Chapter -6
TQM via Design & TEM in Mini Cement Plants

6.1.0 Introduction:
This chapter considers various facets of S.S.I. Units – Mini Cement Plants with reference to TQM. The concept of TQM and its implementation by “Operations Research” seems to be far away in majority of S.S.I. – as these units are “one man manager enterprises”. However, there appears to be a pressing need to study and analyze in detail the implementation of TQM in S.S.I. units.

Mini cement plants come under the category of S.S.I. units. Mini cement plants generally start manufacturing of cement from Clinker – supplied to S.S.I. units by big manufactures of cement.

In Mini Cement Plants wherein all the operations after clinker formation like crushing grinding, mixing etc are identical with that of any big cement plant. However, sizes of these equipments also become mini depending on manufacturing capacity of the plant.

Thus, Mini Cement plants are also “energy intensive plants” and TEM measures is as such also a necessity in these plants. However, these – one man manager enterprises simply do not bother about implementation of even TEM.

Hence, TQM implementation is also ruled out.

Further, stringent Pollution Control Measures put up by the pollution control Board are not being followed by these units. These units also do not bother about Implementation of Cleaner Production Principles (CPP). Overall result being, many mini cement plants are on the verge of closure.

Detailed study on Thermal Engineering Aspects in Mini Cement Plants and Implementation of TEM was carried out for the following units:

1. Parasmani Industries, Bamanbor (Surendranagar)
2. Dhara Cement Industries, Koyba, (Surendranagar)
3. Kamdhenu Cement, Kuvadava (Rajkot)
4. Sharad Industries, Bamanbore, (Surendranagar)
5. Raghuvir Cement Industries, Metoda, (Rajkot)
6. Tapee Cement Industries, Metoda, (Rajkot)
7. Vikas Enterprise, Chikhli (Navsari)
8. Rambo Cement Pvt. Ltd., Metoda, (Rajkot)
9. Mahuva Cement & Grinding, Bhadra, (Bhavnagar)
10. Kailash Cement Industries, Metoda, (Rajkot)
11. Toranto Cement Industries, Jamwali (Rajkot)
12. Ghanshyam Industries, Bamanbore, (Surendranagar)
13. Royal Industries, Hadamtala Industries Area (Gondal)
14. Pruthvi Portland Pvt. Ltd., Veraval (Rajkot)
15. Shree Radheshyam Cement Pvt. Ltd., Chauta (Porbandar)
16. Shri Om Industries, Bamanbore (Surendranagar)
17. Mohit Cement Industries, Padra, Vadodara
18. Sayona Cement Pvt. Ltd., Gondal, Rajkot
19. Dharmkiriti Concrete Pvt. Ltd., Ardoi, Rajkot

A typical mini cement plant manufacturing process is shown in Figure 6.1 which consists of clinker formation from lime stone followed by clinker grinding units.

By appropriate Mechanical Design of Pollution Control Equipments and utilizing only such certified equipments in the plant, can solve their – Pollution Control Board problem. Effective implementation of TQM via Design will only help these entrepreneurs. The approach appears to be costly as it involves increase in expenditure of fixed capital cost, however, ultimately after running a mini cement plant at least for a year, and implementing TEM measures collectively and simultaneously, will certainly yield a “favorable result”. However, during initial period of 1 to 2 years there may be no financial gain.
Figure 6.1 Cement Plant Manufacturing Process
6.2.0 Important Energy Conservation Measures in Mini Cement Plant:
Based on manufacturing process flowsheets in the above mentioned 19 mini cement plants and relevant thermal engineering aspects, following are the important energy conservation measures (ECM) suggested in mini cement plants.

