Consideration of Corrosion Induced Degradation in Design and Operation of Equipments: Example of Corrosion-Fatigue Cracking Degradation Modeling

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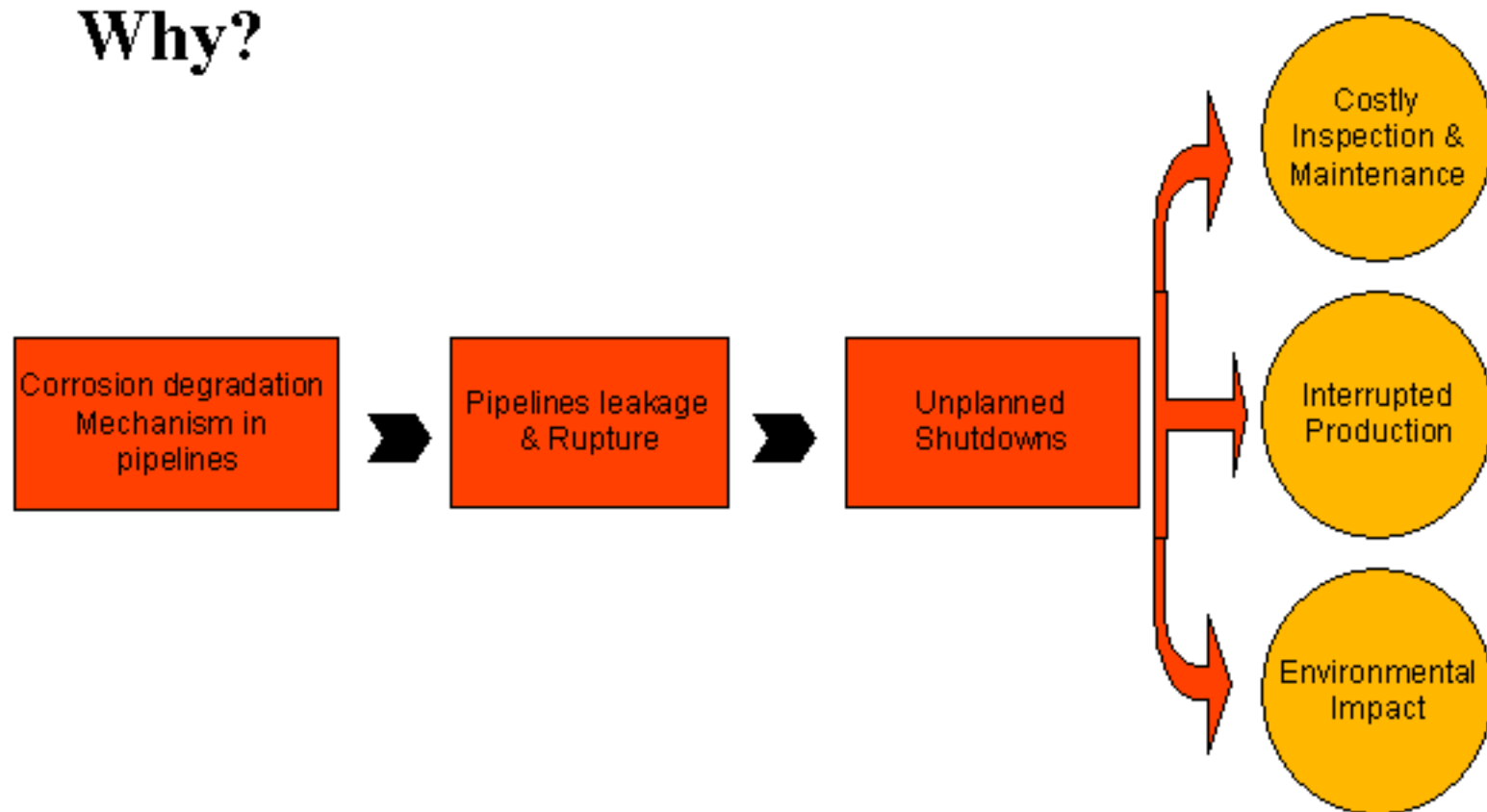
Reliability Engineering

Issues

➢ Corrosion

Objective

Why?

