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Stabilization of torsional vibration in oilwell drillstring system

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Abstract

Stick-slip oscillations also known as torsional vibrations appearing in oilwell drilling systems are a source of economic losses, borehole disruption, pipes disconnection, and prolonged drilling time. The torsional dynamics is modeled by a damped wave equation. An important stability issue is to find a control law that reject perturbations due to torsional vibrations. Hence, the primary aim of this paper is to prove the well-posedness of the damped wave equation. In the next step, using the Riemann invariants, the damped wave equation is transformed into 2×2 first-order transport equations. The backstepping techniques combined with kernel equations and the Lyapunov theory are used to prove the local exponential stability of the transformed system, consequently the torsional dynamic. Simulation results are presented to illustrate the effectiveness of the control law.

Keywords: torsional vibrations, stability, drilling, partial differential equation

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