

How to Achieve True Non-Destructive Surface Preparation

Next generation cold plasma technology offers precision surface preparation for pipeline operators

Pipeline operators are finding that cold plasma is relevant as a true non-destructive surface preparation system that can be implemented in multiple scenarios for non-destructive testing, maintenance, and repair. The patented PlasmaBlast™ 7000 Mobile (PB 7000-M) from Atmospheric Plasma Solutions, Inc. (APS) is a promising addition to the tools and processes that pipeline operators use for inspections, maintenance, and repair. This next generation product performs precision surface preparation like no other.



Figure 1. Using the PlasmaBlast™ 7000 Mobile System to conduct precision surface preparation on a pipe defect

Cold Plasma technology uses only the inputs of low-pressure compressed air and electricity to produce a special form of cold atmospheric pressure air plasma. The system reliably removes coatings used in the pipeline industry while also creating an energized surface that results in increased adhesion to the substrate material. Most of the coating is vaporized into non-toxic gases with the remaining mass of the coating coming off as a dust that can either be captured by a vacuum or vented away.

APS is focused on developing next generation coating removal and surface preparation solutions for hard-to-remove coatings on a wide range of substrates found in marine, aviation, defense, and commercial applications. Between 2011 and 2021, APS, in development with the U.S. Department of Defense perfected delivery of plasma at atmospheric pressures using only compressed air and electricity.

The company's patented flagship PlasmaBlast 7000 Mobile precision coating removal and surface preparation system reduces job costs, provides a safer work environment, and is more environmentally friendly than traditional grit blasting, laser, or water jetting methods.



Figure 2: PB 7000-M

Validation of PlasmaBlast Technology for Pipeline Industry Applications

Recently, APS collaborated with ADV Integrity, Inc. (ADV) in a testing program¹ to validate the impact of cold plasma surface preparation on the performance of composite systems used to repair transmission pipelines. The testing program consisted of two main phases, Phase 1: Lap shear testing and Phase 2: Leak repair full-scale testing.

Phase 1: Lap shear testing compared the effect of different surface treatments: NACE 2, PB 7000-M, and NACE 2 + PB 7000-M in combination, on shear strength capacity. All lap shear samples were constructed using carbon steel and bonded together with a two-part epoxy resin system. Shear strength capacity is a direct indicator of the strength of adhesion created between the bonded substrates (i.e., metal in this test). Untreated and flash rust samples were included; however, the samples did not adhere properly because of the untreated mil scale and untreated flash rust. This untreated condition caused the samples to come apart during final sample preparation. Thus, there is no apt comparison. Testing was conducted according to ASTM D1002.²

As shown in Figure 3, test results indicate that on average, shear strength for the NACE 2 + PB 7000-M combination measured **~3,000 psi [21 MPa] ± ~100 psi [0.7 MPa]**, a **~150% increase in adhesion** compared to NACE 2-only samples. Shear strength of the samples treated with the **PB 7000-M alone** was **~58% better** than those treated with NACE 2, the pipeline industry standard surface finish for composite repair installations.

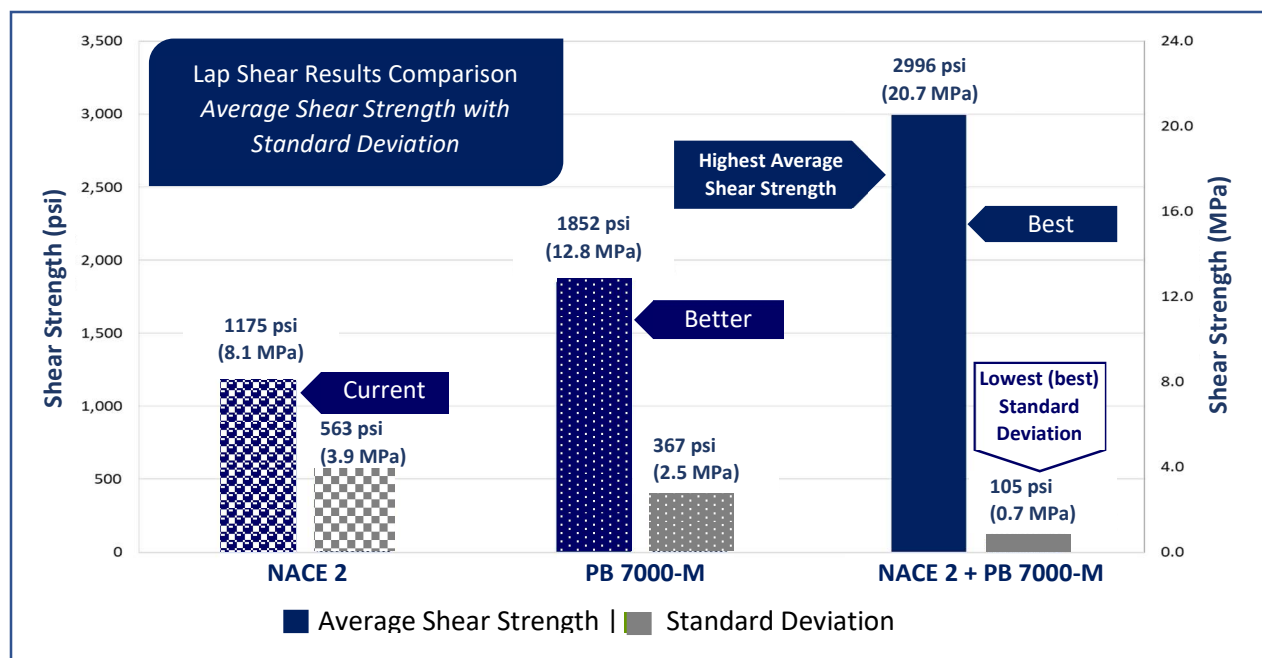


Figure 3. Lap shear testing results: average shear strength values with standard deviations

¹ ADV Integrity. (2021). *Testing Program to Evaluate the Impact of Surface Preparation on the Performance of Composite Systems* (Report No. 100225-RP01-Rev0-072221). Prepared for Atmospheric Plasma Solutions.

