

Composite Repairs and Cathodic Protection

David B. Futch
ADV Integrity, Inc.
28246 FM 2920 Road
Waller, TX 77484
United States of America

Davie Peguero
CS|NRI
3875 Fiscal Ct, Suite 100
Riviera Beach, FL 33404
United States of America

Casey Whalen
CS|NRI
621 Lockhaven Drive
Houston, Texas 77073
United States of America

Stephen Barnett
CS|NRI
3875 Fiscal Ct, Suite 100
Riviera Beach, FL 33404
United States of America

ABSTRACT

Composite repairs have been extensively used over the past twenty-plus years as a high-integrity repair technology for high pressure transmissions pipelines. Numerous industry test programs have increased the knowledge related to repair techniques, repair design, and quality control of installations. However, little work has been performed related to the interactions of cathodic protection and composite repairs. This paper reviews several approaches for determining if cathodic shielding may occur under a composite repair.

Preventing cathodic shielding can be considered in two different phases. First, the coating (or composite repair) must disbond or fail creating a local environment below the coating. Secondly, the coating (or composite repair) must allow for the permeation of cathodic current to the pipe surface providing the corrosion protection. Current industry standards, such as ASME PCC-2, can address the first aspect by examining the results of the cathodic disbondment tests and quantifying the level of disbondment. The second aspect can be addressed through an innovative and comprehensive test program that investigates several commercially available composite repair systems and their interactions with cathodic protection. Multiple test methods were utilized to prove there remains a low probability of shielding for composites of typical thickness and operating environment.

Key words: Coatings, Protective Coatings, Corrosion Potential, Cathodic Protection, Materials Performance, Standardization, Test Methods

INTRODUCTION

The motivation for this work was to perform a comprehensive test program to investigate several commercially available composite repair systems and their interactions with cathodic protection. Multiple

test methods were utilized to prove there remains a low probability of shielding for composites of typical thickness and in a typical environment. This work will also discuss how results from current industry qualification tests (such as those specified in ASME PCC-2) can be considered when making long-term decisions regarding the effects of cathodic protection on composite repairs and the pipelines on which they are installed. This paper provides an innovative approach to test and validate the interactions of cathodic protection with several commercially available composite repair systems. There is no current testing approach available within industry standards, so these results address much needed questions and provide a consistent approach to evaluate other composite repair systems.

REVIEW OF COMPOSITE REPAIRS

Over the last twenty-plus years, the pipeline industry has used composite materials to repair corrosion in gas and liquid pipelines. The primary use of composite materials has been to repair corrosion¹, although research dating back to the mid-1990s has also been conducted for repairing dents², other mechanical damage, wrinkle bends³, branch connections, elbows/bends⁴, girth welds, and more recently crack-like features^{5,6}. These numerous industry test programs (many funded by the Pipeline Research Council International (PRCI) and operator funded Joint Industry Programs (JIPs)) have increased the knowledge related to repair techniques, repair design, and quality control of installations. However, little work has been performed related to the interactions of cathodic protection and composite repairs.

Composite repairs consist of a mixture of a non-metallic wrap along with an polymer resin, shown in Figure 1. A load transfer material will be specified for some features (such as corrosion or dents) to help bring the external surface back to round. Once cured, the non-metallic wrap adds strength to the pipeline system by reinforcing the damaged carrier pipe. These are often buried once the system cures and is therefore exposed to the pipeline's cathodic protection (CP) system bringing into question how the composite repair and CP interact together.