- Incorporation of a Screen to separate fines and small particles to avoid fine generation in crushing
- Incorporation of a magnetic separator to separate iron pieces in coal, which may damage the crusher
- Arrest leakages coming from crushers, hammer mill
- Enclosure for Belt Conveyor to be provided from Jaw Crusher to Hammer mill
- Energy Saving by installation of Variable frequency Drive's for Crushers, Grinders, Kiln, etc
- Energy Saving by using properly size motors
- Avoid use of rewound motors
- Energy Saving by replacement of inefficient lamps with energy efficient lamps
- Energy Saving by means of adopting Natural Lighting
- Coal saving by using alternative fuel in the Vertical Shaft Kiln (VSK)
- Coal saving by Waste heat recovery from Flue Gas
- Temperature in various zones of VSK to be maintained by installation of Thermocouple followed by adequate monitoring
- Install online oxygen analyzer for the flue gas to control excess air and also to monitor the combustion efficiency of Vertical Shaft Kiln
- Providing better outer surface insulation to the burning zone of VSK
- Reduce the kiln stoppage time by better management practices

6.3.0 Pollution Control via Computer Aided Design and Drawings:
Depending on plant capacity, sizes of different equipments get altered. Hence, computerized programme for design of pollution control equipments was prepared and accordingly detailed engineering drawings for these equipments were drawn. All these drawings are a function of mini cement plant capacity. As plant capacity changes design parameters do get change and accordingly design modifications are required in mini cement plants to implement TQM in plant.

Quality of cement produced in a mini cement plant is expected to be good only if working of cement plant is satisfactory. Pollution levels in a mini cement plant are expected to be at lowest level and below the permissible limits prescribed by GPCB only if mini cement plant is operated satisfactorily. Thus quality of cement is expected to be an indirect function of pollution level in a mini cement plant. If efficiency of pollution control equipments is 100%, pollution level in that plant will be at lowest level. This is expected to be feasible only if pollution control equipments are designed appropriately by following computerized design procedure.

A typical mini cement plant – based on Vertical Shaft Kiln Technology is shown in Figure 6.2 which consists of clinker formation from lime stone followed by clinker grinding units.

In the unit under consideration, sources of air pollutants will be as under wherein implementation of Cleaner Production Principles (CPP) needs to be considered in detail:

- Jaw Crusher Operation
- Hammer Mill operation
- Raw Mill operation
- Kiln Operation
- Cement Mill Operation
- All Materials Silo
- Packing Section
Figure 6.2 Typical Mini Cement Plant
6.3.1 Pollution Control Equipment Pulse Jet Bag Filter Inclusive of Typical Design

Drawing:

Pulse Jet bag filter will be installed at crushing section, raw materials proportioning section, raw mill section, blending & storage section, cement mill section and packing section. The pulse jet bag filters and their suction are as shown in the figures 6.3 to 6.6.

The bag filter is made of a metallic housing designed for continuous operation and automatic cleaning. The dirty gas enters through the collector in the bottom part of the body, being sent to the baffle, where the heavier particle is separated and the lighter material is carried away along with the gas pass through the filtering bags wherein all the particulates are collected.

The bag cleaning process is automatically performed through compressed air pulses that are controlled by a timer system. The compressed air is stored in a reservoir located at the upper side of the filter body. Above each row of bags, there is a tube with multiple holes that are aligned with the central air passage gap located on top of the bags, through which compressed air is injected to momentarily invert the gas flow, causing the particulate material accumulated outside the bags to be removed. Such tube is connected to the air reservoir through a solenoid sequencer that activates cleaning of a row of bags.

In the filter, a differential manometer is provided for monitoring of the dirty gas chamber (gas input) and the clean gas chamber (gas output).

As the bags get dirty, the difference in pressure between dirty gas chamber and clean gas chamber increases.

Such AP values provide a reference on the efficiency of the equipment cleaning system and also establish the cleaning interval from one bag row to another and the duration of compressed air pulse.

