PIPELINE CORROSION

CORROSION IN PERSPECTIVE

The average annual corrosion-related costs for onshore natural gas and hazardous liquid transmission pipelines is estimated to be $7.7 billion, which can be divided into the cost of capital (26 percent), operation and maintenance (52 percent) and taxes (22 percent).

Source: PNY19 (RO-1136) March 2001

On average, there have been about 62 corrosion-related significant pipeline incidents per year over the past twenty years. Approximately 4 percent of the incidents involved liquid pipelines; 25 percent occurred on go through pipelines; 3 percent occurred in gathering pipelines; and 6 percent on gas distribution systems.

EXTERNAL CORROSION

The primary method of preventing and mitigating external corrosion on buried pipelines involves a combination of cathodic protection and coatings. Cathodic protection involves maintaining a controlled current at a pipeline through the use of external sacrificial anode (cathodic anode and installed current) sufficient to effectively nullify any outgoing currents from the anodic zones of the pipeline. This maintains a uniform current density along the pipeline so that the steel surface of the pipeline is reduced to the surface area of the material on the pipeline. This method of using cathodic protection involves the following:

1. Return-Flow Current Through Pipeline to Source of Direct Current
2. Cathodic Protection System
3. Auxiliary Ground Connection Usually Tapped "Ground Bed"
4. Buried Pipeline

To assess the structural integrity of a pipeline that may contain corrosion defects, 49 CFR Part 192 (gas) and 49 CFR Part 193 (liquid) pipelines are considered for inspection to identify corrosion and to inspect for cathodic protection continuity.

Environmental Assisted Cracking

Stress Corrosion Cracking (SCC) is a term used to describe a phenomenon in which a metallic structure is dissolved by hydrogen in the presence of stress. This is a form of failure that can occur in carbon steel, high-strength alloy steel, and stainless steel. SCC was discovered in 1955 and has been observed in various industries, including gas transmission, pipelines, and chemical processing.

Environmental conditions that can cause SCC include:

1. Hydrogen Embrittlement: This process involves the trapping of hydrogen in the structure of the metal, leading to a reduction in its strength and ductility. This can occur in the presence of hydrogen gas or in the presence of aqueous solutions, such as those found in natural gas transmission systems.
2. Stress Corrosion Cracking: This process involves the trapping of hydrogen in the structure of the metal, leading to a reduction in its strength and ductility. This can occur in the presence of hydrogen gas or in the presence of aqueous solutions, such as those found in natural gas transmission systems.

Corrosion Damage Assessment Methods

Corrosion damage assessments are critical to ensuring the integrity of pipelines. Two common methods are:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.

Corrosion Damage Assessment Method

Corrosion damage assessment is essential for the safe operation of pipelines. The methods used include:

1. Cathodic Protection Assessment: This method involves monitoring the voltage and current of the cathodic protection system to ensure that it is operating as intended.
2. Corrosion Assessment: This method involves collecting samples from the pipeline and analyzing them to determine the extent of corrosion damage.