Comprehensive Analysis of Electromagnetic Interference Effects on Adjacent Oil and Gas Pipelines by Buried Power Cables

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Abstract: In economically developed areas with great energy demand, the available land resources are gradually decreasing, and overhead power transmission lines are being replaced by underground cables. This has led to inevitable intersections and parallel layouts with buried oil and gas pipelines in the same corridor. The electromagnetic fields generated by high-voltage cables may cause varying degrees of interference to nearby metallic pipelines and other electrical equipment, and may even lead to safety incidents. This paper takes an actual case where a 110 kV high-voltage power cable parallels and crosses with a buried pipeline as the research object, and through numerical modelling with CDEGS software packages, comprehensively analyzes the electromagnetic interference effects of power lines on adjacent pipelines under steady-state balanced operation, steady-state unbalanced operation, and short-circuit fault conditions. The modelling results show that under the steady-state conditions of balanced operation of double-circuit power cables and unbalanced operation of single-circuit with a 5% imbalance, the AC voltage, touch voltage, and AC current density along the pipeline are all significantly lower than the corresponding safety limits, and there is no risk of electric shock safety to human or AC corrosion to pipeline. During the fault operation of the power cable, especially when the cable sheath protector is broken down and grounded, the maximum touch voltage along the pipeline exceeds the safety limit value for transient conditions, reaching more than 2 times, indicating a risk to personal safety. Further modelling results show that at the intersection of the cable and the pipeline, grounding the pipeline through a solid-state decoupler connected to a zinc ribbon can effectively mitigate this safety hazard.

Keywords: Power Cables; Metallic Pipelines; AC Interference; Short-Circuit Faults; Touch Voltage

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