	9415301553

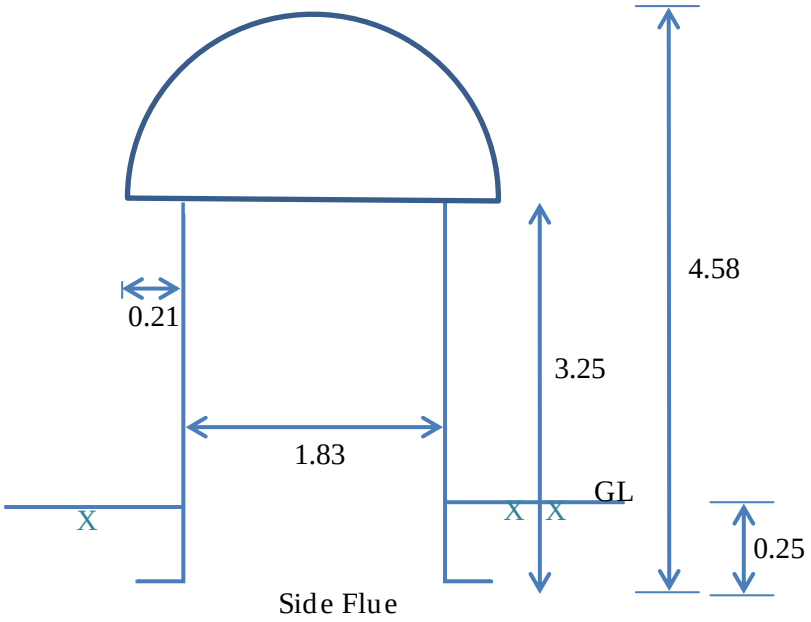
10.2 Details of brick kiln

Type of brick kiln	**Oval shaped BTK**
Green brick molding process	Hand molding
Brick production capacity	7.0 lakh per circuit
Size of trench	
- Width of trench	6.35 metre
- Height of trench	2.72 etre

10.3 Schematic diagram of kiln



Note :All dimensions are in meter (not to scale)



*All dimensions are in feet (not to scale)

10.4 Brick production

Number of rows in each line	**21**
Number of columns in each line	19
Number of bricks per line	3800
Number of lines fired per day	7 – 8
Average size of green brick (mm)	235 x 115 x 69
Average weight of green brick (kg)	3.0
Average size of fired brick (mm)	234 x 115 x 69
Average weight of fired brick (kg)	2.9

10.5 Kiln parameters

Parameter	Range
Ambient temperature (°C)	34.6 – 37.7
Flue gas temperature (FGT) (°C)	542 – 770
Oxygen (O_2) (%)	14.9 – 18.5
CO(ppm)	174 – 832
Firing temperature (°C)	999 – 1032
Feed hole cover temperature (°C)	429 – 440
Kiln surface temperature	
Preheating zone (°C)	53-59
Firing zone (°C)	60-63
Cooling zone (°C)	60-65

The key operating parameters covering one fuel feeding cycle is shown in figure 10.0

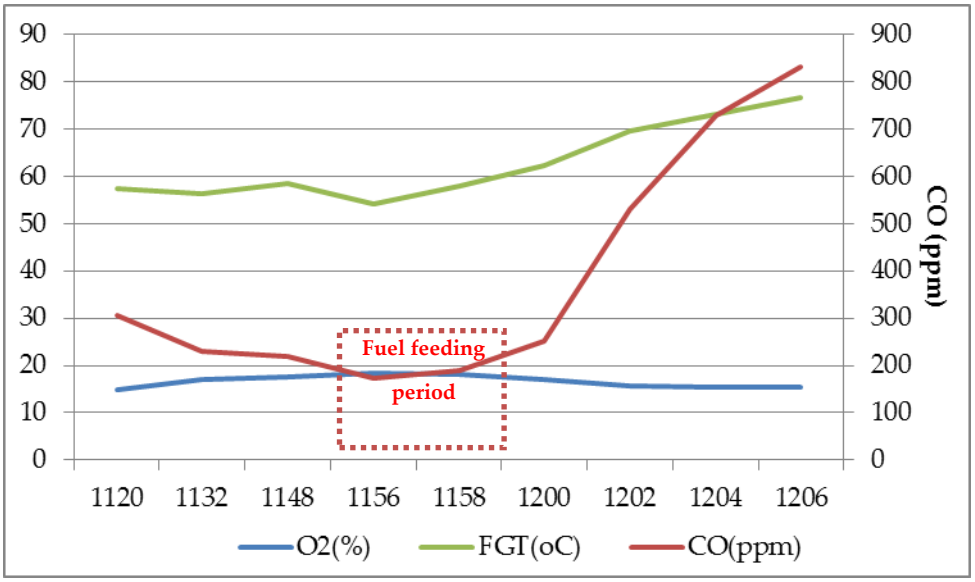


Figure 310.0: Variation in key parameters during kiln operation

10.6 Energy consumption

Type of fuel used	Coal
Coal consumption (kg/ day)	5760
Specific Energy Consumption (MJ/ kg-fired brick)	1.54