Predict the extent of degradation to prevent or reduce consequences
→ **We need a probabilistic Model**

Approach

➢ Based on the mechanistic (physics based) model, propose a simple empirical relationship between degradation and environmental conditions (degradation model).

➢ Develop a routine using MATLAB to run the simulations. Introduce a Markov Chain Monte Carlo approach for Bayesian analysis to update the parameters of the proposed degradation model based on data and evidence gathered from the field.

➢ Apply the updated degradation model on some specific examples such as oil pipelines to determine its uses in practice such as inspection and maintenance intervals.
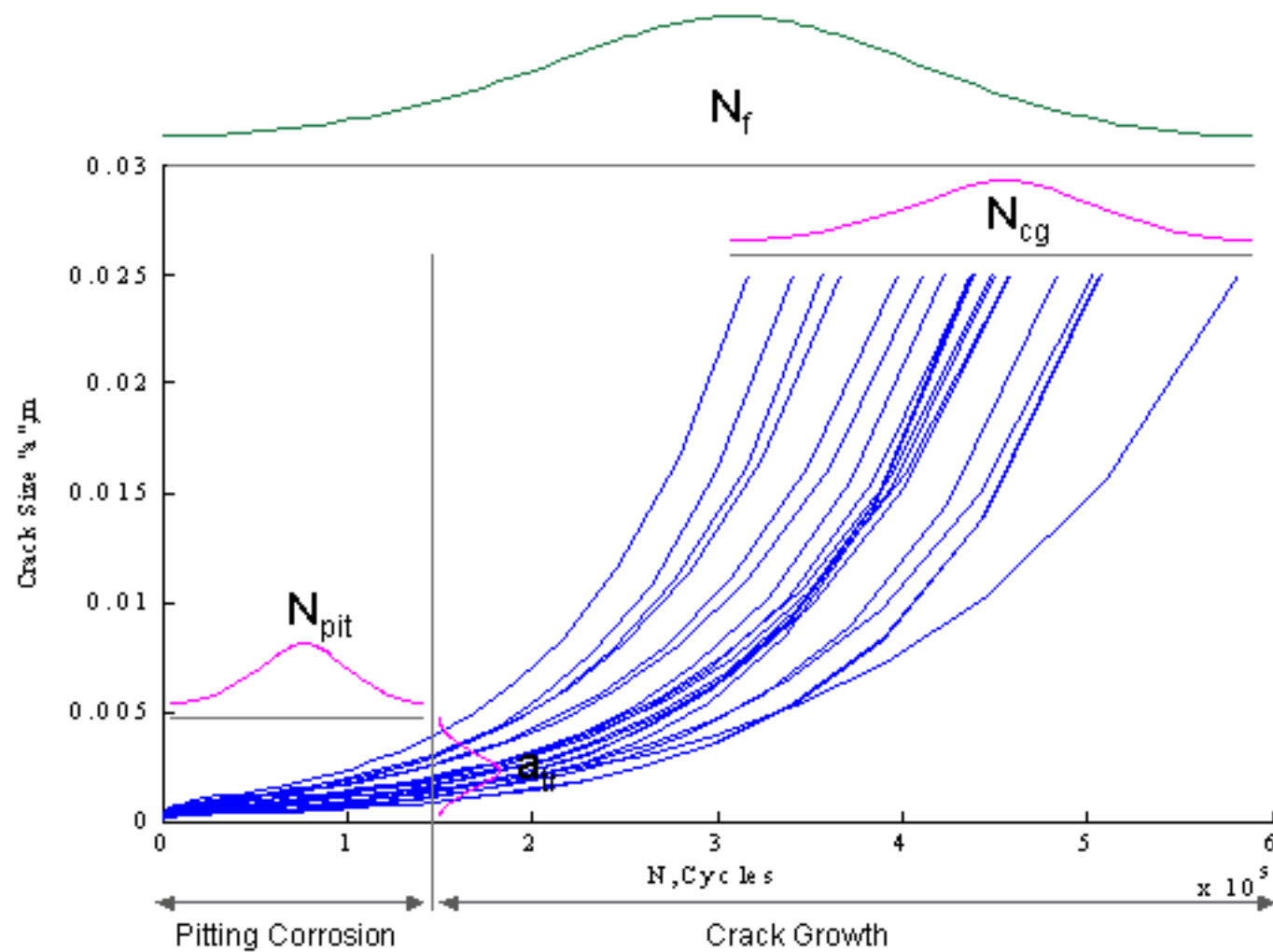
Research Proposal

