Digital reheat furnace control

Russula and Stein Heurtey have developed a fast, inexpensive and robust program for the control of Digit@al Furnaces® that is easily adaptable to customer requirements. A control zone is generated from each burner pair installed on the furnace walls. A temperature control PID (Proportional Integral Derivative) controls each zone and generates an output that relates the heat demand to the length of time the burners will be operating at full capacity depending on the temperature set point and the real temperature that is measured from thermocouples. The digital control philosophy results in a comparatively simple mechanical and electrical installation design.

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The Digit@al Furnace® is a patented concept developed by Stein Heurtey for reheat furnaces. Russula and Stein Heurtey collaborated to configure control programs that use this new philosophy and Russula, having 20 years experience in systems integration for the steel industry, has implemented this technology in four installations worldwide. The result is a practical and structured program solution.

The key idea behind the Digit@al Furnace is to maintain burner capacity at 100% by adjusting the timing and schedule of their use. This new concept is quite different from classical analog furnace control, where the burners modulate continuously between the high and low burner capacity. The digital control philosophy thus results in a comparatively simple mechanical and electrical installation design. Control solutions for the digital furnace employ Russula's structured programming tools, allowing for a simpler control program. The main design goal when using the Digit@al Furnace is to achieve a time-modulation solution that allows a fast, inexpensive, and robust control program that can easily be adapted to whatever configuration is proposed for the project and customer requirements.

BASIC SEQUENTIAL CONTROL

The first step in achieving a flexible, structured control solution is to determine how to split the furnace heating zones *(see Fig 1)*. The classical furnace is sub-divided into either, preheating, heating, and soaking zones, or only heating and soaking zones. Russula's program solution consists of splitting the control zones according to burner pairs installed on the furnace walls. A control zone is generated from each burner pair and a temperature PID controls each zone and generates an output depending on the temperature set point and the real temperature that is measured from thermocouples.

In analog furnace control, temperature control PID outputs are cascaded with air and gas control PID inputs, using a cross reference limit to maintain the required air-gas ratio. The control functions of the Digit@al Furnace use the temperature PID outputs from all zones to keep a sequential queue which controls all furnace operations in order to maintain the heating requirements for each zone and to keep common digital furnace functions (combustion air, gas, and furnace pressure) at stabilized values. As with the classical furnace, the digital furnace uses other common controllers for maintaining combustion air temperature and dilution air.

Sequential control allows for digital operation (burners are either on or off), without resulting in large pressure variations as seen in other basic furnace controls (gas pressure, combustion air pressure and furnace pressure). Large pressure variations typically occur if burners are operated on and off without any logical control.

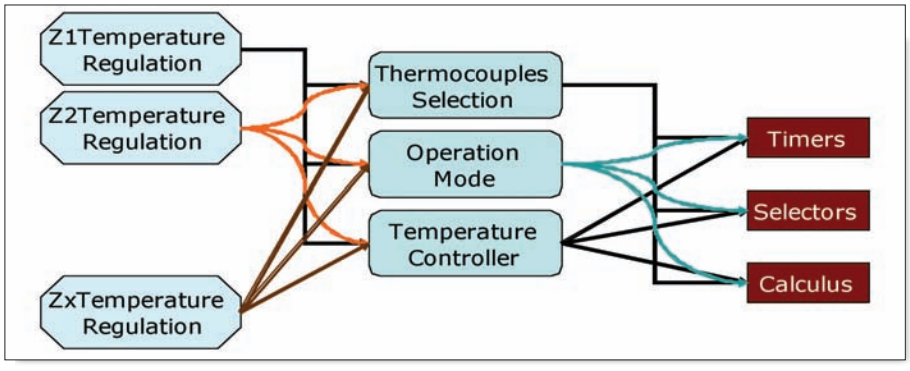

Fig.1 : Structured programming for temperature zone regulation

The PID loops will control the so called zones according to one of the following zone status definitions:

- Zone to be switched on: normal operation during heating process
- Zone to be kept off: if the heating request at any zone is under a threshold, the zone will be kept off
- Zone to be switched on permanently: heating request over a threshold results in permanent zone operation

As a basic mode of operation, sequential control will manage the burner operations to avoid pressure variations in the furnace chamber and at the gas and air supply *(see Fig. 2)*. The control system will manage how many burners are to be on at any given time and controls the steps for increasing or decreasing the number burners simultaneously, ensuring that the furnace is optimised for power consumption while holding to each zone's power requirements.

