Reliability Modeling for Degrading System with Multiple Dependent Failure Modes

To adequately predict reliability and optimize the time-to-maintenance for complex system design and reliability problems, this research develops a new model for complex systems, which are subject to performance degradation and multiple dependent failure modes. In particular, the hazard rate corresponding to each failure mode depends both on time and system state. The system state stochastically degrades over time, and the degradation is described by a stochastic process. The degradation rate, in particular, depends on time and is also a function of the degradation level.

This research develops a reliability model for complex systems, which are subject to performance degradation and multiple dependent failure modes. A joint model of system degradation and failure time is constructed. The system state stochastically degrades over time, and the degradation is described by a stochastic process. Unlike existing reliability models, we consider a realistic scenario where the degradation rate is, not only a function of time, but also the degradation level at that time.

The goal of this research project is to develop the optimum Condition-Based Maintenance (CBM) schedules. The developed model will be used as the basis in our future research on CBM scheduling.

Non-Invasive Monitoring of Oceanic Pipelines to Predict the Formation of Hydrates

Hydrate formation in the Oil & Gas pipelines that runs from the off-shore wells to the on-shore facilities is one of the most serious problems that was faced during last winter season within the industrial settings in Qatar. The main reason was a sudden drop in temperature of the surrounding water that causes the condensation of hydrates, producing heavy paraffin derivatives that essentially choke the pipeline. An estimated 15 to 20 Million Dollars loss of production was faced during the said period by the local industries. While there exists a chemical solution to the problem, which requires the addition of certain specialized chemical in the pipeline that breaks the paraffin bonding, however, by the time the conditions are detected on-shore, the paraffin might already have solidified requiring more and more chemical injection thus increasing the processing as well as material costs.

While the instrumentation is also provided on the two ends of the main pipelines coming through the Arabian/Persian Gulf, the time needed for the actual physical quantities (i.e., flow, viscosity, density, temperature, etc…) is quite large and by the time it is done, the hydrate formation has already gone into its solidification phase. We would like to present some of the initial findings that were obtained conduction lab-grade experiments using a miniature water flow loop with an orifice valve to simulate the blocking conditions. The conditions are picked up as change of sound wave in the channel through microphone attached to the outer skin of the pipe. A detailed Time-Frequency analysis of the data shows remarkable change when that happens, indication the hydrate formation phase.