North American Society for Trenchless Technology (NASTT)
NO-DIG 2005

Orlando, Florida
April 24-27, 2005

VERIFIABLE NON-LEAKING CONNECTION WHERE NO WATER MIGRATES

Larry Kiest, Jr.[1], and Shaun M. Flanery[2]

[1] LMK Enterprises, Inc. Intellectual Technology, Testing and Design, Ottawa, IL 61350
[2] Performance Pipelining, Inc., A Nationwide Trenchless Installation Company, Ottawa, IL 61350

ABSTRACT: There is a common myth among industry professionals that consistently attributes adhesive or “glue-like” qualities to the resin used in cured in-place pipelining applications. It is believed that the resin actually bonds to the host pipe material and in effect, creates a seal between the cured-in-place pipe and the host pipe eliminating any points of infiltration into the collection system. Extensive testing has dispelled this myth entirely as well as raises awareness of the presence of grease and other contaminants that eliminate the possibility of a seal being created between the two components. The concern for adhesion is increased when linings are used to renew lateral pipes and sealing to the main pipe lining is required. Levels of adhesion are relevant to the service life of linings that are specifically designed to seal lateral pipe linings to main pipe linings.

The industry will require methods for testing the connection between cured in-place lateral linings (CIPLL) and the main sewer pipe. Test methods must consider material composition, contaminants, preparation, and external hydrostatic forces. Lateral lining technology has progressed significantly over the last 15-years and this paper discusses those advancements.

1. INTRODUCTION

A private corporation has researched the adhesion levels of thermo-set resins used in cured in-place pipelining. The research includes testing of various types of resins and the varying results of adhesion and shrinkage that may or may not occur between main pipe linings and lateral linings. This research continues and only current information and test results are discussed in this paper.

2. RESIN TYPES

Tests were performed on four types of resin as follows:

1. Standard Isotholic Polyester
2. Vinylester
3. Volatile Organic Compound Free Polyester
4. Volatile Organic Compound Free Vinylester
5. 100% Epoxies and Silicate Resins.

3. PIPE TYPES

Tests were performed on various types of main sewer pipe linings. For a chemical bond to occur with substantial levels of adhesion, the main pipe lining should always be compatible with the lateral pipe linings. Five main pipelining types were used in the testing and are identified as follows:

1. Poly Vinyl Chloride (PVC)
2. Modified Poly Vinyl Chloride (MPVC)
3. Polyethylene (PE)
4. Cured in-Place Pipe (CIPP) with Polyurethane (PU) Film
5. Cured in-Place Pipe (CIPP) with Polyethylene (PE) Film.

4. CONTAMINENTS

Testing procedures included the use of natural grease (Lard-animal fat). This was an essential component in reproducing actual “in-ground” conditions, as grease is a known substance in sewer pipes. One set of test pipes had lard (animal fat) applied to the inner surface of the main pipe lining, thus coating the surface as would occur in an actual collection system. Test results confirmed that the presence of grease is a major concern and a factor affecting the seal made when using cured in-place pipelinings.

5. PIPE PREPARATION

The test in ITEM 6.1 included four separate sets of each host pipe types previously listed. Two sets were prepared by robotically roughening the inner surface of the pipe material. The procedure used to rough the surface was robotic and intended not to remove any coatings, but to rough and slightly mar the surface, removing any glaze or slick finish that might inhibit a proper seal.

6. TEST PROCEDURES

A test protocol was set forth consisting of resin impregnated liners using materials and methods in a controlled manner. Controls for the materials and methods included:

6.1 Four identical sets of pipe types as listed above in Item 3 were tested in the following manner.

6.1.1 The first set used as a control group so the inner surface was not modified, treated or changed in any manner. See Figure 1

6.1.2 The second set of each pipe type was prepared by roughing the (main pipe linings) inner surface and no other modification or preparation. The roughing was performed by use of robotic equipment. The roughing procedure was not intended to remove any coatings, but only to remove any glaze or slick finish. See Figure 2

6.1.3 The third set of each pipe type had a layer of lard applied to the (main pipe linings) inner surface and no other modification or preparation. See Figure 3

6.1.4 The fourth set of each pipe type was prepared by roughing the (main pipe linings) inner surface and a layer of lard was applied to the same surface. See Figure 3

6.2 The cylindrical elongated main pipe portion of the cured in-place main/lateral lining, was inserted and cured within each of the pipe sets as identified in Item 3 under the following conditions.

