ABSTRACT
PROBABILISTIC MODELS DEVELOPMENT AND RISK MANAGEMENT STRATEGIES FOR PIPELINES WITH ANOMALIES

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Pipelines are exposed to many threats such as corrosion and cracking, which can weaken the pipeline integrity and result in leaks or ruptures, resulting in significant safety, economic and environmental consequences. For corrosion defects, many models were developed to predict the failure pressure of a pipeline with a single defect, and only a few models were developed for interacting defects. For cracking defects, the existing models are very limited. Several model performance evaluations have shown that most of the existing models for both corrosion and cracking-like defects are conservative, which may lead to unnecessary repairs and maintenance in a pipeline risk management.

The goal of this research is to develop a cost-effective risk management of pipelines with anomalies based on reliable probabilistic failure prediction models. To achieve this goal, the research includes four objectives: (1) to develop a probabilistic failure pressure model for pipelines with single corrosion defect, (2) to develop a probabilistic interaction rule and a failure pressure model for pipelines with colony of corrosion defects, (3) to develop a probabilistic failure pressure model for pipelines with single crack-like defect, and (4) to build a framework for optimal inspection and maintenance planning for deteriorating pipelines.

For the first three objectives, three comprehensive databases are established, respectively. Each database consists of experimental and numerical data collected from literature and additional numerical data obtained from finite element models constructed in ABAQUS in this study. The pressure prediction models are developed by either utilizing the existing models as independent variables or by adding correction factors to existing models. The framework for optimal inspection and maintenance planning is developed based on a decision tree model by using analytical methods to evaluate events and considering the inspection schedules and the threshold for repair as the design variables.

This study results in probabilistic prediction models for failure pressure of pipelines containing interactive anomalies, providing predictions that are unbiased with reduced variability, and understanding of the propagation of prevailing uncertainties in the prediction models for the quantitative risk management of pipelines.