10.7 Energy balance

Component	Energy consumption (MJ/ton of fired clay)
Heat required for removal of mechanically held water in green bricks	94
Surface heat loss from kiln (top surface and side walls)	329
Other heat components*	1050
Heat loss in flue gases	43
Heat loss due to partial conversion to CO	14
Sensible heat loss in unloaded bricks	7
Total	1537

* Heat required for irreversible chemical reaction and losses such as trench bottom, periodic heating and cooling of kiln structure and due to un-burnt carbon in ash

10.8 Conclusion

The specific energy consumption (SEC) was observed to be high. Some of the factors that may attribute to high SEC level of the kiln include the following:

a) The kiln was not being operated efficiently. The kiln insulation was not proper. The temperature of the feedhole covers was in the range of 429 - 440°C and temperature at the outside of the wicket was about 90°C, which were quite high.

b) Fuel feeding practices were observed to be poor. The fuel feeding frequency was about 45 minutes. Generally for coal fired BTKs the frequency of feeding should be about 30 minutes. The length of firing zone was too small as the firing was being carried out in two lines only against the conventional 3 lines. Similarly the length of cooling zone was very high. This might be one of the reasons for incomplete combustion of coal resulting in high percentage of un-burnt carbon in ash. The higher level of O_2 between two fuel feeding (14 to 18%) indicates either leakage in the kiln or less amount of fuel feedings resulting in higher fuel combustion.

c) Large variation of O_2 and CO level as shown in figure 10.0 indicates poor mixing of air with fuel and leakages in the kiln leading to high fuel consumption.

The acceptance letter from the unit owner regarding baseline energy audit is attached as Annexure 10.

