
EXTENDED ABSTRACT FACSIMILE

Characteristics of Multi-Burner Positioning and Operating Mode in a FLOX Furnace

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ABSTRACT

Flameless Oxidation (FLOX) is a promising combustion technology capable of accomplishing high efficiency and low emission [1]. It is based on delayed mixing of fuel and oxidizer and high flue gas recirculation in the flame zone. High momentum injection of the fuel and air entrain the flue gas through internal recirculation, thus diluting the oxygen concentration in the combustion zone. This leads to a more distributed heat release of the chemical energy, avoiding high peak temperature that can reduce the thermal formation of NO_x. Combined with high preheat temperature of the combustion air, this combustion technique achieves a high efficiency.

In this work, the impact of multi-burner positioning and operation modes are studied in order to find an optimal configuration of six regenerative burners to increase the energy efficiency and reduce the pollutants emissions. Fig. 1 shows a schematic diagram of the multi-burner excess enthalpy combustion furnace. It consists of three pairs of regenerative FLOX burners, each with a rated thermal power of 100kW, 300kW in total. The thermal load is simulated by a cooling system which consists of eight single ended concentric tubes, four placed at the bottom of the furnace and four at the top. The heat transfer fluid is atmospheric air entering the inner tube and is exiting through the outer pipe. Measurements of temperature, flow rates and pressure are performed at various locations. For the emissions, a NDIR gas analyzer monitors the flue gas for NO and CO concentration. All the data is stored by the data acquisition system every second.

Fig. 2 shows the burner positions for the different configurations tested (C1 to C3). Each side has nine flanges and three burners installed among them. Three burners are always firing while the other three burners are regenerating. During regeneration the sucked flue gas is traversing ceramic honeycomb heat exchangers installed inside the burner. Two different operating modes were studied. In parallel mode three burners fire at the same side and in stagger mode two burners fire in one side and one burner at the other side. After a certain frequency time interval, the burners switch and the firing burners start regenerating.

For the different experiments, the heat and mass balance are calculated under steady state conditions, to compare the cooling tube efficiency. Steady state condition is assumed to be reached when the variation of the furnace temperature is almost zero with respect to time. The steady state temperature of the furnace is between 1080 and 1100 °C depending on the operation parameters.

The emission comparison is a very important criterion for choosing the optimal configuration. Fig. 3 shows the NO emission for different configurations, operation mode and excess air ratio. Each configuration (C1 to C3) shows somewhat different trends but similar values. The NO emission increases with excess air ratio because O₂ availability increases in the

combustion zone. Parallel mode shows lower NO than staggered mode in all configurations. The identification of the optimal configuration should also take into account the comparison on CO emission.

The burner positioning and operation mode will be optimized by energy efficiency and emission production characteristics of each case. Furthermore, the transient effect of the periodic operation will be investigated more in depth. In the future, the characteristics of inside furnace conditions will be measured using laser diagnostics such as CARS and LDA for temperature and velocity respectively.

Keywords: FLOX, Multi-burner, Temperature uniformity, Emission, Parallel, Staggered

Proposed Topic: Combustion

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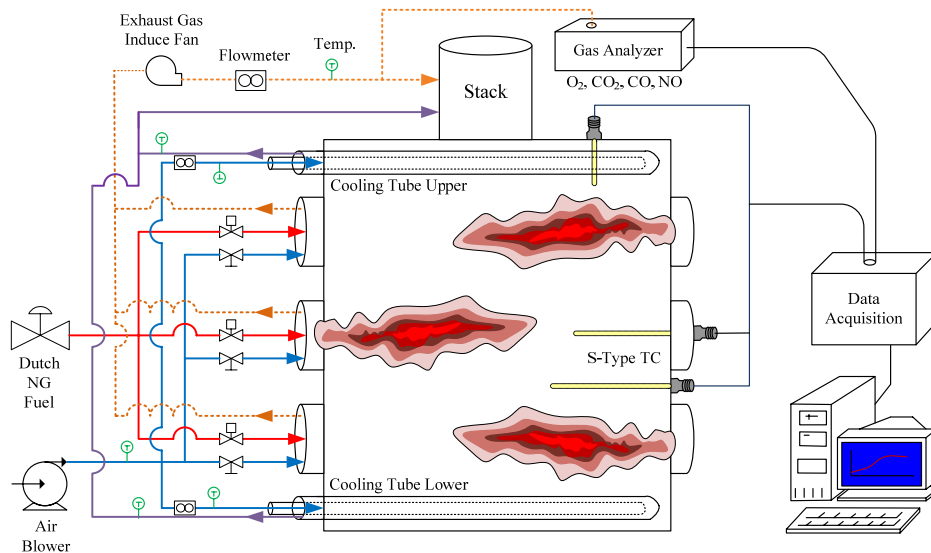


Fig. 1 Schematic diagram of the multi-burner FLOX furnace.

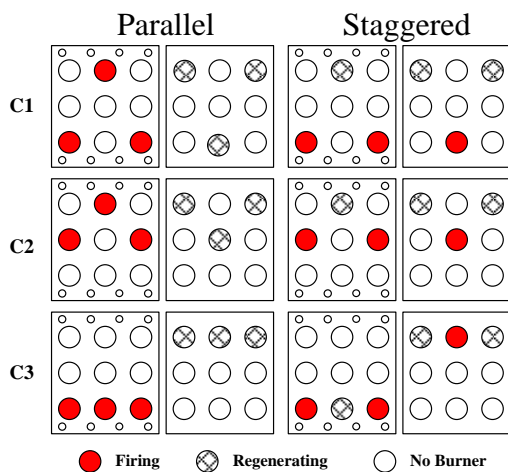


Fig. 2 Burner configurations.

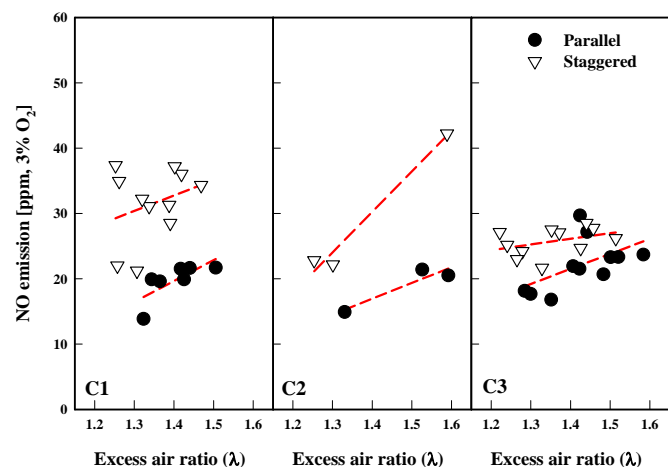


Fig. 3 NO emission for different configurations.

Reference:

[1] J.A. Wüning and J.G. Wüning, 1997, “Flameless oxidation to reduce thermal NO-formation,” *Prog. Energy Combust. Sci.*, Vol. 23, pp. 81~94.