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AN INVESTIGATION TO DEFINE THE PHYSICAL/CHEMICAL CONSTRAINTS WHICH LIMIT NO_x EMISSION REDUCTION ACHIEVABLE BY REBURNING

Quarterly Report 9

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1.0 INTRODUCTION

Reburning is a combustion modification technique which removes NO_x from combustion products by using fuel as a reducing agent. Previous studies have shown that natural gas is more effective than coal as a reburning fuel. It is believed that 60 percent reduction in NO_x emission can be achieved with natural gas reburning. However, kinetic calculations indicate that emission reductions greater than 80 percent are possible using the reburning process.

The objectives of this program are to define the chemical and physical constraints which prevent the attainment of 80 percent NO_x reduction with reburning and to test improved configurations for reburning as an advanced NO_x control technique for coal-fired boilers. The program has been divided into two experimental scales. Bench scale studies are designed to screen the chemical and physical means for enhancing reburning efficiency. Subsequent pilot studies will evaluate the impacts of finite rate mixing on the effectiveness of the various concepts. These studies have been supported with chemical kinetics and boiler performance modeling to generalize the experimental data to full scale boilers. Specifically, the program consists of the following:

- Bench scale studies
  - N_2 formation in reburning zone
  - XN conversion in burnout zone
- Pilot scale studies
- Interpretation and generalization
- Final Report

This quarterly report documents the progress of the pilot scale studies in this reporting period.

2.0 PILOT SCALE STUDIES

The optimized reburning process defined in the bench scale studies will be investigated in a pilot scale facility at 5 x 10^6 Btu/hr (1.5 MW_t). The objectives of the pilot scale studies are to:

- evaluate impacts of finite rate mixing
- determine means for mixing enhancement, and
- verify performance with coal.

2.1 Injection Systems

Based on empirical correlations for entrainment rate, coverage and jet penetration, the injection systems were designed for reburning gas, burnout air, and aqueous reagent solution. The reburning gas injectors are four 1/4-inch round jets located on the same wall. The first burnout air is to be added through four 3/4-inch injectors also on the same wall. The final air stream is to be injected into the furnace at the same location as the $(NH_4)_2SO_4$ solution. A cross-sectional view of the injection scheme is shown in Figure 2-1. The air is injected through two 2-1/2-inch jets at opposite corners and the $(NH_4)_2SO_4$ solution is injected through two pressure atomized nozzles that are opposed and staggered.

2.2 Experimental Conditions

Initially gas temperatures were measured along the furnace axis. Natural gas was fired as the primary fuel at 4.5 x 10^6 Btu/hr with an excess air level of 10 percent (SR_1 = 1.1). Twenty percent reburning or 1.1 x 10^6 Btu/hr of natural gas was applied to yield a reburning zone stoichiometry of 0.9 (SR_2), followed by burnout air and ammonium sulfate injections. Figure 2-2 shows the temperature distribution and locations of all injection systems.

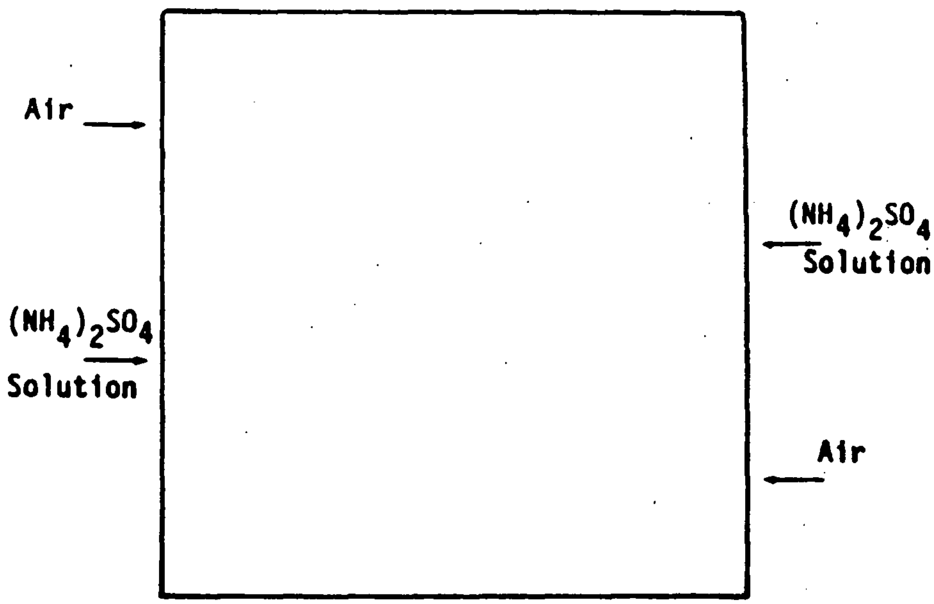

Figure 2-1. Injection configuration.