11.0 Brick kiln - 9

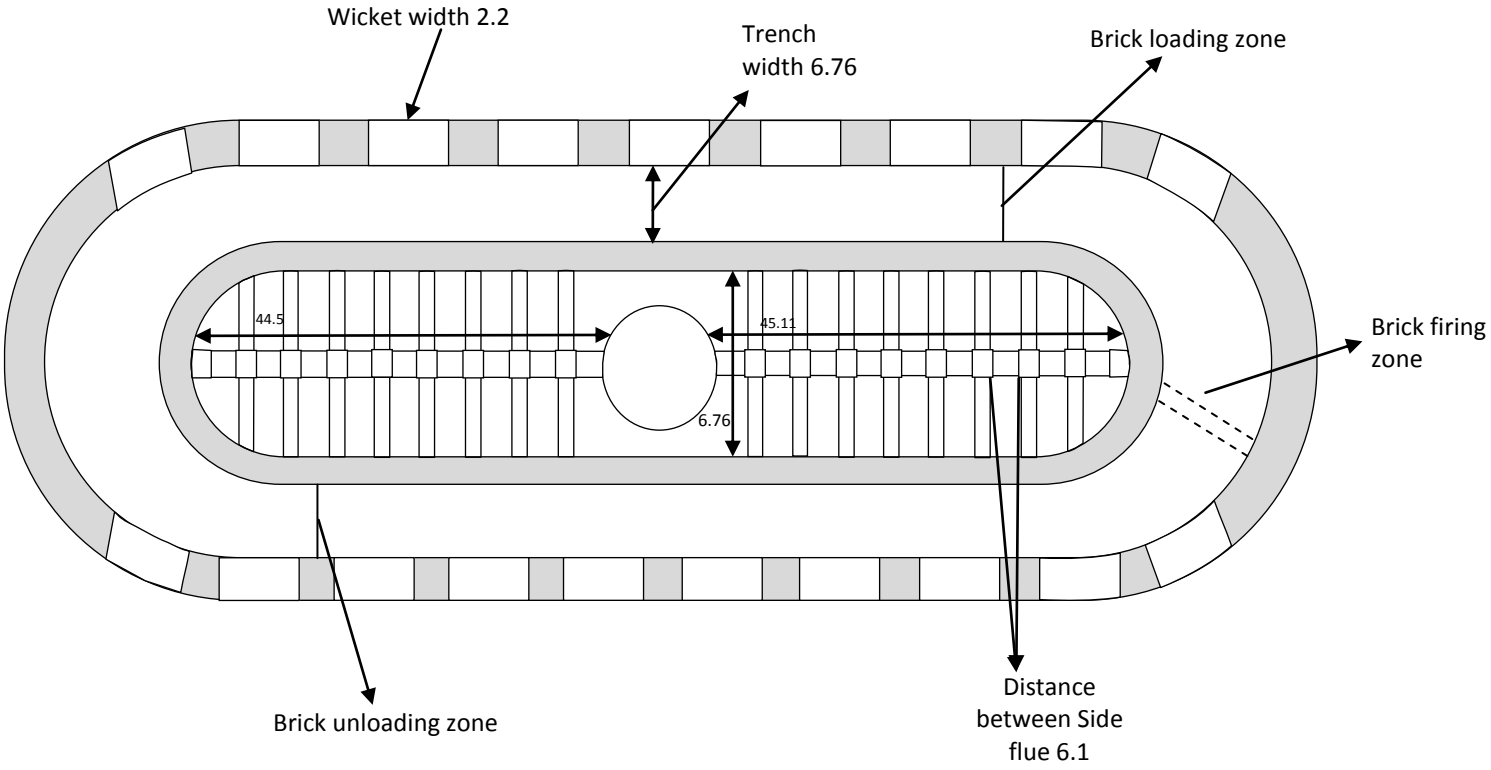
11.1 Basic information

Name of the kiln :	**M/s Dilip Kumar**
Location of kiln :	Village Todarpur, Mohan sarai
Contact Person	Mr. Dilip Kumar
Contact No.	9839156613

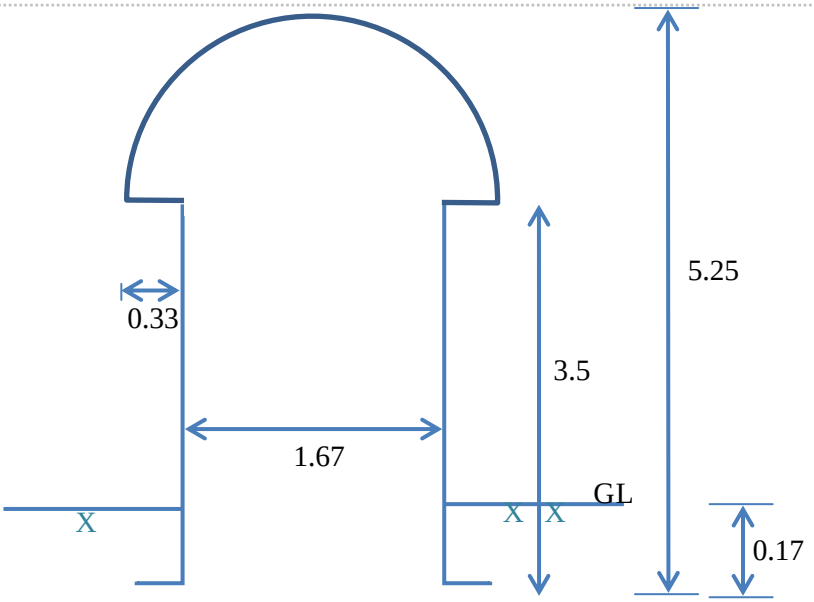
11.2 Details of brick kiln

Type of brick kiln	**Oval shaped BTK**
Green brick molding process	Hand molding
Production Capacity	9.5 lakh per circuit
Size of trench	
- Width of trench	6.76 meter
- Height of trench	2.74 meter
Type of fuel used	Coal

11.3 Schematic diagram



Note :All dimensions are in meter (not to scale)



Side Flue

All dimensions are in feet (not to scale)

11.4 Brick production

Number of rows in each line	**21**
Number of columns in each line	19
Number of bricks per line	3500
Number of lines fired per day	9 - 10
Average Size of green brick (mm)	228 x 113 x 72
Average Weight of green brick (kg)	3.0
Average Size of fired brick (mm)	225 x 110 x 72
Average Weight of fired brick (kg)	2.9

11.5 Kiln Parameters

Parameter	Range
Ambient temperature (°C)	35.7 – 44.9
Flue gas temperature (°C)	52.1 – 58.0
Oxygen (O_2) (%)	14.1 – 18.0
CO(ppm)	192 - 850
Firing Temperature(°C)	1024 - 1035
Feed hole cover temperature (°C)	270.8 – 303.6
Kiln surface temperature	
Preheating zone (°C)	76.6 – 108.9
Firing zone (°C)	115.4 – 122.9
Cooling zone (°C)	131.1 – 159.7

