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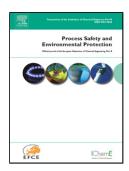
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A comprehensive method for safety management of a complex pump

injection system used for shale-gas well fracturing

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Abstract: A pump injection system used in the shale-gas well fracturing process is subjected to various

adverse factors during its service, such as high pressures of up to 105 MPa and a large displacement,

leading to a high failure rate and a rapid degradation in system performance. To ensure the safety and

reliability of such a system, a comprehensive safety management method based on a dynamic

object-oriented Bayesian network (DOOBN) is proposed in this article. The approach provides a

framework that integrates a system function model, causal model, system behaviour model, and online fault

diagnosis model with a remaining life prediction model, to characterise the behaviours in a complex system,

such as fault propagation and system degradation. This method could achieve fault diagnosis and also

predict the degradation trend of critical components and system performance in the long term, starting from

the current system state. The application of the integrated safety management approach to the specific

example of the pump injection system demonstrates how each phase of the presented method contributes to

the achievement of fault diagnosis and residual life prediction in a systematic and holistic way. It is shown

that the proposed model is a reasonable starting point for forecasting the remaining life of pump injection

systems. This approach could be integrated into a real-time safety warning device for field application.

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