A) Designing of Pulse Jet Bag Filter:

i) Crushing section and Hammer Mill sections:

Suction Points:
1. Crusher
2. Hammer Mill outlet
3. Raw Materials Silos

Dust Parameters:
Temperature : 60 °C to 100 °C
Dust Concentration : 220 g/Nm³ (maximum)
Air Flow Rate (NTP) : 2500 m³/h

Design of Pulse Jet Bag Filter:
Air to Cloth Ratio : 0.03 (m³/s)/m²
Total Cloth Area : 23.14 sq.m
Size of Bag : 160 mm Φ × 1.0 m
Surface area : 1.92 sq.m of each pleated bag
Numbers of bags : 12
Bag Material : Polypropylene

Centrifugal Blower:
Capacity : 2500 m³/h
Static Pressure : 300 mm of Water Column

The detailed engineering drawing of Pulse Jet Bag Filter with bags 12 showing all the relevant details is as per enclosed Drawing. Figure 6.3. The detailed engineering drawing of Pulse Jet Bag Filter with bags 6 and 9 depending on capacity of plant and capacity of blower showing all the relevant details are as per enclosed drawings figures 6.4 and 6.5 respectively.
ii) **Raw Mill Section:**
In the unit, two Raw mills with capacity 100 t/day will be installed. One bag filter will be installed to control dust emissions at the raw mill section and suction points will be as under:

**Suction Points:**
1. Raw Mill Feed Hopper
2. Raw Mill outlet
3. Storage Silos

**Dust Parameters:**
- **Temperature:** 60°C to 100°C
- **Dust Concentration:** 300 g/Nm³ (maximum)
- **Air Flow Rate (NTP):** 3000 cu.m/h

**Design of Pulse Jet Bag Filter:**
- **Air to Cloth Ratio:** 0.03 (m³/s)/m²
- **Total Cloth Area:** 27.78 sq.m
- **Size of Bag:** 160 mm Φ x 1.0 m
- **Surface area:** 1.92 sq.m of each pleated bag
- **Numbers of bags:** 16
- **Bag Material:** Polypropylene

**Centrifugal Blower:**
- **Capacity:** 3000 m³/h
- **Static Pressure:** 300 mm of Water Column

The detailed engineering drawing of Pulse Jet Bag Filter showing all the relevant details is as per enclosed Drawing. Figure 6.6

iii) **Description of Components:**

a) **Filtering Bags:**
These are filtering elements made in needled felt through which the air and dust separation takes place. As the air goes through the filtering elements, solid particles are retained on their external wall. After some time (period), all the bags get impregnated with dust and the need is felt to clean the bags. Such cleaning is performed with a very short blast of compressed air. Pleated bags have advantage of higher collection area per linear foot of element. This allows a more compact bag house for an original design, or allows the air to cloth ratio of an older pulse-jet baghouse retrofit with cartridges to be decreased.

b) **Cages:**
These are metallic frameworks used to support the filtering basis by forming a rigid cylindrical assembly. The inner part is closed while the top part is open, containing a venturi ejector.

c) **Venturi:**
Venturi are accelerator metallic tubes that change the energy from injected compressed air into pressure energy, inducing the air through the filtering bag and as a result from its magnitude to standard air flow, it sends a shock wave to the bag, as a result cleaning it and dislodging impregnated material.

d) **Solenoid Valve and Sequential timer:**
A solenoid valve is an electromechanical valve used to control gas flow rate. By either passing or stopping an electric current through a solenoid, which consists of coil of wire, the state of the valve can be changed conveniently. The cleaning cycle of bags is regulated by a remote timer connected to a solenoid valve. The burst of air is controlled by the solenoid valve and is released into blow pipes that have nozzle located above the bags. The bags are cleaned in a sequential manner row by row.

