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

Quarterly Report 8

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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 preparation work carried out for 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 10 x 10^6 Btu/hr (3.0 MW_t). The objective 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 Pilot Scale Facility - Reburning Tower

Preparation work was carried out to configure the pilot scale facility as shown in Figure 2-1. The Reburning Tower, rated at 3 MW_t, was refractory-lined and water-jacketed with inside dimensions of 1.2 x 1.2 x 8.0 m. The four main diffusion burners each consisted of an inner pipe for axial primary fuel injection and an outer pipe, equipped with swirl vanes, for the main combustion air. This four burner array produced relatively uniform velocity and composition profiles at primary zone exit.

The furnace contained seven rows of ports for reburning fuel and burnout air injection. The temperature profile was manipulated by insertion of cooling panels, positioned against the furnace walls.

2.2 Test Plan

Figure 2-2 illustrates the advanced reburning configurations defined in bench scale studies. In the pilot scale studies, both the 10 percent and 20 percent reburning configurations will be tested. Initially experiments will be conducted with natural gas as the primary fuel. Exhaust measurements of NO_x, CO as well as NH_3 and SO_3 will be performed. Finally a series of verification tests will be conducted with Illinois coal as the primary fuel.

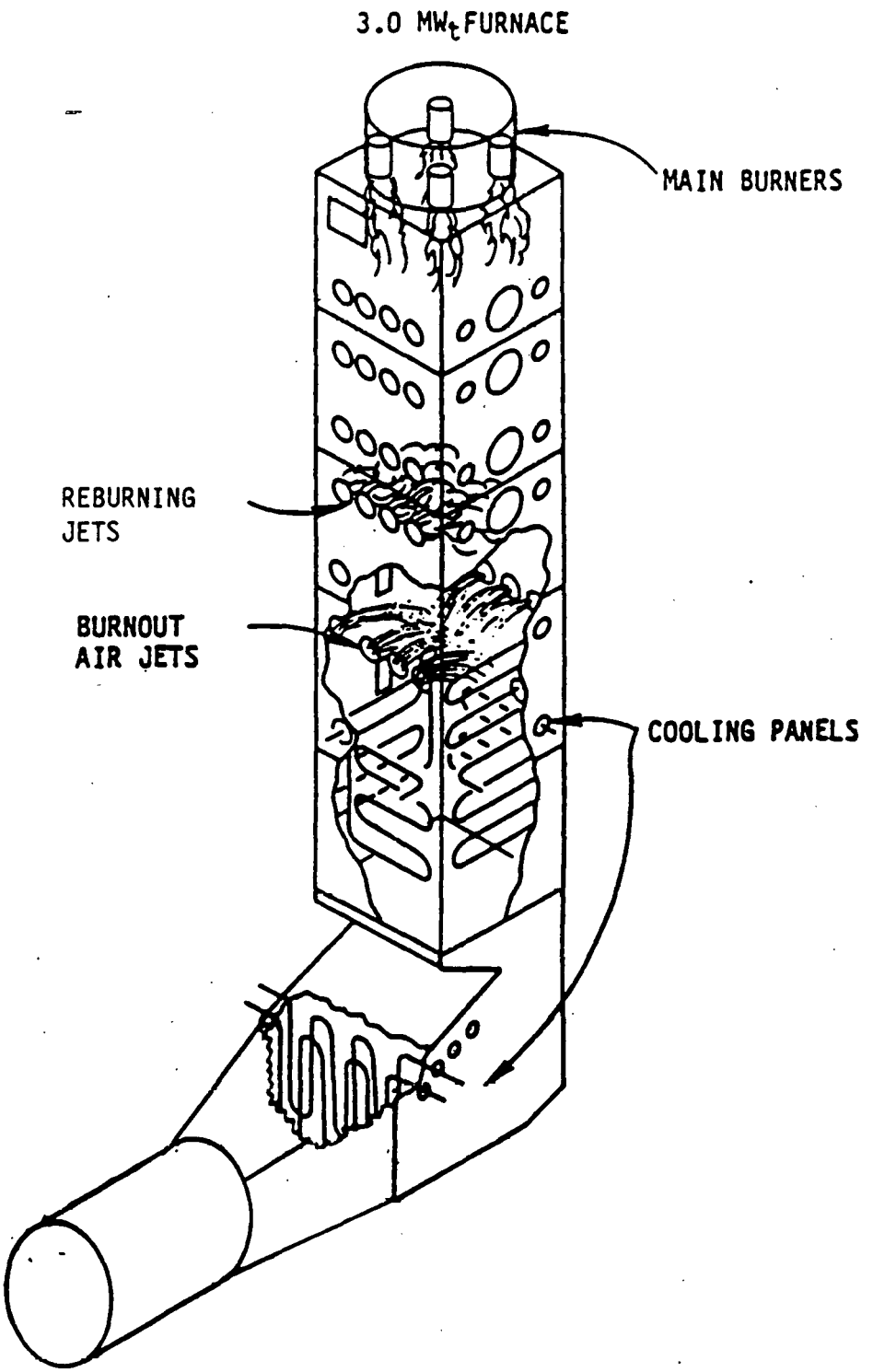

Figure 2-1. Pilot Scale Facility - Reburning Tower

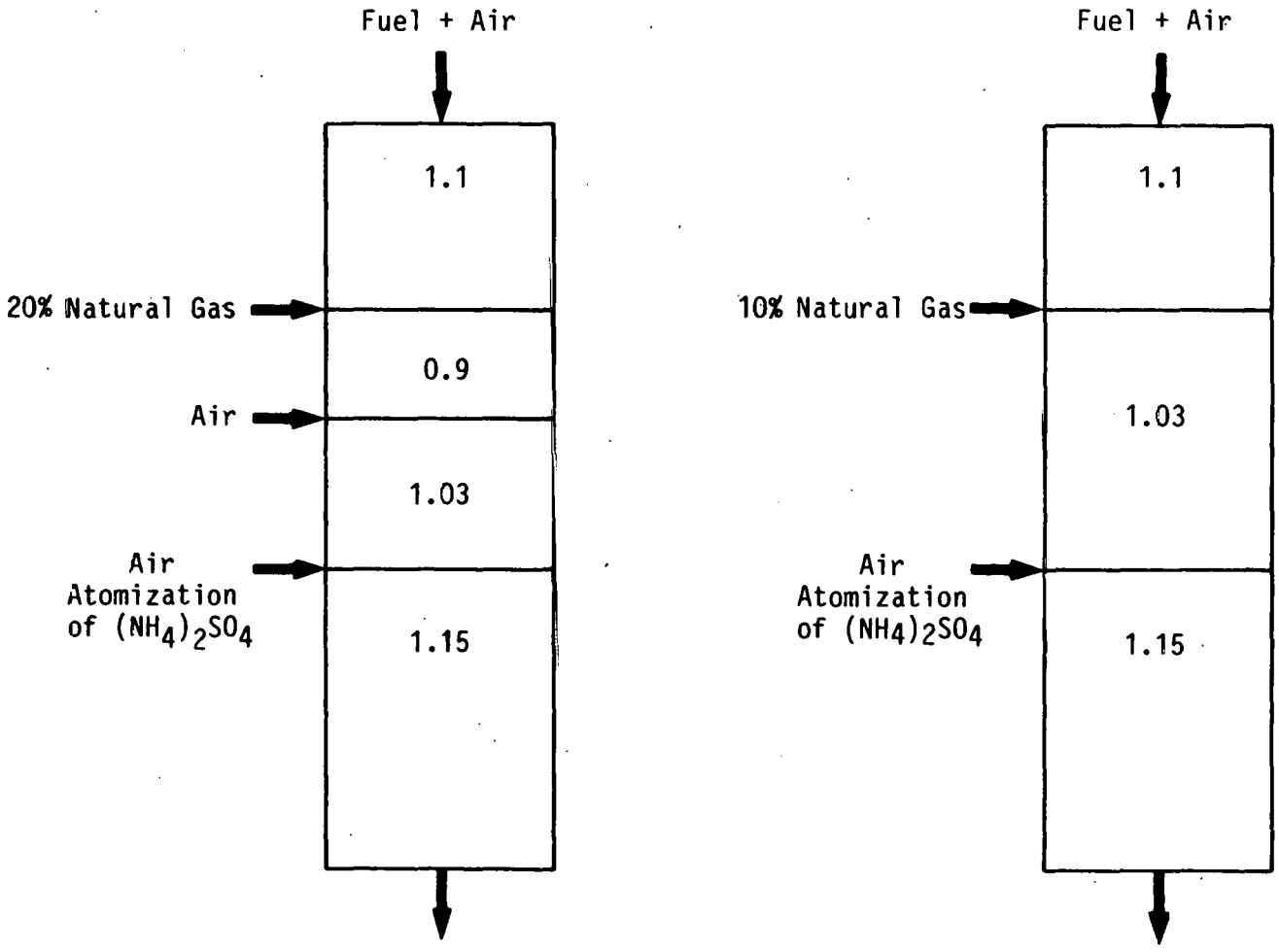

Figure 2-2. Advanced Reburning - Reburning Plus Reducing Agent Injection.