Determining Integrity Reassessment Intervals Through Corrosion Rate Modeling and Monitoring
DTRS56-04-T-0002

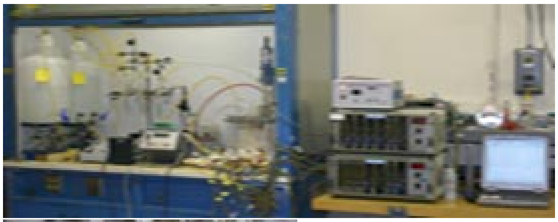
U.S. Department of Transportation

OPS ACCOMPLISHMENTS

Pipeline Safety Research and Development for Focus Area

Challenge

One of the critical elements in determining the pipeline reassessment interval is the size and the growth rate of defects in a pipeline. Growth of defects is influenced by corrosion among other factors. Existing methods for estimating the corrosion growth rate are not applicable under all circumstances, especially in cases where in-line inspection cannot be performed. This work addresses three challenging aspects of estimating corrosion rates: (1) external corrosion rates under CP shielded areas with and without flow, (2) internal corrosion rates as a function of gas quality, and (3) internal corrosion of liquids lines.



The experimental systems used to validate the models for external corrosion under shielded, flowing condition (top) and internal corrosion in gas and liquids lines (left)

Technology Description

1) A commercial finite element code, FEMLAB, was tailored to model the external and internal corrosion rates in the above conditions. Based on the model calculations, simplified rate estimation methods are being developed.
2) Validation tests are being run to simulate corrosion under disbondment with flow and gas permeation.
3) The multielectrode array (MAS) probe was used to monitor corrosion under natural gas pipeline conditions and study the effect of bacteria and corrosion products.
4) The MAS probe thus developed was placed in a liquids line to monitor internal corrosion.

Accomplishments

External and internal corrosion rates were modeled for complex geometries and boundary conditions using a numerical computer simulation. The results were used to develop a simplified corrosion rate estimation procedure.

An important new development is the ability to model flow effects in the disbonded region. Flow carries oxygen deeper inside the shielded area and therefore requires more CP penetration.

External corrosion rates even under these conditions are less than 0.4 mm/y suggested in the regulations as a default value.

A multielectrode array sensor (MAS) was developed and demonstrated for use in monitoring internal corrosion.

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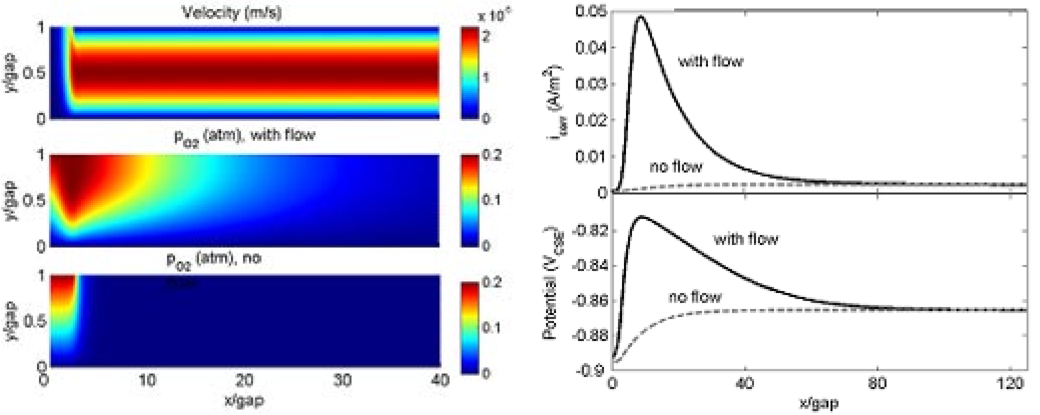
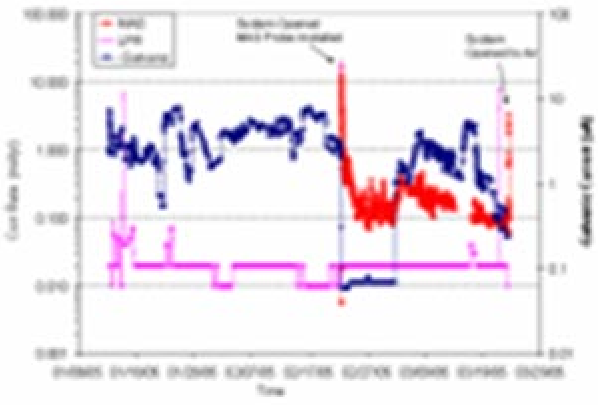


Distribution of flow rate, oxygen concentration in shielded, disbonded region with and without flow rate. Also shown are the CP distribution and current density (proportional to corrosion rate)



The internal corrosion rate in a liquids pipeline (side loop over time). Although the rates are generally low, some spikes are observed when system is opened or other process upsets take place.

The MAS probe was also used in high pressure gas system.

Benefits

The results of this research will yield a technical basis to calculate corrosion rates for estimating reassessment intervals. In the case of internal corrosion, a monitoring probe demonstrated in this project may be used in addition to calculations to determine corrosion rates.

Future Activities

External and internal corrosion modeling will be expanded to tackle more complex chemical conditions. Based on these calculations, recommendations will be made for corrosion rate estimation under different conditions.

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