FLOWNEX®

SIMULATION ENVIRONMENT

SE

CASE STUDY

INVESTIGATING A DELAY IN O2 RESPONSE IN AN AIR/FUEL GAS SYSTEM

The power station experienced a delay in airflow response within the air/fuel gas system during a transient load change. Rapid airflow response is crucial for effective combustion and reducing NOx and SOx emissions. Flownex SE was used to investigate the air/fuel gas and control systems. The simulation revealed that optimizing the feedforward control and increasing the burner line diameter would improve response time.

FOSSIL FUEL POWER GENERATION

CHALLENGE:

Secondary Over Fire Air (SOFA) is used to improve boiler combustion efficiency and reduce NOx and SOx emissions. The power station experienced a delay in airflow control response, leading to undesirable combustion conditions in the furnace. An investigation was needed to identify the factors contributing to the delay.

BENEFITS:

By identifying the factors causing the delayed response, power station personnel could assess the impact of hardware changes and conduct comparative studies to improve boiler efficiency. These factors would normally be evaluated through costly on-site experiments but were more efficiently evaluated via simulation, saving both time and money.

SOLUTION:

Flownex proved to be an ideal tool for modelling the control and air/fuel gas systems interactively. Various parametric studies were conducted to identify the factors contributing to the delayed response, providing the client with valuable and practical recommendations.

INTRODUCTION

During transient operations, delayed airflow response—up to two minutes—leads to undesirable combustion conditions in the furnace.

SYSTEM DESCRIPTION

Utility power station units 1 and 2 use tangentially fired boilers, where, in addition to primary and auxiliary air, Secondary Over Fire Air (SOFA) ducts introduce air into the furnace to reduce NOx and SOx emissions.

