BULLETIN NUMBER: SP8009-0809

DATE: 9/15/08

SUBJECT: Flame Sense Measurements

MODELS: All Gas Griddles

SERIAL NUMBER: All

Background

One of the most important tools in diagnosing the operating status of a gas griddle is the flame sense signal. The magnitude of the measured value is directly related to the health of the gas griddle control system. Low values indicate poor performance and a high risk of failure to operate. Conversely, high values indicate good performance and a low risk of failure to operate.

A flame is the result of a substance being oxidized at a rapid rate at an elevated temperature. This is typically considered combustion. A blue flame is the result of the proper ratio of oxygen to fuel. As the fuel burns, the gasses in and around the flame become electrically charged or ionized. A typical blue flame consists of two parts, the inner and outer cone (see Fig. 1). The inner cone in a blue flame is the light blue portion of the flame surrounded by a darker outer blue portion. The inner cone is considered the oxidation zone where gas and oxygen begin to combine, the tip of which is the part of the flame with the highest temperature. The reaction creates enough energy to excite and ionize gas molecules in the flame, leading to the blue appearance. The darker outer cone is where combustion is finalizing and is also the highest ionized zone of a blue flame. The highly ionized outer cone is where the properties of flame rectification come into play.

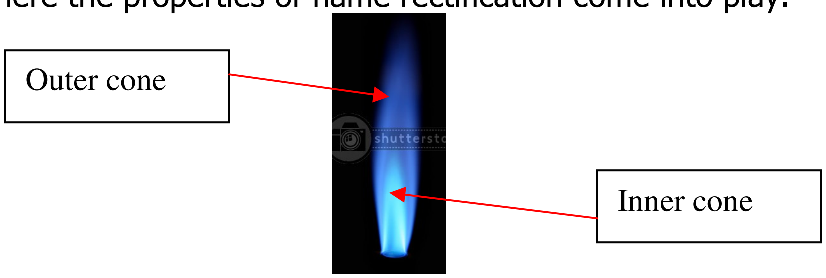

Fig. 1

Ionization is the process of stripping (or adding) an electron from an atom or molecule to form a new particle with an electric charge. These new particles will either attract an opposite-charged particle or repel a like-charged particle. The area of the flame with the highest concentration of ionized can gas can rectify (reorganize) an alternating current (AC) into a direct current (DC), much like a diode. Therefore we are concerned about the outer cone, since this is location of the highest concentration of ionized gases. The inner cone is mainly un-burnt gas and therefore little ionization takes place.

A flame rectification sensing circuit works by applying an AC signal, using properly placed electrodes (probes), across the highly ionized zone of the flame. The diode affect of the flame allows only half of the AC signal to pass through and rejects the other half, effectively rectifying the AC signal into a DC signal. The magnitude of the DC level of the signal is directly proportional to the density of the ionized gas, such that the higher the DC level, the higher the ionized gas density. A high density of ionized gas means a robust flame is present.

In our gas products, the ignition control module uses the level of the rectified current to determine the condition of the flame. A low DC value indicates a poor flame; a high DC value indicates a strong flame. There are several factors that affect the generation of a strong signal: the correct mixture of gas and oxygen; the correct position of the flame sensor probes in the flame; the condition of the flame sensor probe (oxidation buildup); the ground probe; and the ground plane.

Field Corrective Action

How to make a diagnosis:

1. Determine that power is present at the unit.
2. Determine that gas is supplied at the proper pressures to the unit.
3. Install an inch-units H_2O manometer onto the port on the side of the main gas regulator valve and onto the pressure tap outboard of the pilot regulator.
4. Install a flame-sensing probe into the flame sense circuit. (If the ignition module has a yellow wire for the flame sensing, replace the harness with a new one that has an orange wire for the flame sensing circuit.)
    a. A meter with microamp (µA) selection or a microamp adapter must be place in series with the orange flame sense wire. To check microamps, disconnect the orange wire from the flame rod, connect the amp meter in series with the flame sensing rod terminal and the orange wire from the wiring harness.
    b. A volt-measuring adapter (meter set for millivolts) is placed in parallel with the orange flame sense circuit. Attach one end of the adapter to the orange wire and the other to ground.
5. Turn the unit on (Power lamp is lit)
6. If the pilot burner is not lighting and there is no spark, check for 24 VAC input to the ignition module.
    a. If there is 24VAC present at the ignition module and all of the ground connections are good, check the ignition cable for an open or a short to ground.
    b. If there is 24VAC present at the ignition module and all of the ground connections and the ignition cable are good, test for spark by disabling the main regulator gas valve and place the ignitor cable close to ground. Turn the griddle ON. If there is no spark, replace the ignition module.
    c. If there is a spark, check the ignitor probe spark gap on the pilot burner. Adjust, if necessary. If the probes look badly oxidized, replace the probes.
7. If there is spark but no gas to the pilot regulator, check for 24VAC at the gas valve coil. If 24VAC is not present at the coil of the main regulator gas valve, and the connecting harnesses are good, replace the ignition module.