e) **Compressed Air Reservoir:**
A reservoir accumulates the needed compressed air which in turn is used to clean the bags. The reservoir capacity should be enough so that throughout the air blowing time of cleaning operation, air gush is always kept continuous. The pressure of the order of 6.5 to 7 kg/cm² is maintained in the reservoir by compressor.
Figure 6.3 Detailed Engineering Drawing of Pulse Jet Bag Filter Crushing Section and Hammer Mill Sections Having 12 Bags
Figure 6.4 Detailed Engineering Drawing of Pulse Jet Bag Filter Crushing Section and Hammer Mill Sections Having 6 Bags
Figure 6.5 Detailed Engineering Drawing of Pulse Jet Bag Filter Crushing Section and Hammer Mill Sections Having 9 Bags
Figure 6.6 Detailed Engineering Drawing of Pulse Jet Bag Filter Raw Mill Section Having 16 Bags
6.3.2 Pollution Control Equipment Spray Tower / Scrubber Inclusive of Typical Design Drawing:

The spray tower will be installed at Vertical Shaft Kiln to control the particulate matters emissions.

In a spray tower, particulate-laden air passes into a chamber where it contacts a water spray produced by spray nozzles. The dust laden air enters at the bottom of the tower and flows upward. Water sprays downward from nozzles mounted at the top of the tower. Water droplets capture particles suspended in the gas flow through impaction, interception and diffusion. Droplets large enough to settle by gravity collect at the bottom of the chamber. Droplets that remain entrained in the gas stream are collected on a mist eliminator upstream of the nozzles.

A) Designing of Wet Scrubber (Spray Tower):

The spray tower will be installed at Vertical Shaft Kiln. In the unit, four Vertical Shaft kilns with 50 t/day capacity will be installed.

Kiln Dust Parameters:

| Nos. of Kilns  | 4 |
| Kiln Capacity (each) | 50 t/day |
| Temperature | 100 °C |
| Dust Concentration | 500 g/Nm³ (maximum) |
| Air Flow Rate (NTP) | 5000 m³/h |

Design of Spray Tower:

Spray Tower Body:

| Nos. of Unit | 4 (at each VSK) |
| Tower diameter | 1.0 m |
| Total Tower Height | 2.85 m |
| Velocity (gas) | 1.84 m/s |

Water Spray System:

| Liquid to gas ratio | 0.7 lit/m³ |
| Water Requirement | 3500 lit/hour |
| Number of Nozzles | 24 |
| Flow through each nozzle | $4.05 \times 10^{-5}$ m³/s (2.43 lpm) |
| Type of nozzle | Full Cone Spray Nozzle with 60 °C Spray angle @ 30 psi pressure |

The detailed engineering drawing of Wet Scrubber showing all the relevant details is as per enclosed Drawing. Figure 6.7
Figure 6.7 Engineering Drawing of Wet Scrubber
6.4.0 Case Studies with respect to Energy Conservation Measures (ECM):
Out of 19 Mini Cement Plants, for detailed case study purpose the following two mini cement plants were selected.

1. Toranto Cement Ltd. having plant capacity 150 TPD.
2. Raghuvir Cement Ltd. having plant capacity 75 TPD.

Typical equipment layout for Toranto Cement Ltd is as per figure 6.8 For Raghuvir Cement Ltd flow sheet is identical. Based on detailed Cost Benefit Analysis of some energy saving options presented in this chapter for the above two mini cement plants, it is observed that there exists a good potential for “Energy Conservation” in mini cement as could be evident from the following details summarized below.