DIGITAL COMMON CONTROLLER OPERATION

Common controllers with digital operation (combustion air pressure, gas pressure and furnace pressure) use feed forward technology for generating the analog reference for proportional control valves. The feed forward technology allows the management of the critical parameters such as combustion air pressure, gas pressure and furnace pressure in order to produce the best results.

Other common controllers, basic combustion air temperature and dilution air (recuperator protection functions), operate as in any other furnace, with a PID function directly controlling regulation valves. These two controllers have an influence on combustion air pressure regulation; this is the reason why controller output is used by predictive control to compensate possible pressure loss due to their operation.

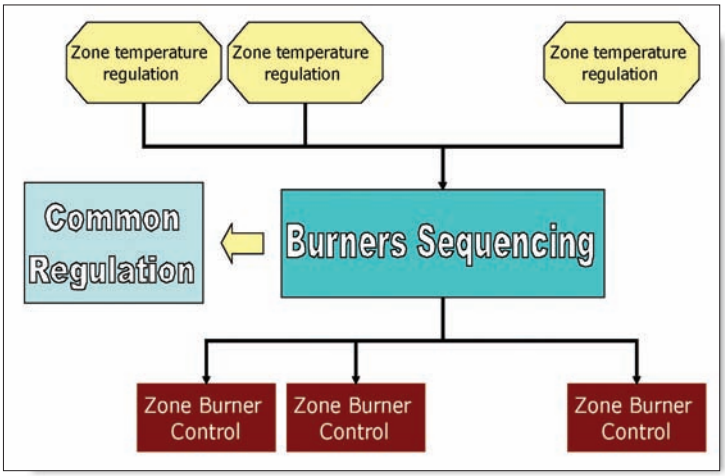

Fig.2 : **Basic sequential control**

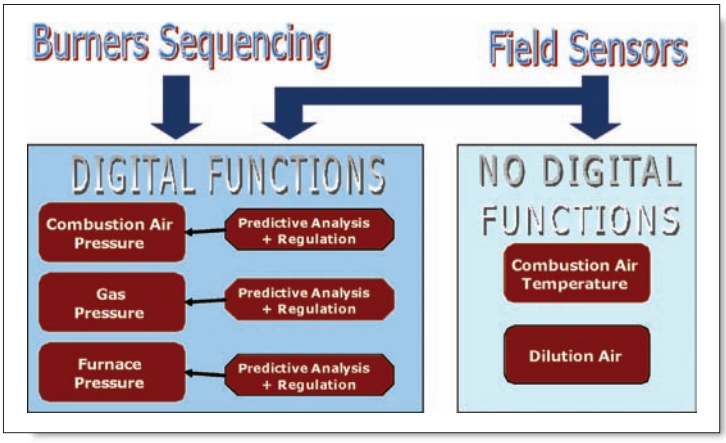

Fig.3 : **Data analysis for common regulation**

PROGRAM DATA FLOW

Digital furnace programming carefully controls data flow between the different sequences in order to maintain furnace pressure, especially at burner turn on/turn off transitions, thus avoiding peak pressure variations during switchovers. It is important to maintain all data flow and program structure in this manner, so that as burners transition, common regulation valves will act at the same time as burner valves, so reducing the impact of transitions and avoiding large peaks in furnace pressure.

This data flow configuration and the use of one regulation zone per pair of burners allows a high flexibility furnace control combination *(see Fig. 3)*. It also allows for simplified operation using a fixed group of configurations customised during system commissioning. Additionally, to change the operational configuration, it is only necessary to modify the sequential controller input data at each zone.

CONCLUSIONS

Russula has configured the digital furnace control programs to facilitate the implementation of the Stein Heurtey Digit@al Furnace concept. These structured programming tools provide program flexibility, and allow for easy adaptation of the standard program to fulfill customer requirements.

ACKNOWLEDGEMENTS

Special acknowledgements to Mr. Alain Morel of Stein Heurtey, the staff of Stein Heurtey, Bilbao and the Russula electrical engineering department.

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