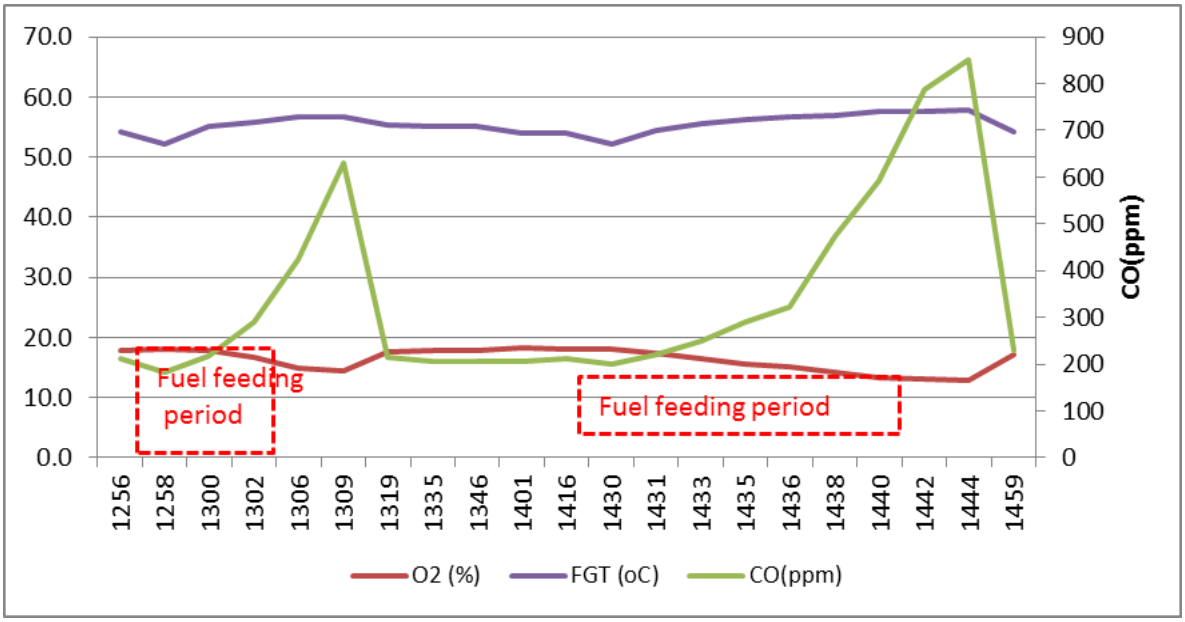


Figure 11.0: Variation in kiln parameters during kiln operation

11.6 Energy consumption

Type of fuel used	Coal
Coal consumption (kg/ day)	5376
Specific Energy Consumption (MJ/ kg-fired brick)	1.53

11.7 Energy balance

Component	Energy consumption (MJ/ton of fired clay)
Heat required for removal of mechanically held water in green bricks	74
Surface heat loss from kiln (top surface and side walls)	274
Other heat components*	1112
Heat loss in flue gases	43
Heat loss due to partial conversion to CO	10
Sensible heat loss in unloaded bricks	17
Total	1529

* Heat required for irreversible chemical reaction and losses such as trench bottom, periodic heating and cooling of kiln structure and due to un-burnt carbon in ash

11.8 Conclusion

The specific energy consumption (SEC) was observed to be high. Some of the factors that may attribute to high SEC level of the kiln include the following:

a) The temperature of the feedhole covers was in the range of 271 -304 ºC resulting in heat loss from the feed hole covers. Similarly the temperature of the kiln surface was in the range of 80 – 160 ºC, which was quite high.

b) Fuel feeding practices were observed to be poor. The fuel feeding frequency was about 75 minutes. Generally for coal fired BTKs the frequency of feeding should be about 30 minutes. The length of firing zone was too small as the firing was being carried out in two lines only against the conventional 3 lines. Similarly the length of cooling zone was very high. This might be one of the reasons for incomplete combustion of coal resulting in high percentage of un-burnt carbon in ash. The higher level of O_2 between two fuel feeding (12 to 18%) indicates either leakage in the kiln or less amount of fuel feedings resulting in higher fuel combustion.

c) Large variation of O_2 and CO level as shown in figure 11.0 indicates poor mixing of air with fuel and leakages in the kiln leading to high fuel consumption.

The acceptance letter from the unit owner regarding baseline energy audit is attached as Annexure 11.

