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STATIC CHARACTERISTICS AND RELIABILITY ANALYSIS OF INDUSTRIAL MANOMETERS

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Abstract: *Industrial manometers are widely used pressure measuring devices in various technological processes where accurate and stable pressure monitoring is essential. Their performance is primarily determined by static characteristics such as accuracy, sensitivity, linearity, hysteresis, and repeatability. This article analyzes these characteristics and discusses how they influence the reliability of manometers in industrial applications. The study also highlights key factors affecting measurement stability and proposes considerations for improving metrological performance in practical environments.*

Keywords: *industrial manometers, pressure measurement, static characteristics, accuracy, sensitivity, linearity, hysteresis, repeatability, metrology, reliability, calibration, measurement uncertainty.*

Introduction. Pressure measurement plays a crucial role in modern industry, including chemical production, energy systems, mechanical engineering, and transportation. Manometers are among the most commonly used instruments for this purpose due to their simplicity, durability, and

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relatively high accuracy. However, their effectiveness depends not only on design but also on their static metrological properties. Understanding these properties is essential for ensuring reliable operation under different working conditions.

Static characteristics describe the behavior of a measuring instrument under steady-state conditions, when the measured pressure does not change over time. For manometers, the most important parameters include accuracy, sensitivity, linearity, hysteresis, and resolution.

Accuracy reflects the closeness of the measured value to the true pressure. In industrial manometers, accuracy classes are typically defined according to international standards, and even small deviations can significantly affect technological processes.

Sensitivity indicates how effectively the instrument responds to changes in pressure. A highly sensitive manometer can detect small pressure variations, which is important in precision systems.

Linearity describes the relationship between input pressure and output indication. Ideally, this relationship should be directly proportional, but in practice, deviations may occur due to mechanical or material limitations.

Hysteresis refers to the difference in readings when pressure is increasing and then decreasing. This phenomenon is usually caused by elastic deformation of sensing elements and can reduce measurement reliability.

Repeatability is the ability of a manometer to produce the same reading under identical conditions over multiple measurements. Poor repeatability often indicates wear, mechanical instability, or manufacturing defects.

The reliability of manometers is influenced by both internal and external factors. Internal factors include the quality of elastic sensing elements, calibration accuracy, and design structure. External factors involve temperature fluctuations, vibration, corrosion, and improper installation.

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In industrial environments, manometers are often exposed to aggressive conditions, which can lead to gradual degradation of their measurement properties. For example, high vibration levels in hydraulic systems may cause mechanical fatigue, while temperature variations can affect the elasticity of sensing components.

Another important aspect is calibration stability over time. Even well-designed manometers require periodic verification to maintain their accuracy. Without proper calibration, measurement drift may occur, reducing the reliability of the entire system.

Discussion. The analysis shows that static characteristics are directly linked to the operational reliability of manometers. Instruments with high accuracy, good linearity, and minimal hysteresis provide more stable and trustworthy readings. However, achieving ideal performance in industrial conditions remains challenging due to environmental influences and mechanical stress.

Modern developments in pressure measurement technology aim to improve these characteristics through advanced materials, digital compensation methods, and improved manufacturing techniques. In particular, electronic manometers equipped with digital correction systems demonstrate better stability compared to traditional mechanical types.

Conclusion

Industrial manometers remain essential tools for pressure measurement, but their effectiveness depends heavily on static characteristics and operational reliability. Ensuring proper calibration, selecting appropriate device types for specific conditions, and minimizing environmental impact are key factors for maintaining accurate measurements. Further improvements in materials and digital technologies are expected to enhance both the precision and durability of these instruments in the future.

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