FLOWNEX®
SIMULATION ENVIRONMENT

BOILER CONTROL OPTIMISATION USING A VALIDATED DIGITAL TWIN

FOSSIL FUEL POWER GENERATION

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OVERVIEW

Coal-fired power stations are under increasing pressure to operate efficiently while meeting stricter emission requirements and responding to changing generation demands. Improving boiler control can reduce fuel consumption, improve load response and support cleaner combustion, but testing new control strategies on an operating unit is expensive, disruptive and often too risky to perform on the live plant.

CHALLENGE

Eskom contracted Nelson Mandela University to assist in evaluating and improving boiler control methodologies without disrupting plant operation. Many control changes can only be tested during outages, while poorly performing control strategies can negatively affect efficiency, emissions and plant stability. The challenge was therefore to create a realistic virtual environment that accurately represented both the boiler's physical behaviour and its control system, allowing engineers to assess new control philosophies before implementation.

SOLUTION

Flownex was used to develop a dynamic digital twin of the boiler's fireside system. The model integrated detailed thermo-fluid behaviour with the plant's control system, creating a realistic simulation environment that accurately predicted boiler performance under actual power station operating conditions.

Additionally, a **Human Machine Interface (HMI)** was developed in Flownex to resemble the Siemens control system used at the power station. This allowed engineers and operators to monitor process conditions, interact with controllers and evaluate operating scenarios through a familiar interface. Historical operating data was used to validate the model, ensuring that the simulated responses matched real plant behaviour during load changes and operational disturbances.

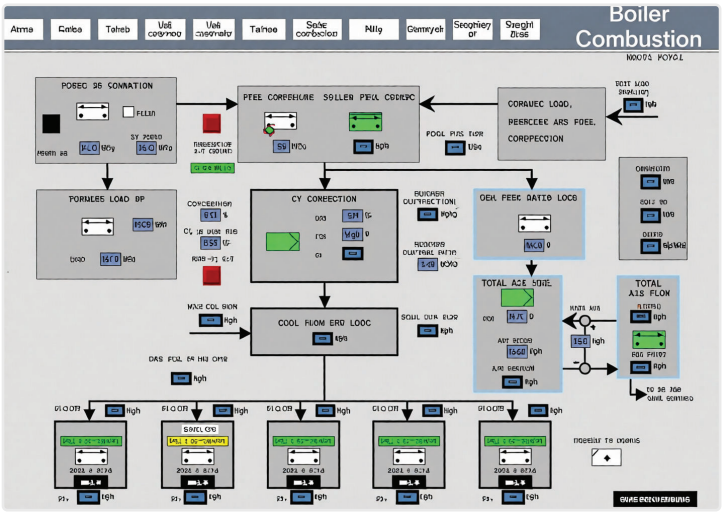

Figure 1: Human Machine Interface built-in Flownex.

"Using the Flownex control library in conjunction with its thermo fluid modelling capabilities made it a valuable application for the problem at hand, and reduced complexities of integrating various software packages. In addition, Flownex has an intuitive design facilitating modelling of large, complex systems."

Andre Kellerman, Senior Control and Instrumentation Engineer
ESKOM

RESULTS

The Flownex digital twin successfully reproduced the behaviour of key boiler systems during load changes, mill trips and fan trips. The close agreement between simulated and plant responses demonstrated that the model could accurately predict boiler behaviour and be used with confidence to evaluate control strategies before implementation.

Eskom NELSON MANDELA UNIVERSITY

CONCLUSION

Flownex enabled Eskom and Nelson Mandela University to develop a validated digital twin of a coal-fired boiler and its firing-side control system. The validated model provided a safe environment for testing control philosophies, optimising controller settings and evaluating operational scenarios without affecting generation. By shifting these activities from the operating plant to a virtual environment, Eskom could reduce implementation risk, minimise disruption and accelerate control-system optimisation.