COMPRESSOR CONTROLS CORPORATION

Series 3 Plus Fuel Controller

for Gas Turbines

Description

The Series 3 Plus Fuel Controller provides a versatile, compact, and economical way to control an industrial or aero-derivative gas turbine. In addition to regulating speed or power, it also protects against excessive temperatures, speeds, or pressures, and sequences the fuel flow during startups and shutdowns.

Models are available for single or multishaft turbines driving variable-speed loads or synchronous generators. Their redundant inputs, fault detection, fallback strategies, and redundant controller features define a new, more economical approach to fault tolerance than has previously been available for such machines.

Fuel Controllers can be combined with Series 3 Plus Antisurge and Performance Controllers to provide integrated control of turbine-driven compressors. They can also be integrated into a distributed control system via Modbus serial communication.

Basic Applications

For turbine-driven generators, the Fuel Controller offers isochronous and droop control modes with selectable local and remote set points:

- Isochronous control uses a PID algorithm to keep the speed equal to the set point.
- Valve droop uses a P+PID algorithm to keep the fuel flow proportional to the droop (that is, the difference between the speed and speed set point).
- Power droop uses a P+PID algorithm to keep the generator's power output proportional to the droop.

Mode switching is implemented via discrete inputs. Redundant inputs can be used for power droop, and the controller can fall back to valve droop if both fail. Synchronization can be achieved by fine-tuning the speed set point before closing the generator breaker. If that breaker opens suddenly, Overspeed Prevention features will reduce or stop the fuel flow to prevent overspeed damage.

For turbine-driven compressors, the Fuel Controller's speed set point is set by a Performance Controller, which in turn implements a tracking mode that prevents integral wind-up if any turbine limitation (the maximum temperature, for example) prevents it from

***Description**, continued on rear panel*

Benefits

Series 3 Plus Fuel Controllers offer benefits you can't get from other mechanical or electronic governors:

- More precise control of turbine speed by eliminating mechanical deadtime and hysteresis effects
- More precise control of turbine-driven compressors because control functions are integrated
- Lower fuel costs because precise temperature control provides maximum fuel efficiency
- More reliable operation because redundant inputs and fallback modes provide fault tolerant control
- Less downtime and reduced maintenance costs because electronic circuits are more reliable than mechanical and hydraulic components
- Lower repair costs because start-up and shut-down sequences provide consistent warmup and cool-down and prevent operation at critical speeds

Description, *continued from front panel*

reaching the desired speed. Decoupling between the Antisurge and Performance Controllers minimizes the possibility of overspeed due to compressor surge or compressor surge due to speed control actions.

For multi-shaft turbines, the Fuel Controller can control either the power turbine (NPT) or gas generator/high-pressure rotor (NGG/NHP) speed.

Speed and Acceleration Limits

Limiting loops are provided for all shaft speeds, and you can define independent high speed alarm and electronic overspeed trip speeds for each shaft. In addition, the overspeed test allows you to raise the turbine's speed until its primary trip is triggered, and captures that maximum speed for later display.

Acceleration and deceleration can be limited not only by scheduling the fuel flow range, but also by setting fuel flow and NGT rate-of-change limits.

Temperature Inputs and Limits

A high-median algorithm is used to select from multiple analog inputs for the combustion (T3) or exhaust temperature (T6). External conditioners are required for thermocouple or RTD signals.

A limiting loop restricts the fuel flow when this temperature exceeds a threshold you can define as a constant or as a function of the compressor discharge pressure (CDP). In the latter case, a default constant limit is used if the CDP input fails.

An alarm is generated if any temperature input fails, if the spread between the high and low signals exceeds a user-defined level, or if the selected temperature exceeds a high alarm limit. The turbine is shut down if all temperature inputs fail, or if the selected temperature is outside of a user-defined range.

Startups and Shutdowns

The Fuel Controller can also sequence the turbine's fuel supply during startups and shutdowns. The start-up sequence provides for pilot light and main burner ignition, timed warmups, and ramped acceleration to operating speed. It will pause if the temperature or acceleration gets too high, and aborts if the fuel valve opens farther than intended, ignition does not occur, or the turbine stagnates.

The stop sequence slows the turbine, pausing for up to two cooldowns, before shutting it down. In contrast, the emergency shutdown immediately closes the fuel control valve. Both the start-up and shut-down set point ramps can skip over two critical speed ranges.

Control Valve Flexibility

In addition to 20 mA and 5 Vdc output signals, the Fuel Controller can also generate nearly any current signal (up to 200 mA) required by pneumatic transducers or hydraulic actuators. The output signal can be linearized relative to the valve's flow characteristics, and an alarm is generated if the valve deviates from its intended position. An optional positioning loop is also offered.

Summary of Features

The many built-in, keyboard-configurable features of the various Series 3 Plus Fuel Controllers include:

- redundant speed inputs (selected value can be transmitted to companion controllers)
- isochronous, valve droop, and power droop control
- primary control of NPT or NGG/NHP and limiting control of other shaft speeds (multi-shaft turbines)
- independent high-speed alarm and overspeed trip thresholds for each shaft
- overspeed test captures overspeed trip limit
- local and remote set points
- variable gain and reset rate
- high-median temperature selection with spread alarm and automatic shutdown if all inputs fail
- over-temperature alarm, high-limiting with scheduled set point, and high and low temperature trips
- limiting control of compressor discharge pressure (CDP) and fallback strategies for CDP input failure
- acceleration and deceleration limits
- fuel sequencing during startups and shutdowns
- set point ramps bypass two critical speed ranges
- cooldown and coastdown timers
- compatible with pneumatic and hydraulic actuators, with analog or LVDT position tracking
- Modbus interface enables communications with host computers or distributed control systems
- standard hardware simplifies maintenance and spare parts stocking

PROCON SYSTEMS INC.
www.proconsystems.com