A. Each lining specimen was vacuum impregnated with the appropriate thermo-set resin.

B. The host pipe was cleaned using tap water at 2,000 PSI from a sewer jet pump, hose and nozzle.

C. Where applicable, as described in Items 6.1.2 and 6.1.4, the surface preparation carried out under controlled measures utilized the same equipment for robotically preparing the pipe wall.

D. The curing agents e.g. catalyst and promoters were consistent for each test specimen. The ambient and curing temperatures were consistent for each test specimen.

E. Each specimen (resin saturated fabric tube) was inserted into the host pipe by means of inversion and held against the pipe wall at 6 PSI.

F. Once cured, test samples being 1 inch wide by 12 inches long, were cut from the host pipe and the cured-in-place lining firmly positioned within the host pipe. Note: in all cases, the host pipe was a type of main pipe lining as described in Item 3.

6.3 The tests were repeated in accordance with test procedures described in Item 6.1 and 6.2 with the exception to Item 6.2 item B. In this case, the cleaning procedure consisted of high-pressure water at 200° F. including a solutions specifically designed to remove grease.

7. TEST METHOD

A destructive test was performed on all samples in an effort to quantify adhesion levels between various main lining materials and lateral lining materials. The destructive test consisted of a sharp wedged shaped gauge. The gauge is incrementally marked along its length measuring the width of the wedge as it becomes wider to identify the point of failure as it is driven between the main pipe lining and the lateral pipe lining.

7.1 Once the main/lateral lining achieved full cure, the test samples were cut into a cross section. When the cured lateral lining fell away and separated from the main host lining, that particular test sample was considered a complete failure and given a zero rating.

7.2 Successful adhesion was gauged at high levels when the wedge test caused destruction to one of the test materials. When two layers were separated and a portion of one layer remained attached to the second layer, it was destructive to the first layer. A successful wedge test that was destructive to one of the lining materials during separation was gauged at a level of 10 on our scale.

7.3 The test showed a pattern of negative effects where low levels or no adhesion occurred on surfaces with grease and surfaces that are of a specific chemical matrix. i.e. pipe types.

7.4 The test showed a pattern of adhesion at high levels on surfaces that were prepared by roughing the pipes inner surface, including those contaminated with lard as well as resin types that inherently offer no level of adhesion. i.e. polyester resin.

