PriMera Scientific Engineering
Volume 1 Issue 1 September 2022

Mini-Review

Failure Probability of Internally-Repaired Corroded Pipes under Thermomechanical Loading

Citation: Ardeshir Savari. "Failure Probability of Internally-Repaired Corroded Pipes under Thermomechanical Loading". PriMera Scientific Engineering 1.1 (2022): 34-36.

Received: August 13, 2022

Published: September 12, 2022

Ardeshir Savari*

Mechanical Engineering Department, Petroleum University of Technology, Ahwaz, Iran

***Corresponding Author:** Ardeshir Savari, Mechanical Engineering Department, Petroleum University of Technology, Ahwaz, Iran.

Abstract

With the mounting demand for oil and gas worldwide, the maintenance of repaired pipelines has posed great importance in recent decades, in which composite materials have eased the way to rehabilitate corroded specimens. This study aims to investigate the failure probability of pipes suffering from internal corrosion repaired by fiber-reinforced composite materials which undergo internal pressure as well as temperature gradient, employing the Monte Carlo method, along with the Spearman rank correlation coefficient signifying the role of input parameters in the level of failure probability.

Method

Employing a probability method based on the Monte Carlo method, the effect of uncertainty on the measurement of input parameters was investigated. The metallic pipe, which contains an internal localized corrosion, undergoes internal pressure, with the conveyed fluid imposing a temperature gradient [1]. This pipe is repaired using a fiber-reinforced composite sleeve, where the impact of adhesive existing between the defected pipe and the composite material is also considered. A theoretical method is followed so as to derive a limit state function used in the reliability analysis, emanating failure pressure as a function of geometry, the mechanical properties of pipe, adhesive, composite wrap and temperature [2]. It is noteworthy that Arrhenius formula has been taken into account in order that the deterioration of composite material characteristics such as elasticity modulus and strength over time could be formulated [3]. Implemented to measure the sensitivity of model, Spearman rank correlation coefficient makes it possible to highlight the influence of each input parameter on the failure of the rehabilitated system [4].

Results and Discussion

Figure 1 indicates the convergence study of Monte Carlo simulation regarding the uncertainty of input parameters in different years. What is discernable is that the probability of failure converges to a figure after the utilization of sufficiently random numbers, which are more-or-less. The failure probability of composite repaired pipe over time shown in Figure 2 reveals that the probability of failure

rises through the years with 0.008 units, commencing at just over 0.187 and ending at 0.195 in 50 years. What is more to mention is that the mean spearman rank for input parameters presented in Figure 3 provides an insight into the significance of input parameters, pinpointing that the pipe's thickness and ultimate strength modulus are the most remarkable parameters withstanding loads, as opposed to internal pressure and temperature which worsen the condition. Figure 4, last but not least, clarifies that the time-dependency of failure probability is negligible, meaning that the degradation process of composite material is unlikely to play a part in the failure. This result, however, highlights the importance of other failure mechanisms such as adhesive deboning as well as fracture, which could be looked upon subsequently, as mentioned by the author regarding externally repaired pipes in a published piece of research [5].

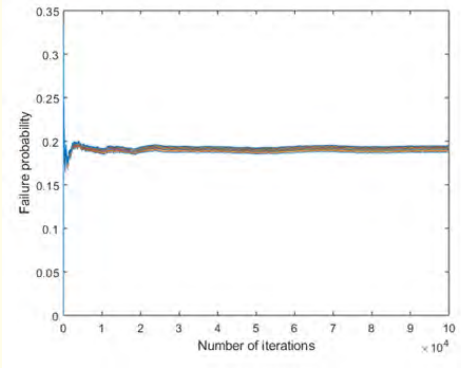

Figure 1: The convergence study of failure probability in various times

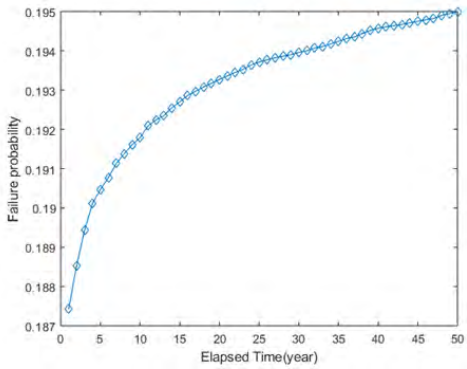

Figure 2: The failure probability of composite repaired pipe over time.

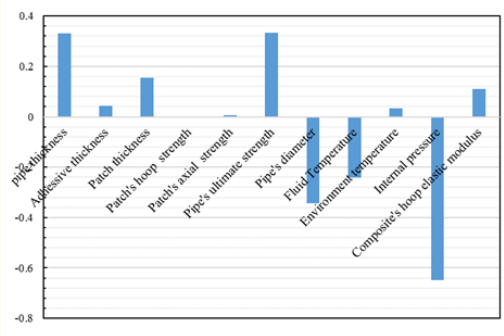

Figure 3: Mean spearman rank for input parameters.

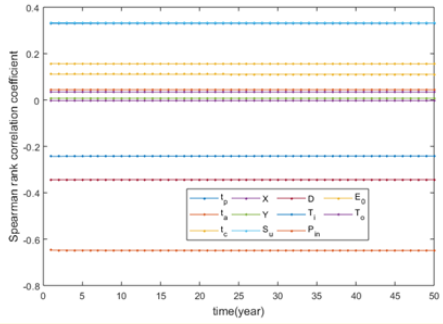

Figure 4: Mean spearman rank for input parameters over time.

Conclusions

From what has been discussed above, one can draw a conclusion that the failure probability of internally repaired pipes increasing over time depends notably on a variety of input parameters, with the ultimate strength of the pipe and internal pressure being the most prominent ones with positive and negative influences, in order.

References

1. A Savari, G Rashed and H Eskandari. "Failure pressure analysis of pipe repaired by composite sleeve subjected to thermal and mechanical loadings". SN Applied Sciences 4.7 (2022): 1-15.
2. S Budhe., et al. "Failure pressure analysis of composite repair system for wall loss defect of metallic pipelines". Composite Structures 176 (2017): 1013-1019.
3. VM Karbhari and MA Abanilla. "Design factors, reliability, and durability prediction of wet layup carbon/epoxy used in external strengthening". Composites Part B 38.1 (2007): 10-23.
4. Y Shuai, J Shuai and K Xu. "Probabilistic analysis of corroded pipelines based on a new failure pressure model". Engineering failure analysis 81 (2017): 216-233.
5. A Savari, G Rashed and H Eskandari. "Time-Dependent Reliability Analysis of Composite Repaired Pipes Subjected to Multiple Failure Modes". Journal of Failure Analysis and Prevention 21.6 (2021): 2234-2246.