12.0 Brick kiln - 10

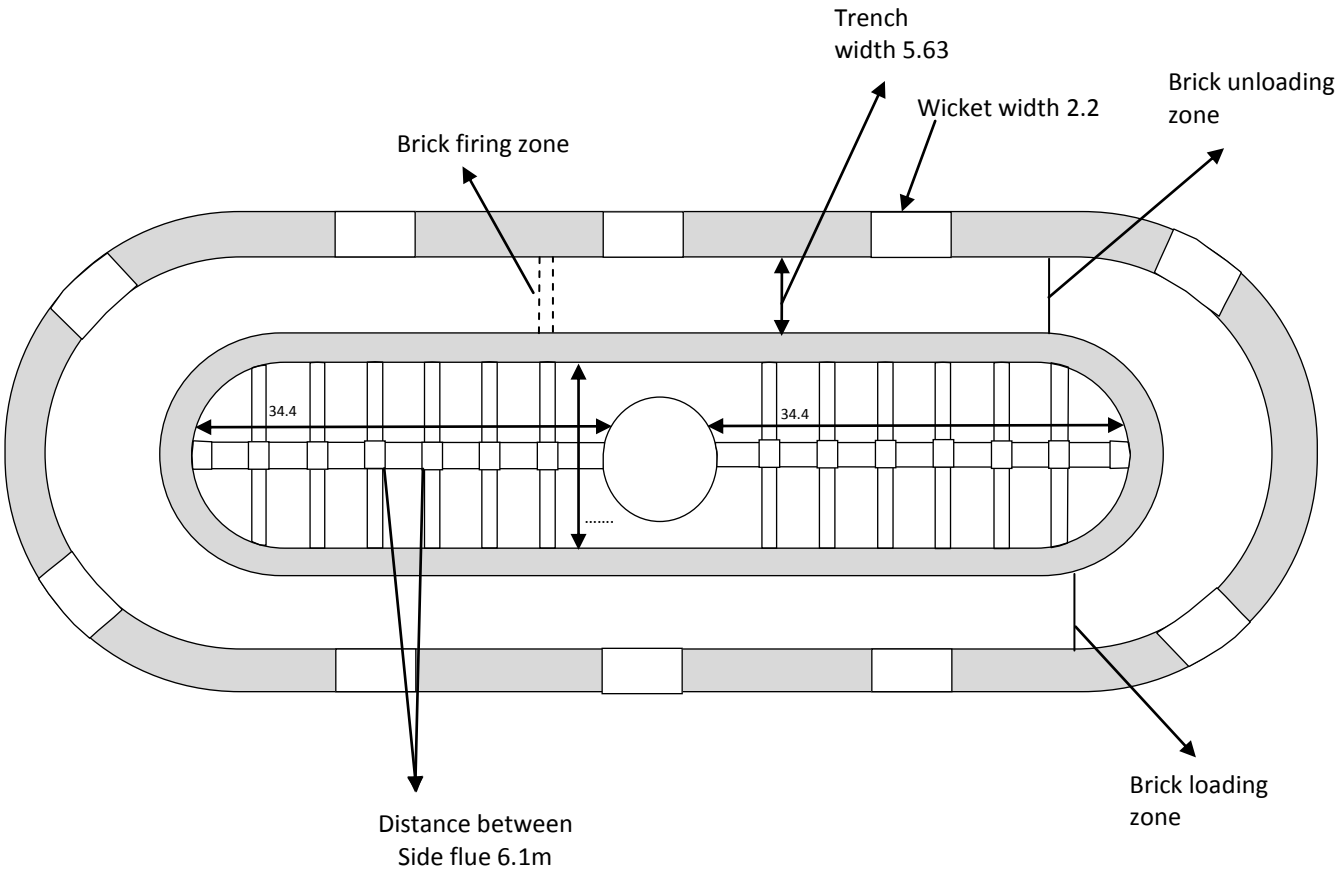
12.1 Basic information

Name of the kiln	**M/s B.S. Enterprises**
Location of kiln	Village Gosainpur Mahaon, Varanasi
Contact Person	Mr. Akshyawar yadav
Contact No.	9415302080

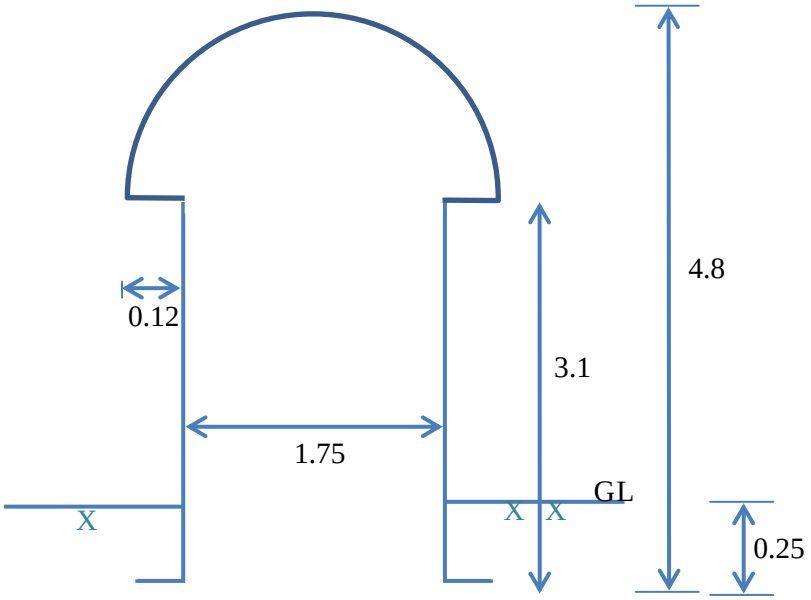
12.2 Details of brick kiln

Type of brick kiln	**Oval shaped BTK**
Green brick molding process	Hand molding
Production Capacity	9 lakh per circuit
Size of trench	
- Width of trench	5.6 meter
- Height of trench	2.6 meter

12.3 Schematic diagram



Note :All dimensions are in meter



Side Flue

All dimensions are in feet (not to scale)

12.4 Brick production

Number of rows in each line	**22**
Number of columns in each line	17
Number of bricks per line	3000
Number of lines fired per day	8-9
Average Size of green brick (mm)	232 x 111 x 71
Average Weight of green brick (kg)	3.0
Average Size of fired brick (mm)	230 x 110 x 70
Average Weight of fired brick (kg)	2.9