8. TEST DATA BASED ON ITEM 6.1

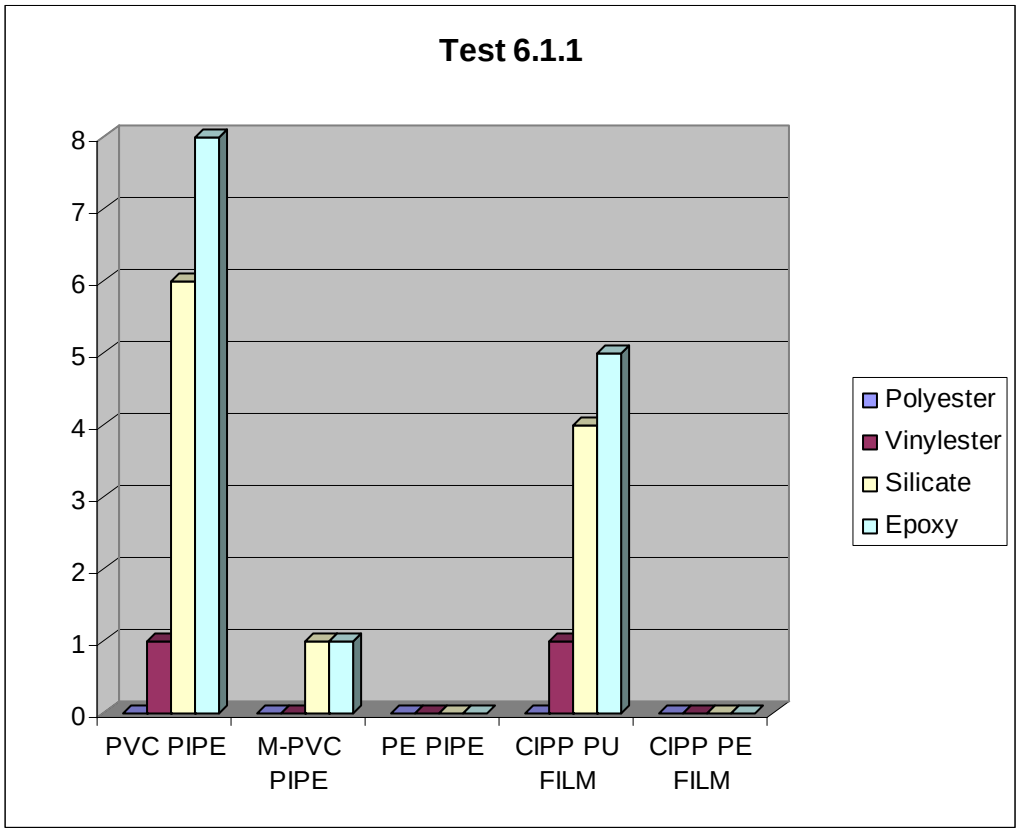

FIGURE 1. F-3 VNLC Where No Water Migrates: Test 6.1.1-The first set of pipes was used as a control group. The inner surface was not modified, treated or changed in any manner.

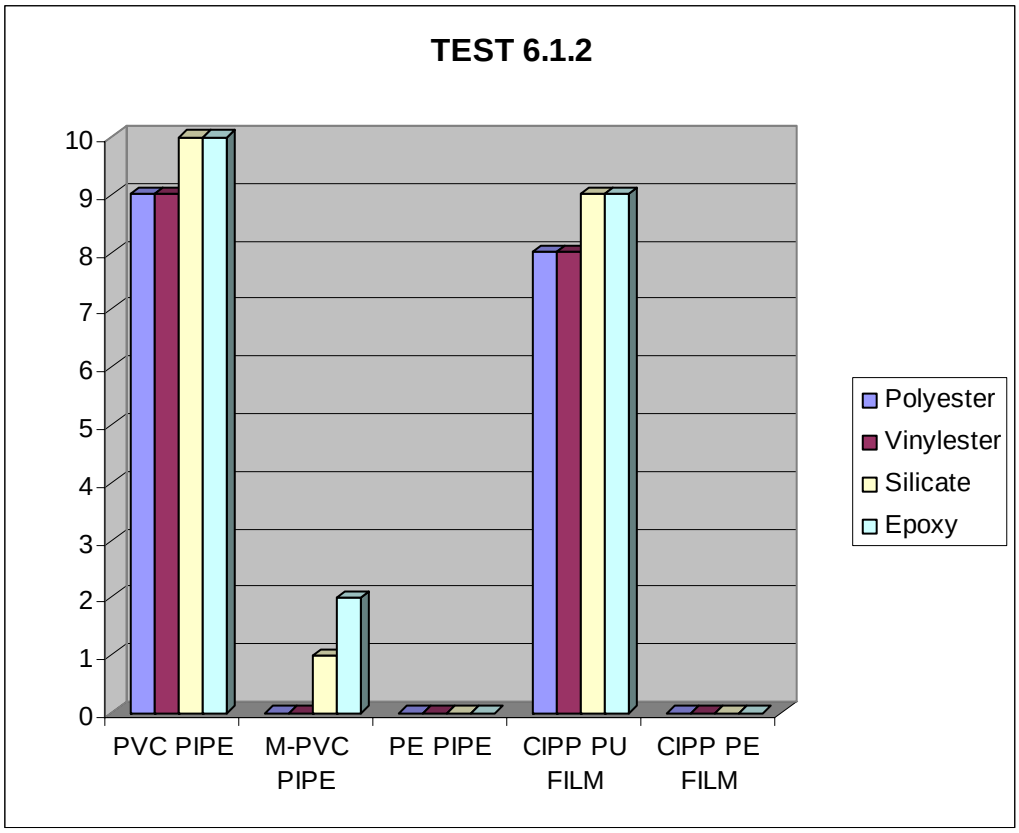

FIGURE 2. F-3 VNLC Where No Water Migrates: Test 6.1.2-The second set of each pipe type was prepared by roughing the inner surface of the main portion of the pipe linings. The procedure to rough the pipe was performed by use of robotic equipment. The procedure was not intended to completely remove any coatings, but only to remove the glaze and/or slick finish.