6.4.1 Case Study – I: Toranto Cement Ltd:

Cost Benefit Analysis of Some Energy Saving Options

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Energy Conservation Measures</th>
<th>Annual Resource Savings</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Investment Required (Rs.)</th>
<th>Simple Payback Period (Years)</th>
<th>Annual GHG Reduction (Tons CO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crushers Section</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Installation of Variable Freq. Drives for crusher</td>
<td>13344 kWh</td>
<td>80064</td>
<td>75533</td>
<td>1</td>
<td>11.12</td>
</tr>
<tr>
<td>2</td>
<td>Leakage to be arrested coming out from Crusher side flap</td>
<td>63.6 Ton of Limestone</td>
<td>13245</td>
<td>10000</td>
<td>0.76</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Incorporation of a Rate Type Grizzly Feeder prior to Crusher but after dumper unload</td>
<td>15815 kWh</td>
<td>86984</td>
<td>100000</td>
<td>1.15</td>
<td>13.17</td>
</tr>
<tr>
<td>4</td>
<td>Leakage to be arrested coming out from Hammer Mill</td>
<td>63.6 Ton of Limestone</td>
<td>13231</td>
<td>10000</td>
<td>0.76</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Raw Mill Section</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Installation of Variable Freq. Drives</td>
<td>142337 kWh</td>
<td>782852</td>
<td>805680</td>
<td>1</td>
<td>118.6</td>
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<td></td>
<td>Pre-Heater Installation</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Installation of Reheater</td>
<td>652 T Coal</td>
<td>3572115</td>
<td>6000000</td>
<td>1.7</td>
<td>1173.4</td>
</tr>
<tr>
<td></td>
<td>Vertical Shaft Kiln</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Insulate the burning zone of Vertical Shaft Kiln with ceramic fiber Blankets to prevent heat losses from the surface of kiln</td>
<td>46 Ton Coal</td>
<td>173966</td>
<td>100000</td>
<td>0.58</td>
<td>83.5</td>
</tr>
<tr>
<td>8</td>
<td>Installation of Variable Frequency Drive for the kiln blowers</td>
<td>160129 kWh</td>
<td>960773</td>
<td>906390</td>
<td>1</td>
<td>133.4</td>
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</table>
Figure 6.8 Flow Sheet of Mini Cement Plant Toranto Cement Ltd
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Energy Conservation Measures</th>
<th>Annual Resource Savings</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Investment Required (Rs.)</th>
<th>Simple Payback Period (Years)</th>
<th>Annual GHG Reduction (Tons CO²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>Use of alternative fuel with coal</td>
<td>496 Ton Coal</td>
<td>1858312.5</td>
<td>1000000</td>
<td>0.54</td>
<td>893</td>
</tr>
<tr>
<td>10.</td>
<td>Reduction in stoppage time of kilns</td>
<td>2650 Ton Clinker</td>
<td>1060000</td>
<td>Nil</td>
<td>Immediate</td>
<td>-</td>
</tr>
<tr>
<td>11.</td>
<td>Elimination of unburnt Clinker wastages</td>
<td>360 Ton Clinker</td>
<td>720000</td>
<td>Nil</td>
<td>Immediate</td>
<td>-</td>
</tr>
</tbody>
</table>

### Lighting Systems

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Energy Conservation Measures</th>
<th>Annual Resource Savings</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Investment Required (Rs.)</th>
<th>Simple Payback Period (Years)</th>
<th>Annual GHG Reduction (Tons CO²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.</td>
<td>Replacement of Rorescent tube lights with T5's</td>
<td>1526 kWh</td>
<td>15683</td>
<td>25000</td>
<td>1.6</td>
<td>2.4</td>
</tr>
<tr>
<td>13.</td>
<td>Replacement of all HFMV Lamps in office and plant area with HPSV</td>
<td>1325 kWh</td>
<td>2970</td>
<td>11754</td>
<td>1.85</td>
<td>2.4</td>
</tr>
</tbody>
</table>

**TOTAL** | 9337226 | 9032603 | 0.96 | 2428.59 |

**Table 6.1 Cost Benefit Analysis of Some Energy Saving Options at Toranto Cement Ltd**

Justifiable annual investment required is Rs. 90.0 lakhs. Annual energy cost saving potential is of the order of Rs. 93.0 lakhs. Thus, simple pay back period is one year. It means after one year, Rs. 7 to 8 lakhs per month will be reduction in recurring expenditure which can be considered as a gain. And this amount can be invested in “Pollution Control Equipments”. Thus, techno-economically it is a viable proposition.

