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Design of PID Control Strategies for Spherical and Triangular Vessel Storage System

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Abstract: *Liquid level control in storage vessels with complex geometries, such as spherical and triangular tanks, presents significant challenges due to their nonlinear and time-varying dynamics. Accurate control is essential to maintain process efficiency, safety, and product quality in industrial applications. This paper investigates the design and performance of classical Proportional-Integral-Derivative (PID) controllers applied to spherical and triangular vessel storage systems using three widely adopted tuning methods: Ziegler-Nichols, Lambda tuning, and Kappa-Tau (τ-κ) tuning. Mathematical models of the vessels are developed based on first principles and fluid dynamics, capturing the nonlinear behavior inherent to each geometry. PID controllers are then designed and tuned using each method, and their performance is evaluated through simulation using standard control performance metrics such as rise time, settling time, overshoot, and integral error criteria. The comparative analysis reveals that while Ziegler-Nichols provides faster response, it often leads to higher overshoot. Lambda tuning offers smoother and more robust control, whereas the Kappa-Tau method achieves a balance between responsiveness and stability. The study concludes that the choice of tuning method significantly influences control performance and should be selected based on the specific dynamics of the vessel geometry.*

Keywords: *Liquid level.*