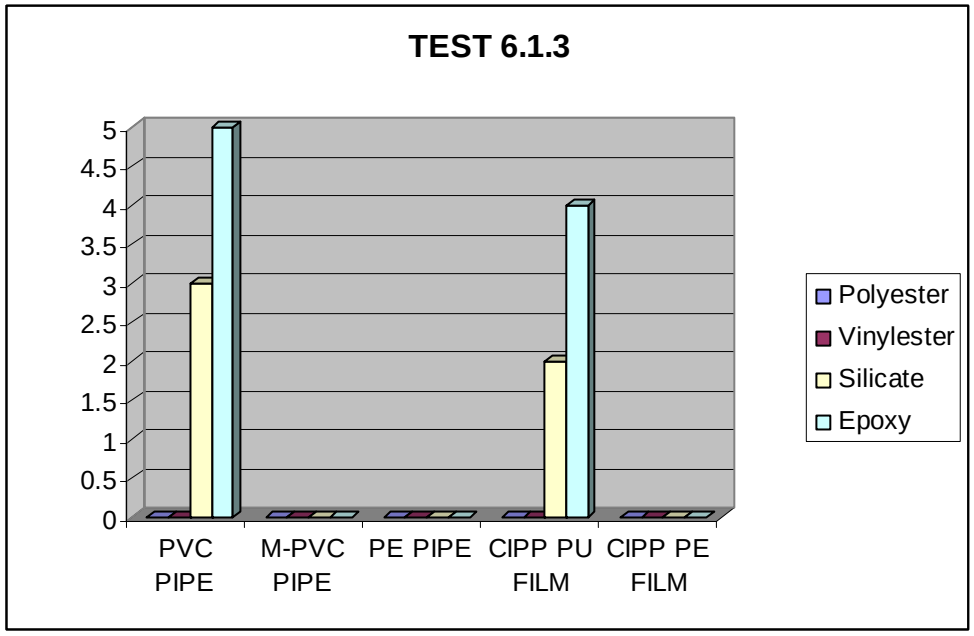

FIGURE 3. F-3 VNLC Where No Water Migrates: Test 6.1.3- The third set of each pipe type had a layer of lard applied to the (main pipe linings) inner surface.

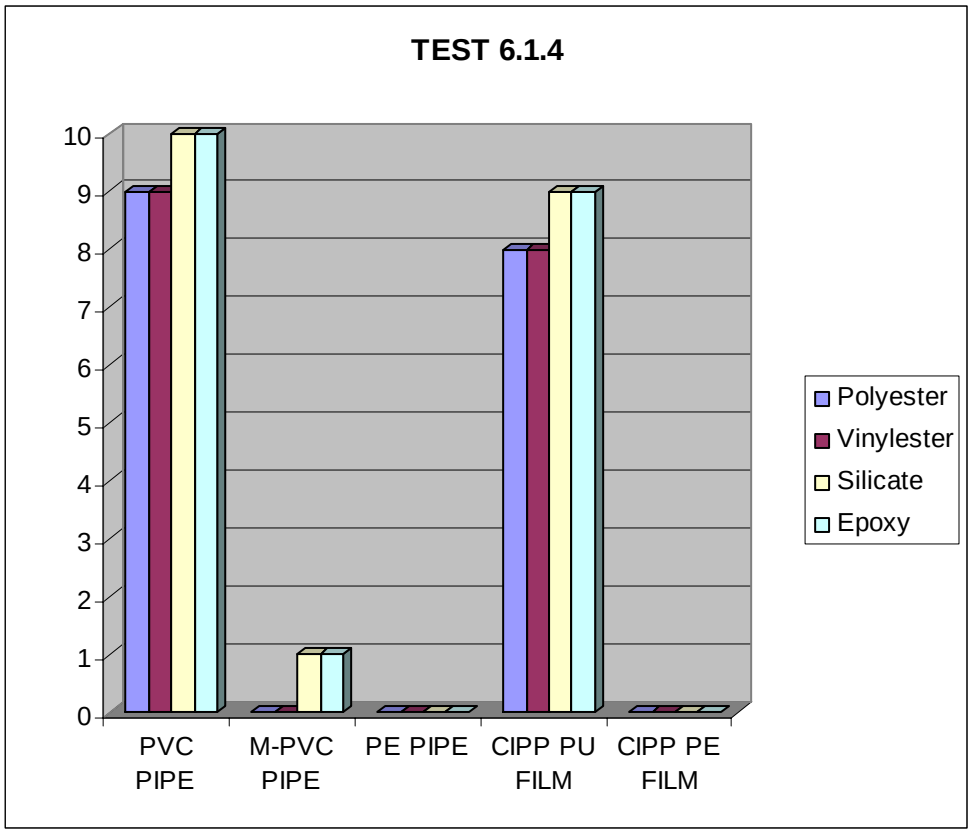

FIGURE 4. F-3 VNLC Where No Water Migrates: Test 6.1.4-The fourth set of each pipe type was prepared by roughing the (main pipe linings) inner surface and a layer of lard was applied to the same surface.