8. If 24VAC is present at the gas valve coil and no gas is flowing to the pilot regulator, replace the main regulator gas valve. When changing the valve, check for debris in the gas line and valve. Ensure that a drip leg is installed before the unit.
9. If the pilot burner is lighting, determine if the sensing signal level is 25mV (1.07µA) or higher (see the attached millivolt to microamp chart).
    a. If the level is less than 25mV (1.07µA), check for proper gas pressures to the main regulator and to the pilot regulator. For natural gas, the pressures must be 5" H_2O for the main gas valve and 3.5" H_2O for the pilot burner regulator. For propane gas, the pressures must be 10" H_2O for the main gas valve and 8.0" H_2O for the pilot burner regulator.
    b. If the gas pressures are good but the sensing signal level is still poor, check the pilot orifice for obstruction. Clean or replace as necessary.
    c. If the gas pressures are good, the pilot orifice is clean, the burner surface is glowing orange to bright orange but the signal level is still poor, replace the ignitor probe set and ground plane.
10. Four types of meter readings are possible: 0 millivolts or 0 micro amps; a steady reading of 25 millivolts or 1.07 microamps or more; a low reading less than 25 millivolts or 1.07 microamps; or a fluctuating reading that won't stabilize. The possible causes for each type of reading are:
    a. **0 millivolts or micro amps –** Look for an open or grounded sensor wire or flame rod, or a defective ignition module. The wire and rod can be diagnosed with an ohmmeter. Make the diagnosis of a defective ignition module after all other possibilities have been exhausted.
    b. **25 millivolts or 1.07 microamps, with a steady reading –** The system is operating within normal parameters.
    c. **Fluctuating meter reading –** Check that the flame sensor probes are properly located. Also check for drafts that can cause an unstable flame. A dirty orifice can also cause an unstable flame.
    d. **Less than 25 millivolts or 1.07 microamps –** Look for a pilot flame that's not properly engulfing the flame-sensing rod. A flame sensor probe too close to the tile will not be in the proper part of the flame, with not enough ionized gas to allow a proper signal level to be conducted. Conversely, the same thing holds true if the flame sensor is too high. Also check the ground connection back to the ignition module. Check that the flame-sensing rod and ground plane are not oxidized. Clean both with a non aluminum oxide abrasive.

Important! The ignition module should be the last item that is replaced. Ignition modules are designed and tested to rigorous standards to ensure safe and consistent operation. Therefore, focus on other less robust components before swapping out the ignition module.

Approximated Volts (displayed millivolts) to microamps conversion

Displayed millivolts	microamps	Displayed millivolts	microamps	Displayed millivolts	microamps
8	0.00	31	1.45	54	2.89
9	0.06	32	1.51	55	2.95
10	0.13	33	1.57	56	3.01
11	0.19	34	1.63	57	3.08
12	0.25	35	1.70	58	3.14
13	0.32	36	1.76	59	3.20
14	0.38	37	1.82	60	3.27
15	0.44	38	1.88	61	3.33
16	0.50	39	1.95	62	3.39
17	0.57	40	2.01	63	3.45
18	0.63	41	2.07	64	3.52
19	0.69	42	2.14	65	3.58
20	0.76	43	2.20	66	3.64
21	0.82	44	2.26	67	3.70
22	0.88	45	2.32	68	3.77
23	0.94	46	2.39	69	3.83
24	1.01	47	2.45	70	3.89
25	1.07	48	2.51	71	3.96
26	1.13	49	2.57	72	4.02
27	1.19	50	2.64	73	4.08
28	1.26	51	2.70	74	4.14
29	1.32	52	2.76	75	4.21
30	1.38	53	2.83	76	4.27

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