SENOVOL CORPORATION

Understanding PID Sensors: Principles, Technology, and Selection

Tech Note 250203

Overview

This article explains the concept, function, applications, and technology behind **Photoionization Detectors (PIDs)**, which are widely used in **gas detection, air quality monitoring, environmental monitoring, industrial safety, and gas chromatography.**

What is a PID?

A **Photoionization Detector (PID)** is a device used to measure **volatile organic compounds (VOCs)** and some **inorganic compounds** in the air. It operates by using **vacuum ultraviolet (VUV) light** to ionize gas molecules, generating **positive ions and electrons** that produce an electrical current. This current is proportional to the gas concentration, allowing the PID to detect VOC levels effectively.

How Does a PID Work?

A PID consists of the following key components:

- **VUV Lamp** – emits high-energy ultraviolet light.
- **Lamp Driver** – provides high voltage to ignite the lamp.
- **Ionization Chamber** – where gas molecules are exposed to UV light.
- **Electrodes (Detector)** – collect generated ions and electrons to measure current.

When the **VUV lamp** is ignited, it emits high-energy photons that ionize VOCs present in the air. The resulting **positive ions and electrons** are collected by the electrodes, creating an electric current. The magnitude of this current correlates with the VOC concentration, allowing for accurate gas detection.

PID Lamp Design

The **UV lamp** is the most critical component of a PID, as it emits photons in the **vacuum ultraviolet (VUV) range**, necessary for ionizing VOCs.

Why Are Special Crystals Used in PID Lamps?

Standard silica glass **does not transmit** the low-wavelength light needed for VOC ionization. Instead, **special salt crystals** are used as windows for the UV lamps. The quality, thickness, and aging of these crystals directly impact **UV light transmission** and, consequently, the **PID's sensitivity and performance.**

Additionally, PID lamps also emit lower-energy light at visible wavelengths, often appearing **blue or violet** when illuminated. However, these lower-energy photons do **not** have enough energy to ionize most VOCs.

Types of PID Lamps

There are several types of **PID lamps**, each with different energy levels and applications.

1. 10.6 eV Lamps *(Most Common)*

- The **most widely used** PID lamps.
- Built with a **Magnesium Fluoride (MgF_2) crystal window** and a **glass enclosure** filled with **krypton gas**.
- Long lifespan: typically lasts **10,000+ hours** (over a year of continuous use or several years of intermittent use).
- Detects **a broad range of VOCs** with high sensitivity.

2. 11.7 eV Lamps *(Higher Energy, Shorter Lifespan)*

- Detects **more compounds**, including many **chlorinated aliphatic compounds**.
- Built with a **Lithium Fluoride (LiF) crystal window** and a **glass enclosure** filled with **argon gas**.
- **Shorter lifespan** due to the **higher solubility** and fragility of LiF crystals.
- More prone to **solarization (degradation from UV exposure)** and **etching by moisture**, reducing efficiency over time.

3. Lower Energy Lamps (8.4 eV, 9.5 eV, 9.8 eV) *(For Specific Applications)*

- These lamps use **different crystal windows** to provide **better selectivity** for detecting specific gases.
- Used in applications requiring **high specificity** for certain VOCs.

Electrodeless PID Lamps *(Advanced Design)*

Not all PID lamps are built the same way. Some modern **electrodeless PID lamps** offer **advantages in lifespan and sensitivity** by eliminating metal electrodes inside the lamp.

Why Use Electrodeless PID Lamps?

- Traditional lamps contain **metal electrodes**, which can degrade over time and release contaminants onto the crystal window, **blocking VUV light transmission**.
- Electrodeless designs **eliminate internal contamination sources**, leading to:
    - **Longer operational lifespan**
    - **Higher sensitivity**
    - **More stable performance over time**

Conclusion

Photoionization Detectors (PIDs) play a crucial role in gas detection by utilizing **high-energy UV light** to ionize VOCs and measure their concentration. The **choice of PID lamp** greatly affects the device's **sensitivity, longevity, and selectivity**.

- **10.6 eV lamps** are the most common and long-lasting.
- **11.7 eV lamps** detect more compounds but have a shorter lifespan.

- **Lower-energy lamps** are used for specialized applications.
- **Electrodeless lamps** offer better **durability and performance.**

By selecting the right **PID lamp type**, industries can ensure **precise and reliable gas detection** for various applications, from **environmental monitoring** to **industrial safety.**