9. IN CONCLUSION

Successful lateral renewal installations MUST also provide a **verifiable non-leaking connection (VNLC™) to the main pipe lining.** In order to achieve such a connection and sealing properties based on adhesion between the two lining materials, pipe materials, contaminants and surface preparation must be considered and addressed from design through installation and end product testing. If, these key issues are not addressed with verifiable results, then the rehabilitation methods being utilized will most likely provide fruitless results and the removal of ground water infiltration will remain unresolved.

Additionally, test data showed certain main pipe lining materials resist adhesion by resins used in cured in-place lateral linings. In this case, an alternate solution exists. Hydrophilic bands have been utilized in conjunction with lateral linings where a cylindrical elongated main pipe portion extends into the main pipe lining. These hydrophilic bands surround the cylindrical main portion of the lateral lining as shown in figure (5 and 6) below. These hydrophilic bands are designed to swell in the presence of water. Once the liner is in place and cured, the rubber bands act as full circle pressure gaskets. These bands swell to eight (8) times their original thickness. This swelling action provides equal force on the entire circumference of the main liner. The cylindrical mainline liner is put under compression and provides a watertight seal between the host pipe and the liner. The key to this remedy is the fact that adhesion is not a factor; the bands will make a seal to any type of material including polyethylene as well as greasy surfaces typically found in any collection system.

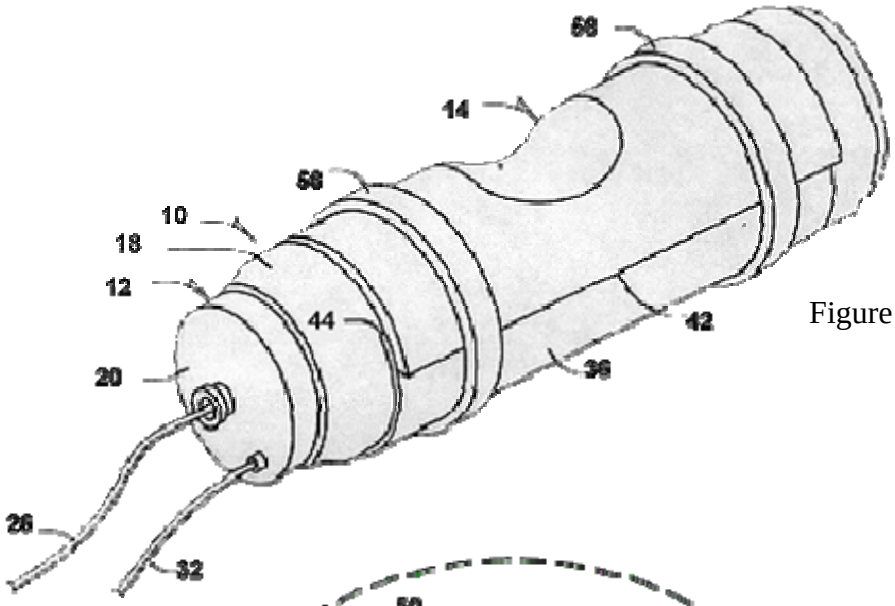

Figure 5

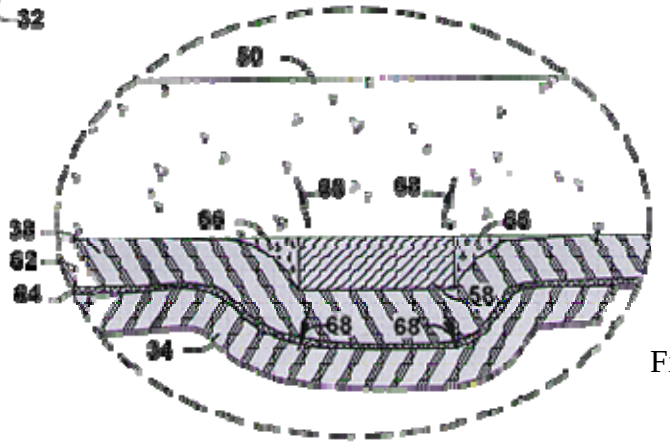

Figure 6