Optimizing Combustion Efficiency of Furnace

Firing is the most cost intensive part in any ceramic industry, whether it may be using oil or natural gas. Slightest deviation from the scientific technique may consume more fuel than theoretically required. It is crucially required to optimize the Combustion air – Fuel ratio. Deviation from stoichiometric combination of air and fuel may affect in two ways –

1. *Less air than required: It may lead to incomplete combustion of fuel and thereby generation of Carbon Monoxide (CO), a potentially harmful gas*

2. *More air than required: It may lead to over utilization of fuel, as more oxygen attracts more fuel in combustion chamber, increasing the fuel consumption.*

A few kilns were studied using a portable Flue Gas cum Combustion Efficiency Analyser and the results obtained were quite surprising, and after the analysis, the precautionary measures to be undertaken and expected results were even more surprising.

Combustion Efficiency Indicator:

1. As a rule, the most efficient and cost-effective use of fuel takes place when CO_2 concentration in the exhaust is maximized. Theoretically, this occurs when there is just enough O_2 in the supply air to react with all the carbon in the fuel.

2. The absence of any O_2 in the flue gas directly indicates deficient combustion air while presence indicates excess air. Ideally, the O_2 level shall be maintained 2 % to 6 %, CO_2 level shall be maintained 8 % to 11 %, CO level shall be maintained 80 ppm - 100 ppm and excess air shall be maintained 5 % to 7 % (high pressure burner) for natural gas.

3. Carbon monoxide (CO) is a sensitive indicator of incomplete combustion; its levels should range from 0 to 400 ppm by volume. The presence of a large amount of CO in flue gas is a certain indicator of deficient air.

The same can be maintained by regular monitoring of flue gas sample with the help of a portable flue gas analyser or by installing O_2 sensor at the furnace exhaust for flue gases and a modulating motorized damper or RPM of combustion air blower through VFD for combustion air control. The sensor will provide constant feedback of O_2% to

the damper / VFD which will in turn regulate the flow of combustion air to maintain the combustion efficiency at optimum level of 80 - 90% (Achievable combustion efficiency).

<table>
<tr><th>Intervening Technique</th><th>Optimization of Combustion Efficiency of Melting Furnace in Container Glass Manufacturing Industries (Fuel : Natural Gas)</th></tr>
<tr><td>Before CP</td><td>
Flue gas exhaust at the Furnace was monitored. The flue gas analysis for the Furnace was carried out at the exhaust of individual furnaces. Two furnaces were subjected to the exercise. The measured parameters are shown in tables below:

% O2 in flue gas varies from 12 % to 13 %.
Flue gas temperature also varies from 518 °C to 525 °C. % O2 in flue gases should be between 3– 4%.

Flue Gas Monitoring Parameters at 95 TPD Furnace
<table>
<tr><th>Parameters</th><th>Reading 1</th><th>Reading 2</th><th>Reading 3</th></tr>
<tr><td>Oxygen (%)</td><td>12.4</td><td>12.6</td><td>12.8</td></tr>
<tr><td>Carbon Monoxide (ppm)</td><td>821</td><td>408</td><td>146</td></tr>
<tr><td>Combustion Efficiency (%)</td><td>44</td><td>42</td><td>42</td></tr>
<tr><td>Carbon Dioxide (%)</td><td>4.8</td><td>4.6</td><td>4.6</td></tr>
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Flue Gas Temperature (°C)	518	522	525
Access Air (%)	148	144.8	151.8
Pressure (mBar)	0.18	0.20	0.21

Flue Gas Monitoring Parameters at 55 TPD Furnace

Parameters	Reading 1	Reading 2
Oxygen (%)	13	12.1
Carbon Monoxide (ppm)	0.0	0.0
Combustion Efficiency (%)	42.8	46
Carbon Dioxide (%)	4.6	4.9
Flue Gas Temperature (°C)	525	525
Access Air (%)	151	140
Pressure (mBar)	0.17	0.21

Recommendation:

- The same can be maintained by regular monitoring of flue gas sample with the help of a portable flue gas analyzer or by installing O2 sensor at the furnace exhaust for flue gases and a modulating motorized damper for combustion air control.
- The sensor will provide constant feedback of O2% to the damper which will in turn regulate the flow of combustion air to maintain the combustion efficiency at optimum level of 80 - 90% (Achievable combustion efficiency).

	• Thus, it is recommended to operate the furnaces at optimum efficiency by controlling (manual/auto) air fuel ratio so that to get maximum combustion efficiency, the fluidised bed furnaces are known for generating maximum combustion efficiency in principal more than 80 %, thus plant should target to achieve the same initially manual adjustment through frequency adjustment and monitoring oxygen percentage in flue gases and then putting the drives in auto with online O2 sensor in exhaust and feedback to supply air, although caution need to be considered with setting of minimum air requirement for pressure & draft control within furnace. • By maintaining optimum combustion efficiency even upto 75 % from existing (average 45 %) in these two furnaces, plant can save approximately 280524 SCM per annum.
Benefit	
Environmental	• Per Day reduction in the gas consumption: 779 SCM. • Per Year reduction in gas consumption: 280524 SCM. • Per Day reduction in Greenhouse Gas (CO2) emission: 1.46 MT of CO2 • Per Year Reduction in Greenhouse Gas (CO2) emission: 525 MT of CO2
Economical	Investment: Rs. 30,00,000/-for 2 nos. of Furnace

	Annual Savings: Rs. 50,49,000/- per annum Payback Period: 8 months