### 6.4.2 Case Study – II: Raghuvir Cement Industries Ltd:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Energy Conservation Measures</th>
<th>Annual Resource Savings</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Investment Required (Rs.)</th>
<th>Simple Payback Period (Years)</th>
<th>Annual GHG Reduction (Tons CO²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Installation of Variable Frequency Drives</td>
<td>6043 kWh</td>
<td>36256</td>
<td>67500</td>
<td>1.9</td>
<td>5.04</td>
</tr>
<tr>
<td>2.</td>
<td>Leakage to be arrested coming out from Crusher side flap</td>
<td>22 Ton of Limestone</td>
<td>8880</td>
<td>10000</td>
<td>1.13</td>
<td>-</td>
</tr>
<tr>
<td>3.</td>
<td>Incorporation of a Rate Type Grizzly Feeder prior to Crusher but after dumper unload</td>
<td>7162 kWh</td>
<td>42970</td>
<td>100000</td>
<td>2.33</td>
<td>5.96</td>
</tr>
<tr>
<td>4.</td>
<td>Leakage to be arrested coming out from Hammer Mill</td>
<td>22 Ton of Limestone</td>
<td>11754</td>
<td>100000</td>
<td>0.85</td>
<td>-</td>
</tr>
</tbody>
</table>

**Crusher Section**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Energy Conservation Measures</th>
<th>Annual Resource Savings</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Investment Required (Rs.)</th>
<th>Simple Payback Period (Years)</th>
<th>Annual GHG Reduction (Tons CO²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Installation of Variable Frequency Drives</td>
<td>72511 kWh</td>
<td>435067</td>
<td>810000</td>
<td>1.9</td>
<td>60.402</td>
</tr>
</tbody>
</table>

**Raw Mill Section**

**Pre-Heater Installation**

- 155 -
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Energy Conservation Measures</th>
<th>Annual Resource Savings</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Investment Required (Rs.)</th>
<th>Simple Payback Period (Years)</th>
<th>Annual GHG Reduction (Tons CO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>Installation of Reheater</td>
<td>712 Ton Goal</td>
<td>2495215</td>
<td>3000000</td>
<td>1.2</td>
<td>1281.6</td>
</tr>
<tr>
<td>7.</td>
<td>Insulate the burning zone of Vertical Shaft Win with Ceramic Fibre Blankets to prevent heat losses from the surface of kiln</td>
<td>36.359 Ton Coal</td>
<td>127255</td>
<td>50000</td>
<td>0.39</td>
<td>65.44</td>
</tr>
<tr>
<td>8.</td>
<td>Installation of Variable Frequency Drive for the kiln blowers</td>
<td>60426 kWh</td>
<td>362556</td>
<td>453195</td>
<td>1.25</td>
<td>50.33</td>
</tr>
<tr>
<td>9.</td>
<td>Use of alternative fuel with coal</td>
<td>204 Ton Coal</td>
<td>714000</td>
<td>1000000</td>
<td>1.4</td>
<td>367.2</td>
</tr>
<tr>
<td>10.</td>
<td>Reduction in stoppage time of kilns</td>
<td>2000 Ton Clinker</td>
<td>800000</td>
<td>Nil</td>
<td>Immediate</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 6.2 Cost Benefit Analysis of Some Energy Saving Options at Raghuvir Cement Industries Ltd

Justifiable annual investment required is Rs. 55.0 lakhs. Annual energy cost saving potential is of the order of Rs. 45.2 lakhs. Thus, simple payback period is one and half year. It means after one year, Rs. 4 lakhs per month will be reduction in recurring expenditure which can be considered as a gain. And this amount can be invested in “Pollution Control Equipments”. Thus, techno-economically it is a viable proposition.

6.5.0 Summary:

This chapter considers various facets of S.S.I. Units – Mini Cement Plants with reference to TQM. The concept of TQM and its implementation by “Operations Research” seems to be far away in majority of S.S.I. – as these units are “one man manager enterprises”. However, there appears to be a pressing need to study and analyze in detail the implementation of TQM in S.S.I. units.