12.5 Kiln parameters

Parameter	Range
Ambient temperature (°C)	32.2 – 36.5
Flue gas temperature (°C)	55.3 – 67.2
O_2 (%)	15.5 – 17.8
CO(ppm)	168 - 1886
Firing temperature (°C)	1007 - 1026
Feed hole cover temperature (°C)	332.6 – 379.6
Kiln surface temperature	
Preheating zone (°C)	85.7 – 110.5
Firing zone (°C)	85.1 – 89.6
Cooling zone (°C)	115.5 – 135.2

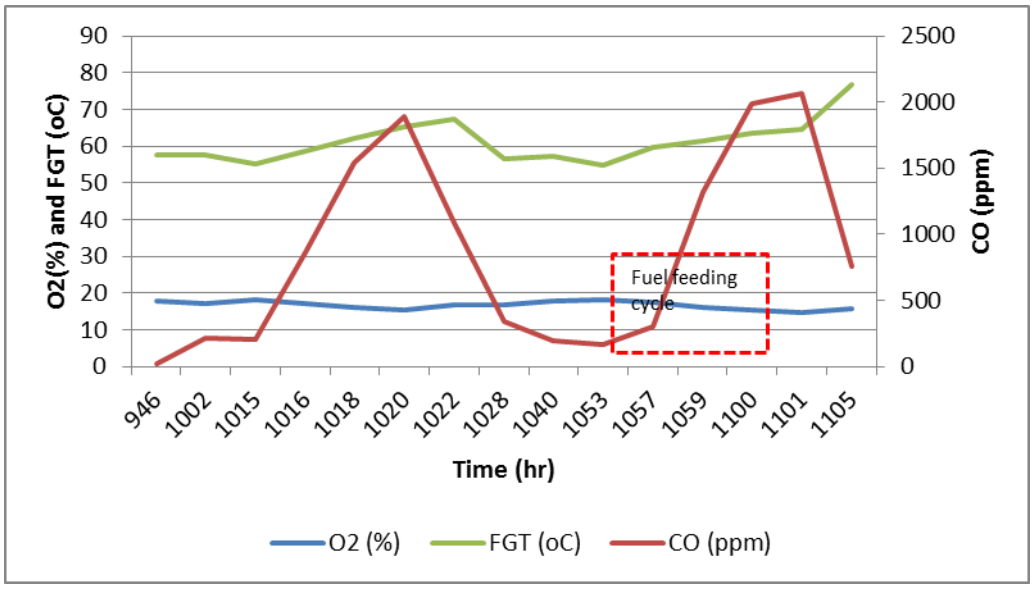


Figure 12.0: Variation of key parameter during kiln operation

12.6 Energy consumption

Type of fuel used	Coal
Coal consumption (kg/ day)	3584
Specific Energy Consumption (MJ/ kg-fired brick)	1.67

12.7 Energy balance

Component	Energy consumption (MJ/ton of fired clay)
Heat required for removal of mechanically held water in green bricks	101
Surface heat loss from kiln (top surface and side walls)	222
Other heat components*	1254
Heat loss in flue gases	56
Heat loss due to partial conversion to CO	25
Sensible heat loss in unloaded bricks	17
Total	1674

* Heat required for irreversible chemical reaction and losses such as trench bottom, periodic heating and cooling of kiln structure and due to un-burnt carbon in ash

12.8 Conclusion

The specific energy consumption (SEC) was observed to be high. Some of the factors that may attribute to high SEC level of the kiln include the following:

- ✓ The first round of the kiln was in operation and generally more heat is required during first round to heat up the kiln structure.
- ✓ The kiln was not being operated efficiently. The kiln insulation was not proper. The temperature of the feedhole covers was in the range of 330 - 380°C and temperature at the outside of the wicket was about 80°C, which were quite high.

- ✓ The fire in the kiln was not running smoothly and in order to control the same the quantity and frequency of fuel feeding was erratic. The higher level of O_2 between two fuel feeding (14 to 18%) indicates either leakage in the kiln or less amount of fuel feedings resulting in higher fuel combustion.

- ✓ Large variation of O_2 and CO level as shown in figure 3.5 indicates poor mixing of air with fuel and leakages in the kiln leading to high fuel consumption.

The acceptance letter from the unit owner regarding baseline energy audit is attached as Annexure 12.

Annexure 3

Tin No. 09781906558

M/S SINGH INTT BHATTHA UDYOG

KHARUPUR NARAYANPUR VARANASI

Ref Date

20.08.2015

TO WHOMSOEVER IT MAY CONCERN

This is to confirm that The Energy and Resources Institute (TERI) had carried out baseline audit in our Kiln M/s Singh Intt Bhattha Udyog, Village Kharupur, Varanasi. We have seen the baseline audit report of our kiln prepared by TERI. We confirm that baseline audit report is acceptable to us.

Parikshit Singh

प्रोप्राइटर
सिंह ईंट भट्ठा उद्योग
खरूपुर,नरायनपुर,वाराणसी

(PARIKSHIT SINGH)
Proprietor

Annexure 4

TIN No. 09181906156
WEF 10/11/08

9415201067
Mob. : 9415205136
9415826251

R. B. COMPANY

BHANDHA, KAITHI
VARANASI

Ref. No. ..... Date .....

