TECHNICAL ARTICLE

Principle of Flame Rectification in Gas Ignition Controls

F-35-1003
June 2019

INTRODUCTION

When controlling a burner using natural gas or propane as a fuel, it is critical to monitor the flame for safe operation. Gas burner safety standards require a reaction time to a loss of flame within 800 milliseconds which disqualifies heat-sensing methods such as a thermocouple. Flame rectification is the most common method of electronic flame sensing. Flame rectification is dependable, complies with all safety requirements and is a cost-effective electronic flame detection method.

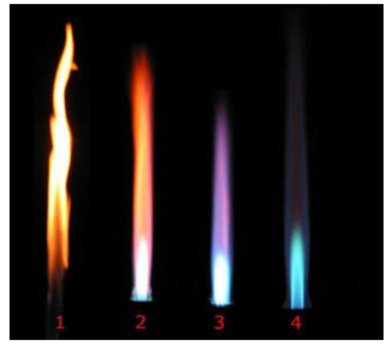

Figure 1. Types of Gas Flames:
Fuel rich (1) to Stoichiometric (ideal) combustion (4)

COMBUSTION

Stoichiometric combustion (see Figure 1) is the ideal process where fuel is burned completely transforming all the carbon (C) to Carbon Dioxide (CO_2), all the hydrogen (H) to Dihydrogen Oxide (H_2O) and all the sulfur (S) to Sulfur Dioxide (SO_2). The central region of the combustion flame is mostly pure unburned gas and has very little or no ionization. The outer region, the blue portion of the flame, has the highest amount of ionization and is so unique it can conduct electricity. This property makes flame detection with applied voltage possible.

FLAME RECTIFICATION

In flame rectification the diode effect or diode terminals, Anode and Cathode, are defined by the flame sense and ground rods, or by the flame sense rod and the burner. The flame behaves like a diode and the current flows from the anode to the larger cathode. In most cases, the flame sense rod, being smaller, acts as the anode with the cathode defined by the large metal surface area of the burner or bracket assembly. Applying an alternating voltage (AC) between the flame sensing rod and burner ground when the flame is present allows the ions in the flame to provide a flow of electrons in the forward direction. Because the metal surface of the burner is much larger than the sensing flame rod, more electrons flow in one direction, resulting in a net negative charge or DC offset current. The rectification effect of the flame ensures safe, fast and reliable flame detection. Flame rectification circuits also easily distinguish between the presence of a flame and a short circuit in the flame sense rod. There will be a zero DC offset should the flame sense rod short out to burner ground, because the amount of electron flows is the same in both directions and the net charge is zero.

Flame rectification depends on a reliable low-resistance conductor path for the flame current. When a flame sense rod is used, the flame sense rod bracket must have a reliable connection to ground. This low resistance path can be created by running a wire from the flame sense rod bracket assembly directly to the ground (burner) terminal, and typically should have a resistance of less than one Ohm.

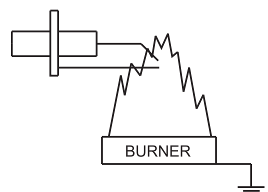

Figure 2. Proper Electrode-flame Sensor Assembly Placement

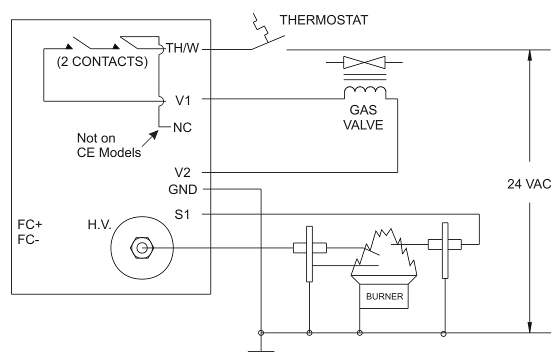

Figure 3. Typical Wiring of Gas Ignition Control with Remote Flame Sensing

CONCLUSION

In Fenwal Controls gas ignition controls, the principle of flame rectification is well proven, reliable and safe, with the response to flame detection within 0.8 seconds to meet agency requirements. Depending upon the control series and software, the response to flame failure can be re-ignition, recycle, lockout or lockout with programmed time for automatic retry. Depending upon the application, applicable regulations and if the appliance is attended or unattended, a wide range of software programs, timings and sequences are readily available.

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