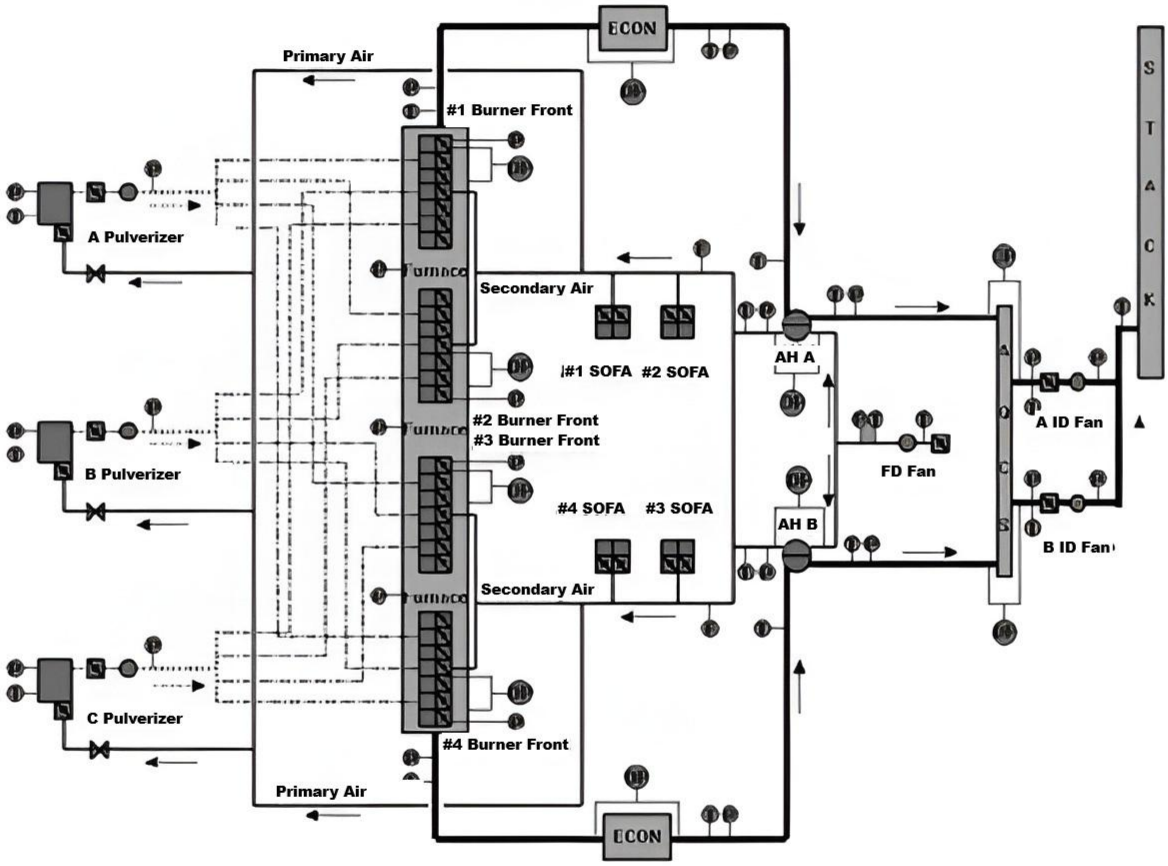

Figure 1: Layout of the air/fuel gas cycle for power station units

A Flownex model was developed to simulate the main air/fuel gas cycle, from the Forced Draft fan inlet to the Induced Draft outlet, including the primary air system and relevant control aspects.

FLOWNEX MODEL

The model was set up by first obtaining the geometrical parameters of the air/fuel system and using Flownex's "Pipe" element to simulate flow and pressure losses. Pressure losses through the furnace, economizer, air heater, and scrubber were provided by the client as delta P vs. volume flow characteristics, which were then modelled in Flownex. Heat transfer was modelled using temperature data provided by the client at various locations. Fan performance charts were used as inputs for the Flownex "Fan" and "Variable Speed Fan" components.
The control systems relevant to the problem were modelled with assumptions designed to simulate the controller's actual response. The controllers included:

- ID Fan controller to adjust fan speed and maintain the required furnace pressure.
- FD Fan controller to control the FD damper and maintain the required air/fuel ratio.

- Exhaust fan controller to regulate the exhaust inlet damper and maintain exhaust outlet pressure.
- Fuel damper controller to adjust the fuel damper opening and maintain primary air mass flow.

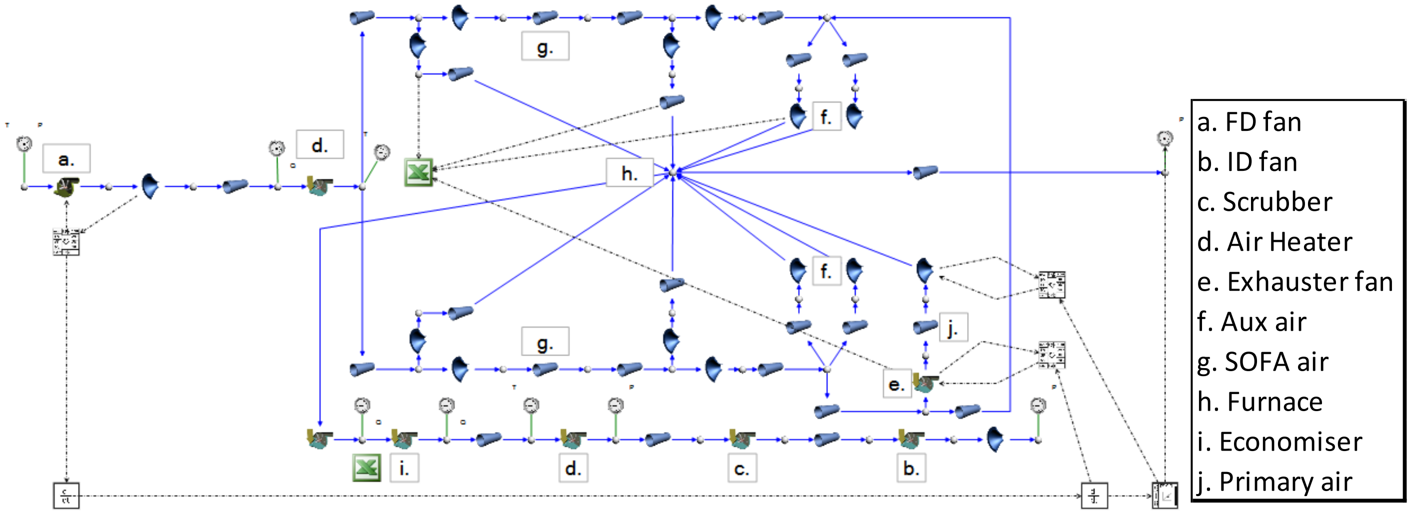

Figure 2: Flownex network showing air/fuel gas system and control

The model was first characterized to establish a base network scenario by adjusting the damper positions and fan speeds to ensure proper pressure and mass flow distribution through the system.

