

Hydrogen Pipeline In-line Inspection Case Study

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Abstract

There is a growing network of hydrogen pipelines operating in the United States: 1,600 miles (2,575 km) are already in place. Throughout their lifecycle, hydrogen gas pipeline assets need to be inspected periodically for safety and integrity of supply.

Magnetic flux leakage (MFL) has been used for decades as an in-line inspection (ILI) technology. Because MFL tools must be durable and robust, their design has relied on well-established materials such as high strength alloy steels and rare earth permanent magnets. These materials are especially susceptible to hydrogen embrittlement, which occurs when a material is mechanically stressed while being exposed to hydrogen.

Successfully inspecting hydrogen-carrying pipelines while reducing the risk of hydrogen embrittlement requires the use of alternate materials and methods to develop a capable ILI tool. This white paper will discuss the challenges of this unique inspection environment, which were resolved through innovative ILI tool design and focused pipeline operation during the inspection process.

Introduction

Air Products, which manufactures and sells chemicals and gases for industrial use, operates the world's largest hydrogen pipeline network, the Gulf Coast Connection Pipeline (GCCP). GCCP runs 183 miles (295 km) between Plaquemine, Louisiana, and Port Neches, Texas, uniting 22 hydrogen plants and creating a network consisting of 600 miles (966 km) of pipe. [2] The GCCP is an 18-inch pipeline with bi-directional flow capabilities which give Air Products the ability to transport hydrogen safely to where the demand is highest and keep the refineries and plants along the Texas Gulf Coast operating at full capacity. Heavy wall thickness pipe was selected for all above-ground sections to protect against damage from vehicle impacts. Construction began in May 2011 and was completed in August 2012.

In the United States, hydrogen transportation by pipeline falls under Code of Federal regulations (CFR) 49, Department of Transportation (DOT) 192 regulations that require verification of pipeline integrity. This can be accomplished through a number of methods, including pressure test, in-line inspection (ILI) and direct assessment. The GCCP pipeline passes through DOT high consequence areas (HCA) for approximately 1.26% of the total pipeline length.

The GCCP pipeline operates at a dew point of less than 20°F with a critical relative humidity of 60%. These conditions confirm the dry nature of the pipeline and are not conducive to internal corrosion. Operating pressure for some sections of this pipeline exceed 60% SYMS and are coated with fusion bonded epoxy (FBE), however most of this pipeline operates less than 60% specified minimum yield strength (SYMS) at ambient temperatures. This means that all of the conditions required for near neutral or high PH stress corrosion cracking (SCC) are not present at the same time on this pipeline system. With all of these threats considered, as part of its integrity process, Air Products determined the need to baseline the GCCP pipeline for external corrosion.

One method used to detect corrosion is external corrosion direct assessment (ECDA). ECDA would be difficult on the GCCP network for a number of reasons. Much of the network is underground concrete coated pipe or crosses through extensive swamp land and rivers. In addition, 60% of the pipeline is located in areas that required horizontal directional drilling (HDD), making access to the pipeline there extremely challenging. Because of customer demand and product delivery contracts, hydrostatic testing is not a feasible inspection technique as the pipeline cannot be taken out of service for an extended period of time in order to fill, test, and dewater. Given the challenges associated with those methods, the company chose ILI, which would allow the GCCP to remain in service and full of hydrogen.

Air Products considered running the ILI tool in several different mediums, including water, air, nitrogen or the pipeline product, hydrogen. The company had never attempted running an ILI tool in hydrogen service before, however they concluded that hydrogen made the most sense from a timing, logistics and cost perspective. Air Products contacted ILI service provider T.D. Williamson (TDW) regarding a partnership to provide a solution for their hydrogen pipelines and to select the proper technology for the inspection of GCCP while it remained in service.

ILI Tools and Hydrogen Gas Compatibility