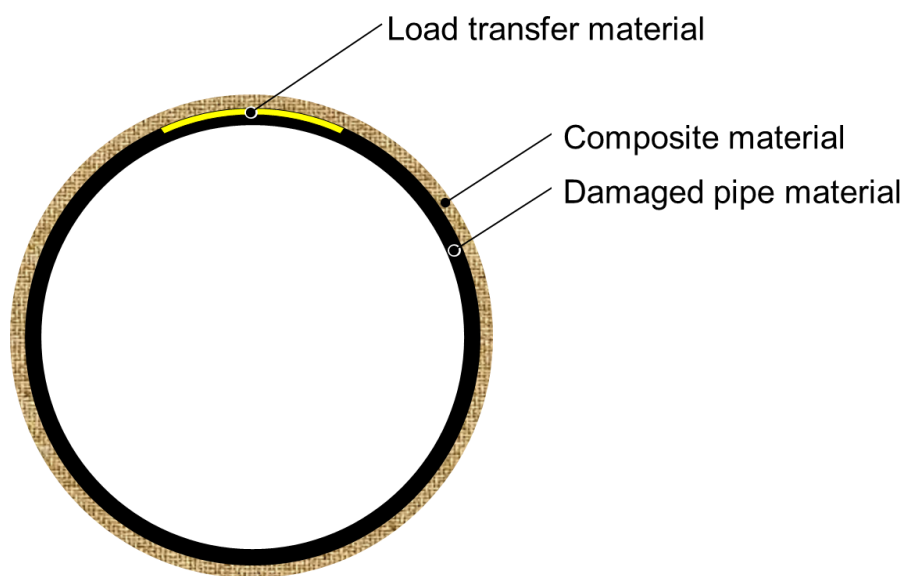


Figure 1: Composite repair schematic.

CATHODIC DISBONDMENT AND SHIELDING OF COMPOSITES

The shielding effect of a composite repair can be considered with the same approach as a typical pipeline external coating. This should be considered in two distinct evaluation time-scales – and which evaluation

time-scale is of greater interest is based on the composite repair's age or expected life of the repair. These distinct subsets include a Near-Term evaluation and Long-Term evaluation:

Near-Term Evaluation

Near-Term evaluation can be summarized by the ability of the composite repair to remain intact, well adhered, and provide a barrier between the external environment and the pipe surface. For cathodic shielding to occur, the coating must disbond or fail creating a local environment below the coating which is subsequently not protected. Therefore, if the coating remains intact for a significant period of time, the risk of shielding is little to none. This is commonly tested through a cathodic disbondment test performed to a variety of industry standards. Having a good, passing result should provide confidence that the composite repair will remain intact and therefore eliminating the risk of shielding. This assertion should be qualified as no coating will remain intact forever, therefore, a Long-Term evaluation discussed below should be considered.

Cathodic disbondment results for two common composite repair systems performed to ASME PCC-2⁷ are presented in Table 1.

Table 1: Cathodic Disbondment Results

Composite System	Disbondment (mm)
A+	13.97
Atlas	0

Long-Term Evaluation

Long-Term evaluation can be summarized by the ability of the composite repair to allow for the permeation of cathodic current to the pipe surface providing the corrosion protection. This evaluation is not currently explored in any industry related testing program. Therefore, the experimental procedure described in the sections below help address the long-term stability of a composite repair subjected to cathodic protection.

Therefore, based on the assertions above, if the composite repair is properly installed, remains intact, the risk of shielding is small assuming a passing cathodic disbondment test per ASME PCC-2. However, no coating, including composite repairs, can be expected to remain in the same condition in the significant future as it was the day it was installed. Therefore, understanding the ability of the composite to allow for permeation of cathodic current is critical. Presumably, the ability of a composite repair to pass CP likely gets better with time and is easier on repairs with fewer layers – i.e., as the composite repair is exposed to environmental conditions or is thinner, the composite will permeate CP more efficiently. The interdependence of the Near-Term and Long-Term evaluation is shown graphically in Figure 2. This schematic indicates a low risk in the near-term due to the high integrity of a composite repair and transitions to a low risk in the long-term due to the time-dependent nature of CP permeation. At some point in time these curves cross as the risk transitions from near-term to long-term. This crossing point depends on the composite system and the number of layers (thickness).