OBJECTIVE OF SIMULATION

Various simulation cases were then set up to investigate potential causes of the air flow control response delay during a load change. These scenarios included:

- FD Fan Control based on coal and O2 control.
- Two scenarios, with and without SOFA included.
- Two primary air ducting layout configurations.
- Ideal vs. actual exhaust fan performance.
- Different burner line diameter options.

RESULTS

Initial simulations were run by disabling all controllers and increasing the FD and ID fan mass flows simultaneously. The results showed no substantial lag in FD and ID fan air flow, thus eliminating system hardware configuration as the cause of the system response delay. By comparing the coal control and O2 control methodologies, it was found that the coal control methodology allows for a closer tracking of the optimum air/fuel ratio.

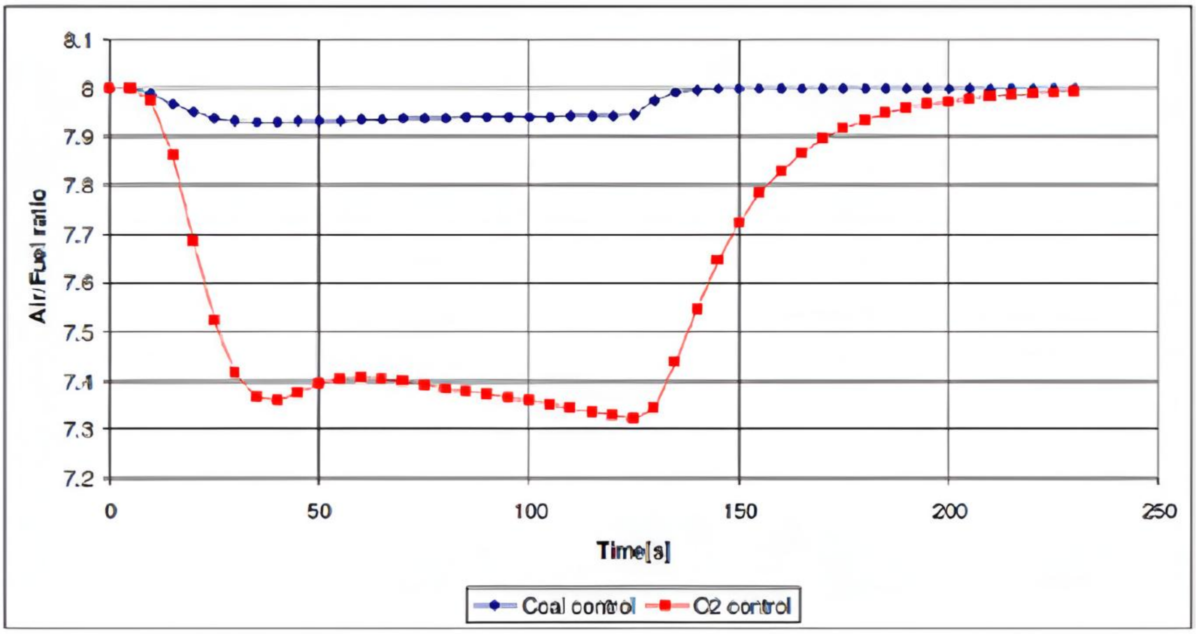

Figure 3: Coal control vs O2 control response on Air/Fuel ratio

CONCLUSION

Flownex proved to be the ideal simulation tool for quickly analysing and identifying the root cause of the air flow response delay. Various parameter studies allowed the simulation engineer to gain a swift understanding of the issue, enabling applicable and implementable recommendations to be made to the utility provider.