

ABSTRACT:

Control valves are among the most critical assets in industrial process plants, and their degradation can significantly impact process performance, product quality, energy efficiency, and plant reliability. Common valve issues such as stiction and leakage often remain undetected until they result in poor control performance, increased maintenance costs, or unplanned operational disruptions. As industries move towards digitalization and predictive maintenance strategies, there is a growing need for intelligent monitoring solutions capable of providing early and reliable insights into valve health.

This talk presents an AI-driven approach for control valve monitoring that integrates anomaly detection, fault diagnosis, and performance assessment within a unified framework. The proposed methodology combines advanced machine learning techniques with process signal analytics to identify abnormal valve behaviour and distinguish between common degradation modes, including leakage and stiction. By leveraging historical operating data and control loop signatures, the framework enables non-invasive assessment of valve condition without requiring additional hardware installation or plant shutdowns.

The approach has been evaluated using industrial benchmark datasets, real plant data, and simulated operating scenarios representing a wide range of process conditions. The results demonstrate its capability to reliably detect and classify valve performance issues under realistic industrial environments, including challenging oscillatory operating conditions. The framework provides actionable insights that support predictive maintenance decision-making and improve the reliability of control valve assets.

The work highlights how artificial intelligence and data-driven monitoring technologies can support the transition from reactive maintenance practices towards more proactive and reliability-centered asset management strategies. The findings offer practical implications for process industries seeking to enhance operational excellence, reduce maintenance costs, and improve overall plant performance through intelligent asset monitoring solutions.