20.08.2015

TO WHOMSOEVER IT MAY CONCERN

This is to confirm that The Energy and Resources Institute (TERI) had carried out baseline audit in our Kiln M/s R.B. Company, Village Bhandha, Kaithi, Varanasi. We have seen the baseline audit report of our kiln prepared by TERI. We confirm that baseline audit report is acceptable to us.

For R. B. Company

Proprietor

RIP मार्का प्रयोग करें।

Annexure 5

TIN No 09881908938 Mob. 9451572064

खेलाड़ी ईंट भट्ठा

रौना कला, सुनारी-वाराणसी

पत्रांक..... दिनांक 20-08-2015

20.08.2015

TO WHOMSOEVER IT MAY CONCERN

This is to confirm that The Energy and Resources Institute (TERI) had carried out baseline audit in our Kiln M/s Khiladi Int Bhatta, Village Raunakalan, Varanasi. We have seen the baseline audit report of our kiln prepared by TERI. We confirm that baseline audit report is acceptable to us.

खेलाड़ी ईंट भट्ठा
रौना कला पुनारी
वाराणसी

Annexure 6

TIN No. 09383701816 Mob. :

स्वरूप ईंट उद्योग

उच्चकोटि के ईंट के निर्माता व विक्रेता

गोला मोहाँव (चोलापुर), वाराणसी

पत्रांक..... दिनांक 20-8-2015

TO WHOMSOEVER IT MAY CONCERN

This is to confirm that The Energy and Resources Institute (TERI) had carried out baseline audit in our Kiln M/s Swarup Int Udyog, Village Gola, Cholapur, Varanasi. We have seen the baseline audit report of our kiln prepared by TERI. We confirm that baseline audit report is acceptable to us.

वास्ते, स्वरूप ईंट उद्योग

प्रोप्राइटर

Annexure 7

20.08.2015

TO WHOMSOEVER IT MAY CONCERN

This is to confirm that The Energy and Resources Institute (TERI) had carried out baseline audit in our Kiln M/s Asim Brick Field, Village Undi, Varanasi. We have seen the baseline audit report of our kiln prepared by TERI. We confirm that baseline audit report is acceptable to us.

Aseem Brick Field
KNff
Partner

Annexure 8

PAN : ACFPS7750Q
TIN : 09585304550

09415207373
Cell : 09415523200
08933907373

SHYAM INT UDYOG

Office : J-12/19, Dhoopchandi, Jagatganj, Varanasi (U. P.) 221001
Residence : Matiyari, Belawn, Deokali, Kerakat, Jaunpur (U. P.)

Ref. No. :

Date : 20.08.2015

TO WHOMSOEVER IT MAY CONCERN

This is to confirm that The Energy and Resources Institute (TERI) had carried out baseline audit in our Kiln M/s Shyam Int Udyog, Village Jaipar, Varanasi. We have seen the baseline audit report of our kiln prepared by TERI. We confirm that baseline audit report is acceptable to us.

Annexure 9

टिन : 09283802241 / 30.10.2003

शैल ईंट भट्ठा

9918400421
रैचन्दपुर–वाराणसी
मो. ~~9936499775,~~
9415353947

पत्रांक

दिनांक 20/08/2015

20.08.2015

TO WHOMSOEVER IT MAY CONCERN

This is to confirm that The Energy and Resources Institute (TERI) had carried out baseline audit in our Kiln M/s Shail Int Bhatta, Village Raichandpur, Varanasi. We have seen the baseline audit report of our kiln prepared by TERI. We confirm that baseline audit report is acceptable to us.

वास्ते शैल ईंट भट्ठा

प्रोप्राइटर

Annexure 10

TIN No. 09881911606S

Mob No. 9415301553
9839615530

Sahara Brick Industries

Vill. Sultanpur, Sarnath, Varanasi

Ref :

Date:
20.08.2015

TO WHOMSOEVER IT MAY CONCERN

This is to confirm that The Energy and Resources Institute (TERI) had carried out baseline audit in our Kiln M/s Sahara Brick Industries, Village Sultanpur, Sarnath, Varanasi. We have seen the baseline audit report of our kiln prepared by TERI. We confirm that baseline audit report is acceptable to us.

