

White Paper: Bimetallic Temperature Switches in Liquid Environments

Introduction

Bimetallic temperature switches are essential components in various industrial applications, providing reliable temperature monitoring and control. Their simplicity, durability, and cost-effectiveness make them suitable for a wide range of uses, especially in environments where electronic sensors may not be ideal. When deployed in liquid environments, the choice of enclosure material becomes critical to ensure longevity and performance. This paper explores the operating principles of bimetallic temperature switches and examines the advantages of using Polypropylene (PP), Acetal (POM), and Polyvinylidene Fluoride (PVDF) enclosures in liquid applications.

Operating Principle of Bimetallic Temperature Switches

Bimetallic temperature switches operate based on the principle of differential thermal expansion. They consist of two bonded metal strips with different coefficients of thermal expansion. As temperature changes, the differing expansion rates cause the composite strip to bend. This mechanical movement can open or close electrical contacts, thereby controlling a circuit.

There are two primary types of bimetallic switches:

- Snap-Action Switches: These switches rapidly change state at a specific temperature, providing quick response and minimal contact arcing.
- Creep-Action Switches: These switches gradually change state over a temperature range, offering precise control but slower response times.

The choice between snap-action and creep-action depends on the application's requirements for response time and precision.

Challenges in Liquid Environments

Deploying bimetallic switches in liquid environments introduces several challenges:

- Corrosion: Exposure to liquids, especially those that are chemically aggressive, can corrode metal components, leading to failure.
- Thermal Conductivity: The enclosure material must allow efficient heat transfer to ensure accurate temperature sensing.
- Mechanical Stress: Pressure and flow within liquids can exert mechanical stress on the switch assembly.

To address these challenges, selecting appropriate enclosure materials is crucial.

Advantages of Polypropylene (PP) Enclosures

Polypropylene is a thermoplastic polymer known for its chemical resistance and mechanical properties.

- Chemical Resistance: PP resists many acids, bases, and organic solvents, making it suitable

for various liquid environments.

- Low Water Absorption: Its low moisture absorption ensures dimensional stability and electrical insulation.
- Thermal Properties: PP can operate in temperatures up to 100°C, suitable for many applications.
- Cost-Effectiveness: PP is relatively inexpensive, offering a balance between performance and cost.

These properties make PP enclosures ideal for applications like water treatment and chemical processing.

Advantages of Acetal (POM) Enclosures

Acetal, also known as Polyoxymethylene (POM), is a high-performance engineering thermoplastic.

- High Strength and Stiffness: Acetal maintains structural integrity under mechanical stress.
- Low Friction and Wear Resistance: Its low coefficient of friction reduces wear, extending the switch's lifespan.
- Dimensional Stability: Acetal exhibits minimal thermal expansion, ensuring consistent performance.
- Chemical Resistance: It resists hydrocarbons and solvents, suitable for fuel and lubricant applications.

Acetal enclosures are well-suited for automotive and industrial applications where mechanical durability is essential.

Advantages of Polyvinylidene Fluoride (PVDF) Enclosures

PVDF is a highly non-reactive and pure thermoplastic fluoropolymer.

- Exceptional Chemical Resistance: PVDF withstands strong acids, bases, and solvents, ideal for aggressive chemical environments.
- High Thermal Stability: It operates effectively in temperatures up to 150°C.
- Low Permeability: PVDF's low permeability to gases and liquids ensures protection against contamination.
- UV and Radiation Resistance: It resists degradation from UV exposure and radiation, suitable for outdoor and specialized applications.

PVDF enclosures are preferred in industries like pharmaceuticals, food processing, and chemical manufacturing.

Conclusion

Bimetallic temperature switches are reliable and efficient devices for temperature control in various applications. When used in liquid environments, the choice of enclosure material significantly impacts performance and longevity. Polypropylene offers a cost-effective solution with good chemical resistance, Acetal provides mechanical strength and stability, and PVDF delivers exceptional chemical and thermal resistance for the most demanding

conditions. Selecting the appropriate enclosure material ensures optimal switch performance, safety, and durability in liquid applications.