Theory

Pit Nucleation → Pit Growth → Crack Nucleation (Pit to crack transition) → Crack Growth
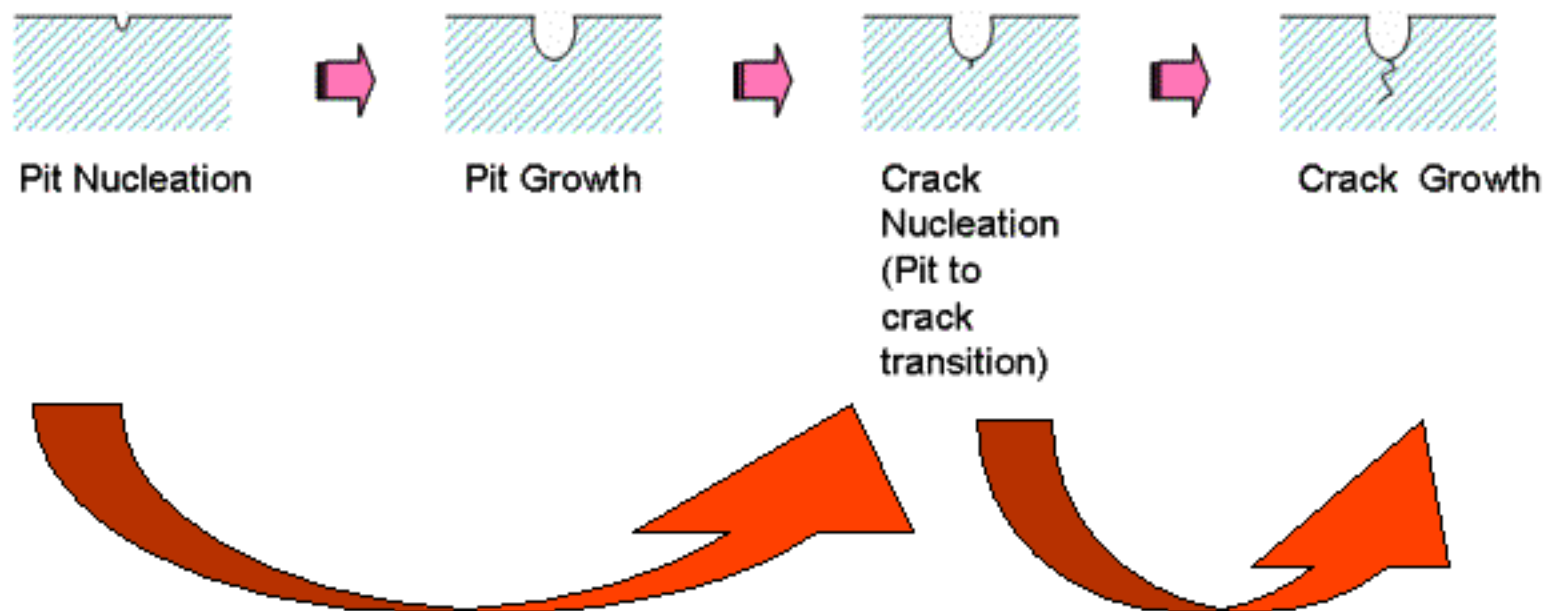
The criterion for transition : $\left(\dfrac{da}{dt}\right)_{crack} \geq \left(\dfrac{da}{dt}\right)_{pit}$

