The Heart of Photoionization Detector (PID) - Vacuum Ultra-Violet (VUV) Lamp

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Photoionization detector (PID) is a powerful tool for VOC detection and has been widely applied to industrial safety, environmental monitoring, and emergency response. The heart of PIDs is the VUV light source, which plays an important role in PID's stability, sensitivity, and lifespan. Vacuum Ultra-Violet (VUV) light source with wavelength from 100-200nm and ionization energies from 8.4 to 11.8 eV are gas discharge lamps that are available in both DC discharge excitation and RF discharge excitation.

A DC discharge excitation lamp (Fig. 1) is typically made of sealed glass envelope with two metal electrodes (anode and cathode) embedded in the glass envelope.

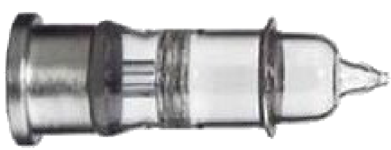

Fig. 1 DC discharge excitation lamp

A high voltage of 600-1500V DC is applied between anode and cathode to initiate a glow discharge inside the lamp. After the initial excitation, the voltage is reduced to 300 V to sustain the glow discharge. Due to the need to place two metal electrodes inside the glass envelope and seal, the production process of the lamps is relatively complicated and hard to reduce to a smaller size or miniature size. The typical size of this type of lamp is about 2" long and ¾ to 1" diameter. The power consumption of DC lamps is relatively high and in the range of several watts.

Due to the use of metal electrodes inside the DC lamp, heat will be generated when applied a high voltage to the electrodes. This will require a significant warm up time for the instrument to achieve thermal equilibrium. In addition, it will prevent condensation on the lamp surface and in the sensor cavity. Because the excited gas directly contacts the metal electrodes in the DC lamp, a possibility for corrosion exists and limits the fill gases. Another risk is the metal electrodes under excited gas or ion or electron will be damaged or could result in a sputtering, which deposits to the lamp window. This reduces VUV lighting transmission or output and could cover the whole window, thus resulting in no lighting output.

A RF discharge excitation lamp (Fig. 2) is relatively simple in design and made of sealed glass envelope (typically salt crystals) with VUV light transmission windows and fill gas

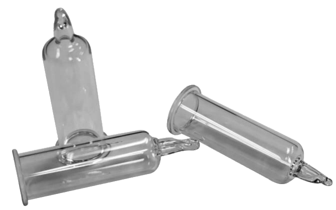

Fig. 2 RF discharge excitation lamps

This is different from the DC discharge lamp excitation method. This method usually utilized AC electric field excitation, which uses a pair of parallel electrodes placed outside the glass envelope to drive the lamps. High voltage and low frequency RF signal (<100 kHz) is applied to the electrodes to excite the lamp. The glow discharges can be operated in a non-continuous fashion with an on-off frequency that is fast compared to the time constant of gas flow through the ionization chamber. For this operation,the power consumption of the PID can be reduced. This excitation method occasionally results in an initial difficulty in turning on the lamp, therefore, requires a little higher initial power used to turn on the lamp and then sustain the glow discharge with a lower power.

The RF discharge excitation lamp method has these advantages compared to DC discharge excitation lamp method:

1. Production process of the RF lamps is simpler and easier than the DC lamps due to no metal electrodes placed inside the glass envelope.
2. It is much easier to reduce lamp size or make mini lamps for small PID sensors
3. The absence or reduction of contaminants inside the glass envelope helps maintain the purity of the fill gas and ensures proper VUV light transmission through the lamp window.
4. It provides longer life, higher sensitivity, and higher intensity.
5. It enables lower power consumption.

Based on DC and RF lamp features, RF discharge excitation lamp method provides the solution to demands for low cost, long life, better stability and low-power drive circuitry used in modern PID or Volatile Organic Compound (VOC) monitors.