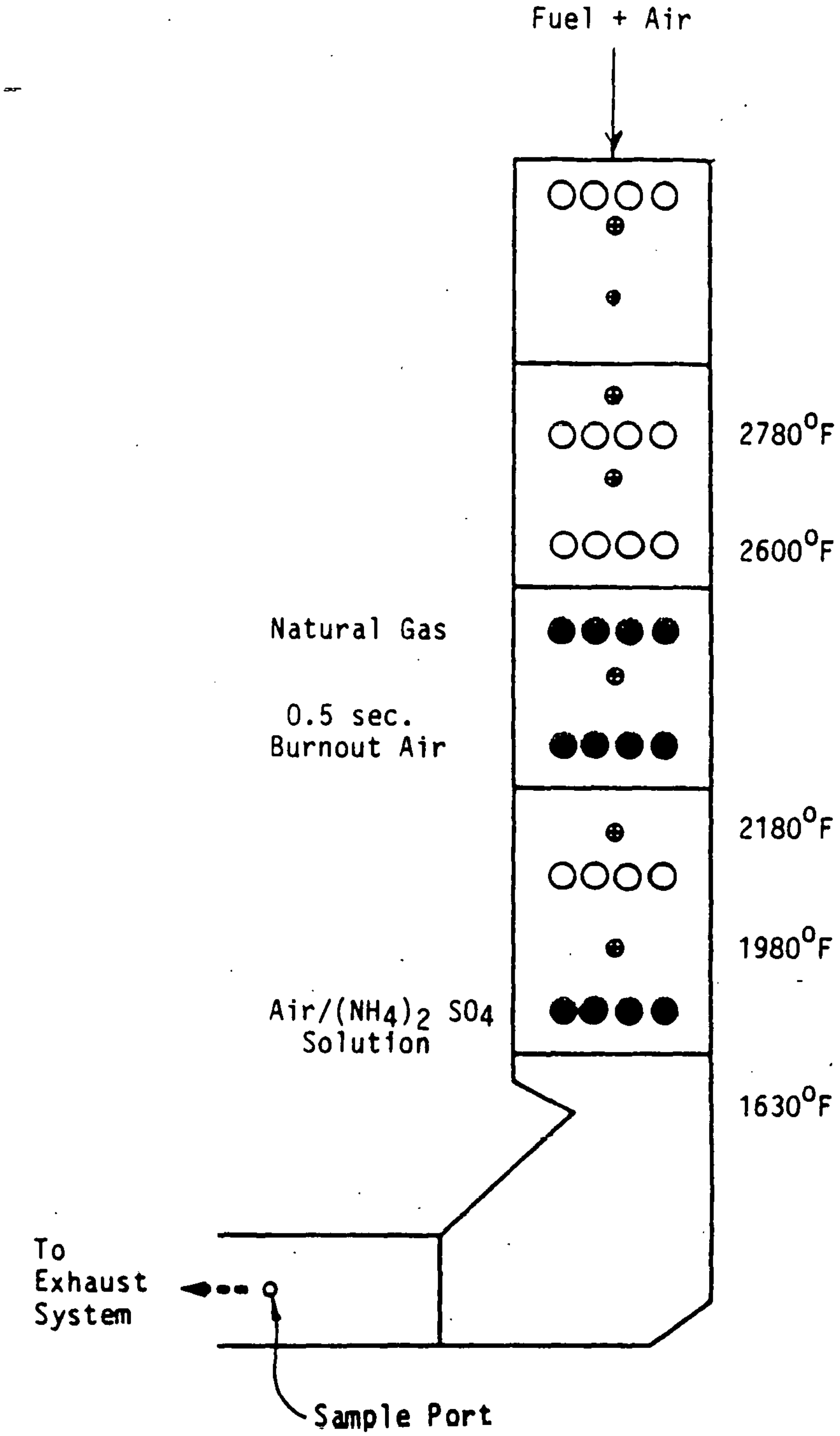

Figure 2-2. Temperature distribution and injection locations.