Application Note AN2010-06

Power Plant – Steam Control

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INTRODUCTION

This application note presents SEL logic devices, such as the SEL-2411 Programmable Automation Controller (PAC), SEL-2440 Discrete Programmable Automation Controller (DPAC), and SEL-3530 Real-Time Automation Controller (RTAC), as distributed control system solutions for one of the most fundamental sectors in the electrical generation industry—steam control.

PROBLEM

The main objective of a steam control system is the safe and efficient transfer of energy from the input fuel source into the output electric generator steam turbine.

In order to maximize the electrical generation process efficiency, the control system should optimize the steam energy level before it is delivered to the next step in the conversion process. After the energy from the steam is fully absorbed by the generator turbine, it can be returned to the boiler in a fluid form to start the cycle again.

The system is a complex, multivariable, and interactive process. Parameters like the burner firing rate, combustion air, feed water, steam temperature, and pressure must be closely monitored and controlled. All variables can affect or be affected by each other.

SEL SOLUTION

The SEL solution uses control logic algorithms distributed into the SEL-2411 PAC and the SEL-3530 RTAC. The SEL-3530 RTAC works as an interface with the SCADA (supervisory control and data acquisition) system interacting with the SEL-2411 PAC for localized process control and the SEL-2440 DPAC for interlocks and alarms.

Following configuration, the operation of the control system can be set to work as a boiler follower. In this configuration, the main steam valve to the generator turbine can be directly modulated by the SEL POWERMAX® power management and control system, based on the electrical system power and frequency demands. The SEL-2411 PAC modulates the boiler systems to maintain a constant steam pressure. Other configurations are possible by using POWERMAX as a coordinated unit to modulate the boiler and steam valve in parallel.

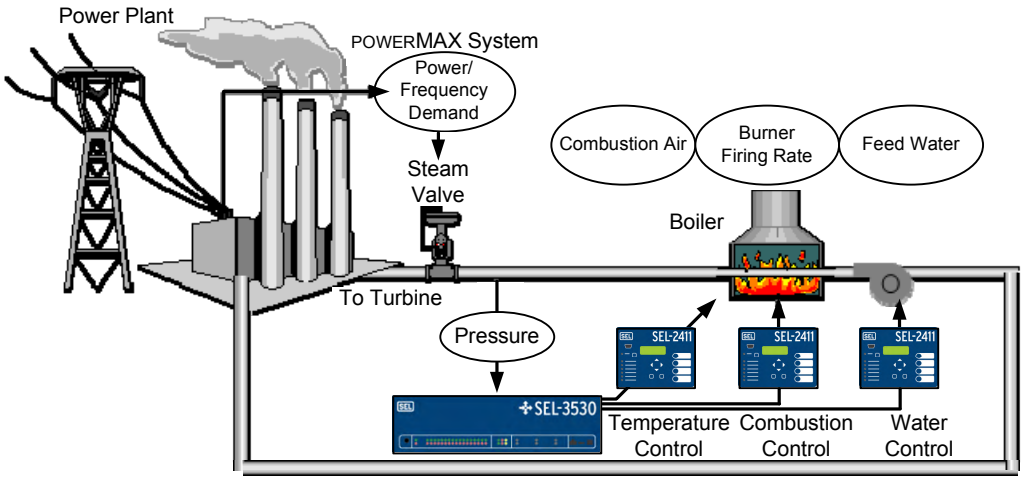

Figure 1 Steam Control

COMBUSTION CONTROL

The boiler combustion control is critical to guarantee an efficient use of fuel to produce the required steam demand. This process must be executed safely to avoid any risks to personnel, equipment, and the environment. A cross-limited combustion control implemented on the SEL-2411 PAC modulates the air damper and fuel valves to obtain the correct mix for an efficient combustion process, as shown in Figure 2.

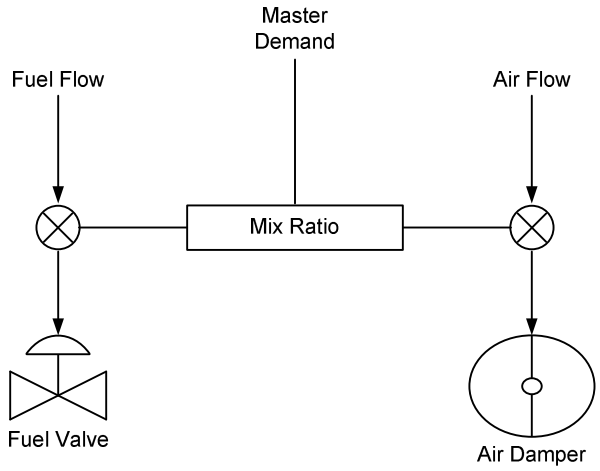

Figure 2 Combustion Control

FEED WATER CONTROL

The objective of an SEL-2411 PAC as a feed water control is to supply enough water to match steam demand. The system keeps a constant water level of around 50 percent in the boiler. The level is controlled not only using a level transmitter but also by incorporating steam flow and water flow gauges in the control algorithm to avoid false valve operations due to swell or shrinkage processes in steam boilers.

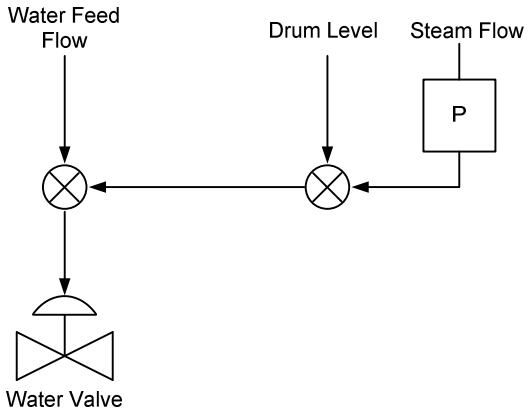

Figure 3 Feed Water Control

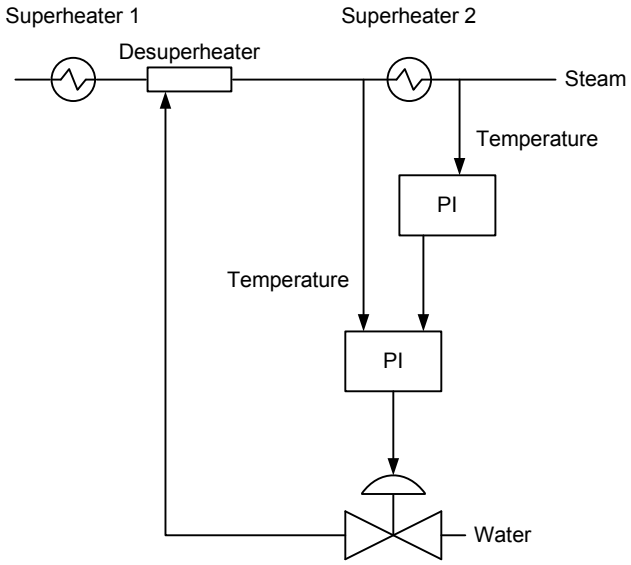

Figure 4 Steam Temperature Control

STEAM TEMPERATURE CONTROL

Heat in the boiler is used to convert water to steam and increase the steam temperature in the superheat stages. The SEL-2411 PAC logic controls the temperature at which the steam leaves the boiler and keeps it constant over the entire load range. The SEL-2411 PAC can send output signals to desuperheaters based on cascade temperature PI (proportional integral) loops.

For more information, please see *Power-Plant Control and Instrumentation: The Control of Boilers and HRSG Systems*, by David Lindsley, The Institution of Electrical Engineers, London, United Kingdom.

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