Mini cement plants come under the category of S.S.I. units. Mini cement plants generally start manufacturing of cement from Clinker – supplied to S.S.I. units by big manufactures of cement. In Mini Cement Plants wherein all the operations after clinker formation like crushing grinding, mixing etc are identical with that of any big cement plant. However, sizes of these equipments also become mini depending on manufacturing capacity of the plant.

Thus, Mini Cement plants are also “energy intensive plants” and TEM measures is as such also a necessity in these plants. However, these – one man manager enterprises simply do not bother about implementation of even TEM. Hence, TQM implementation is also ruled out.

Further, stringent Pollution Control Measures put up by the pollution control Board are also not being followed by these units. These units also do not bother about Implementation of Cleaner Production Principles (CPP). Overall result being, many mini cement plants are on the verge of closure.

Detailed study on Thermal Engineering Aspects in Mini Cement Plants and Implementation of TEM was carried out in 19 mini cement plant units:

Based on detail study of manufacturing flowsheets and relevant thermal engineering aspects, important energy conservation measures (ECM) in mini cement plants have been suggested.

By appropriate Mechanical Design of Pollution Control Equipments and utilizing only such certified equipments in the plant, can solve their – Pollution Control Board problem. Effective implementation of TQM via Design will only help these entrepreneurs. The approach appears to be costly as it involves increase in expenditure of fixed capital cost, however, ultimately after running a mini cement plant at least for a year, and implementing TEM measures collectively and simultaneously, will certainly yield a “favorable result”. However, during initial period of 1 to 2 years there may be no financial gain.
Pollution Control via Computer Aided Design and Drawings has also been discussed. Detailed engineering flow sheet for mini cement plant indicates that via design of plant equipments, cement of required quality can be obtained.

Depending on plant capacity, sizes of different equipments get altered. Hence, computerized programme for design of pollution control equipments was prepared and accordingly detailed engineering drawings for these equipments were drawn. All these drawings are a function of mini cement plant capacity. As plant capacity changes design parameters do get change and accordingly design modifications are required in mini cement plants to implement TQM in plant.

Computer aided design of pulse jet bag filter and wet scrubber depending on the capacity of mini cement has been done and the relevant detailed dimensional drawings are incorporated in this chapter.

Further, it may be noted that such type “Equipment Design and Drawing” related information is not available in the literature. Computer aided design drawing set of 10 different drawings depending on capacity of mini cement plants has been prepared which could be utilised conveniently by mini cement plant manufacturers.

It is expected that by using appropriate set of these drawings, pollution control equipments can be fabricated and lowest levels of pollution can be maintained in the mini cement manufacturing plant.

Based on detailed Cost Benefit Analysis of some energy saving options presented in this chapter for the two mini cement plants, it is observed that there exists a good potential for “Energy Conservation” in mini cement as could be evident from the following details summarized below.

Case Study of Toranto Cement Ltd indicates that justifiable annual investment required is Rs. 90.0 lakhs. Annual energy cost saving potential is of the order of Rs. 93.0 lakhs. Thus, simple pay back period is one year. It means after one year, Rs. 7 to 8 lakhs per month will be reduction in recurring expenditure which can be considered as a gain. And this amount can be invested in “Pollution Control Equipments”. Thus, techno-economically it is a viable proposition.

Case Study of Raghuvir Cement Industries Ltd indicates that justifiable annual investment required is Rs. 55.0 lakhs. Annual energy cost saving potential is of the order of Rs. 45.2 lakhs. Thus, simple pay back period is one and half year. It means after one year, Rs. 4 lakhs per month will be reduction in recurring expenditure which can be considered as a gain. And this amount can be invested in “Pollution Control Equipments”. Thus, techno-economically it is a viable proposition.