Computational Methodology

Empirical Model Development

With further simplification of the empirical model we get,

$$a = \left[A' \times 10^{12} \nu^{\varepsilon_1} \sigma T^3 \sqrt[3]{N} \right] + \left[B' \times 10^{27} \nu^{\varepsilon_2} \sigma^{\varepsilon_3} e^{\varepsilon_4 \sigma} T^2 N^2 e^{\varepsilon_5 N} \right]$$
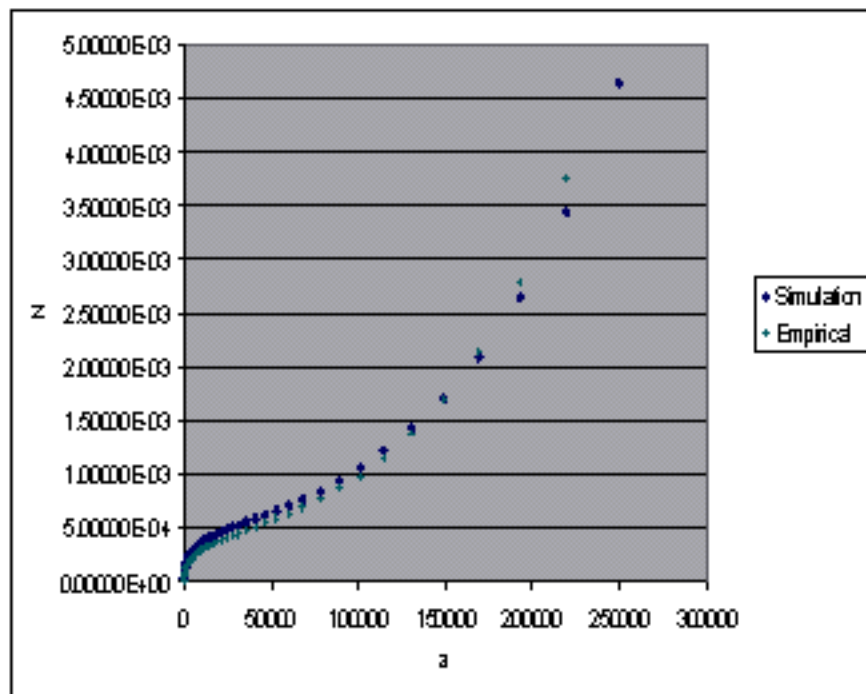
$$\varepsilon_1 = -0.3103$$

$$\varepsilon_2 = -0.3191$$

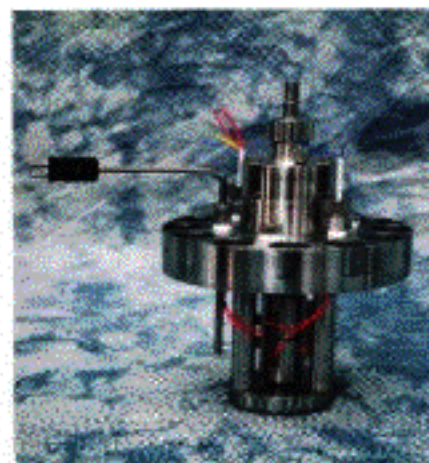$$\varepsilon_3 = 7.64761$$

$$\varepsilon_4 = -0.0139$$

$$\varepsilon_5 = 0.45451 \times 10^{-5}$$

Chart on Right shows how close is the results of this simplified empirical model with the simulation data

Test Lab Development

Cortest Proposed Corrosion-Fatigue Testing Equipment

Thank You