सहारा ब्रिक इन्डस्ट्रीज
वी.के.तिवारी
प्रोप्राइटर

Annexure 11

Tin No.09482302399

मेसर्स दिलीप कुमार

D63/63 A17 आदर्श नगर महमुरगंज वाराणसी

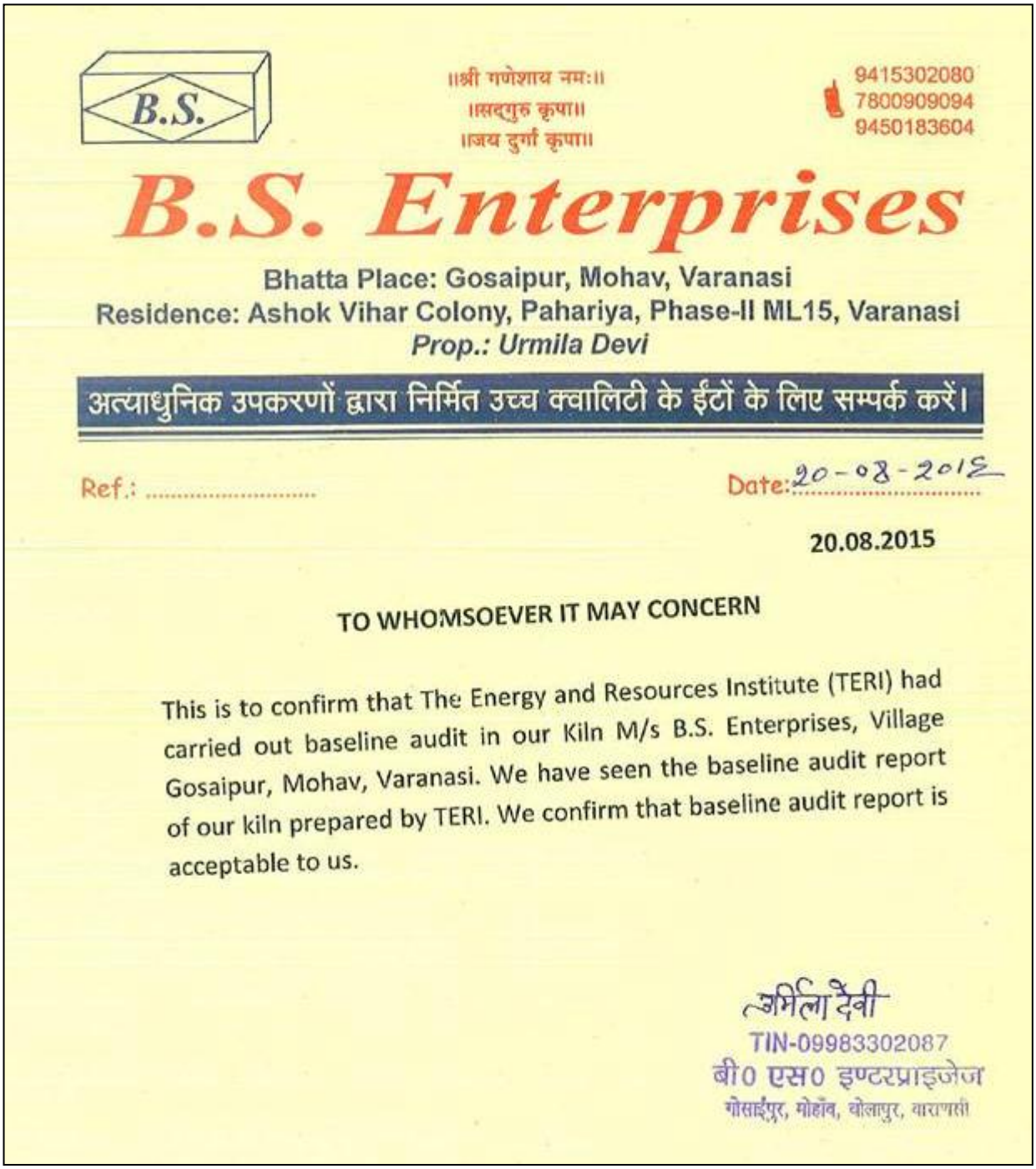
पत्रांक..... दिनांक.....

TO WHOMSOEVER IT MAY CONCERN

This is to confirm that The Energy and Resources Institute (TERI) had carried out baseline audit in our Kiln M/s Dilip Kumar, Village Todarpur, Varanasi. We have seen the baseline audit report of our kiln prepared by TERI. We confirm that baseline audit report is acceptable to us.

M/s Dilip kumar
Proprietor

Annexure 12



B.S.

॥श्री गणेशाय नमः॥
॥सद्गुरु कृपा॥
॥जय दुर्गा कृपा॥

9415302080
7800909094
9450183604

B.S. Enterprises

Bhatta Place: Gosaipur, Mohav, Varanasi
Residence: Ashok Vihar Colony, Pahariya, Phase-II ML15, Varanasi
Prop.: Urmila Devi

अत्याधुनिक उपकरणों द्वारा निर्मित उच्च क्वालिटी के ईंटों के लिए सम्पर्क करें।

Ref.: .....

Date: 20-08-2015

20.08.2015

TO WHOMSOEVER IT MAY CONCERN

This is to confirm that The Energy and Resources Institute (TERI) had carried out baseline audit in our Kiln M/s B.S. Enterprises, Village Gosaipur, Mohav, Varanasi. We have seen the baseline audit report of our kiln prepared by TERI. We confirm that baseline audit report is acceptable to us.

उर्मिला देवी
TIN-09983302087
बी0 एस0 इण्टरप्राइजेज
गोसाईंपुर, मोहॉव, बोलापुर, वाराणसी