² ASTM. (Reapproved 2019). D1002 - 10. Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal). West Conshohocken, PA, United States: ASTM International.

Phase 2: Leak repair full-scale testing compared the effect different surface treatments had on leak repair performance of composite repair systems, when subjected to pressure cycling. As shown in Figure 4, the test was conducted on a pipe sample with a severe corrosion feature produced in the pipe surface that included a through-wall defect. The defect area wall thickness was a total of 1 mm, which made repairing the pipe even more difficult.



Figure 4. Pipe with PB 7000-M ONLY surface preparation with severe corrosion feature

As shown in Figure 5, pipe samples were reinforced with a steel sleeve/E-glass/acrylic adhesive system. NACE 2 only, PB 7000-M only, and a combination of both treatments were evaluated. A flash rust sample was included for comparison.



Figure 5. Pressure cycle testing of hybrid composite/steel sleeve repaired pipes

Test results showed the PB 7000-M + NACE 2 combination sample reached the cyclic pressure runout condition of **25,000 cycles** at a ΔP of 1,650-psig. **The pipe burst pressure was recorded at 2500 psig.** The cycle count of the samples treated with the PB 7000-M alone was **18,327**, which was **145% better** than those treated with just a NACE 2 surface profile, which had a cycle count of only 7,455. There was also a **235% increase** in pressure cyclic performance of the combination sample PB 7000-M + NACE 2 when compared to untreated NACE 2 samples.

Overall, the testing program proved that samples and specimens prepared by PB 7000-M alone performed better than samples prepared with a NACE 2 surface profile. This has significance as it can change how pipeline operators approach surface preparation of critical defects, by implementing a non-abrasive method for preparation that is safe for non-leaking defects. Surface adhesion was also significantly improved when the cold plasma surface preparation (PB 7000-M) was applied to the defect features. The adhesion improvement is very important because of the implications it may have on repairs conducted as part of a pipeline integrity management program.

From the test program results, ADV Integrity, Inc. identified additional applications where the *PlasmaBlast* 7000 Mobile technology could be very beneficial:

- Surface treatment prior to installation of any composite repair system that relies on adhesion
- Nonabrasive surface treatment of severe defects, through-wall cracks, and corrosion features
- Surface treatment of dents, stress corrosion cracks, and seam weld defects
- Surface treatment of vintage girth weld for reinforcement against geohazard loading
- Surface treatment on pipes and components at compressor stations
- Possible replacement for mechanical tools, such as grinders and needle scalers, for performing rust removal, coating removal, and adhesives removal

How *PlasmaBlast* Technology Works

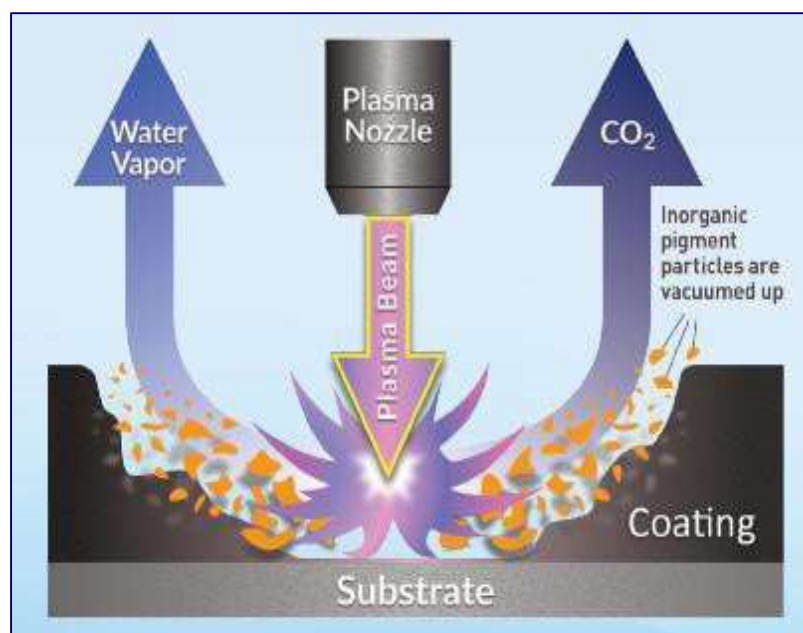


Figure 6: Simultaneous coating removal and substrate preparation = better adhesion

The PlasmaBlast 7000 Mobile precision surface preparation system is designed to remove even hard-to-reliably-remove coatings and provide additional adhesion on virtually any substrate material. As illustrated in Figure 6, the PB 7000-M system vaporizes most paint and coatings into harmless gases and leaves behind a small amount of dust that is safely collected with a vacuum. Unlike traditional coating removal methods, no abrasive media or chemicals are used, reducing the need for containment and the disposal of waste by-products. The system can significantly reduce the cost of the coating removal process, while increasing productivity and safety for workers and the environment.

PlasmaBlast Technology is Safe for Workers and the Environment

An operator needs only safety glasses, leather welding gloves, basic hearing protection, and an appropriate mask to safely operate the PlasmaBlast 7000 Mobile. A full protective suit is not required because neither chemicals nor mechanical coating removal are used. Without the use of chemicals in the surface preparation process, less residual cleaning is required, and removal of dust is minimal. In addition, the PB 7000 M can be used to remove any grit residue from the surface if grit or sand was used in a conventional surface preparation process. The system is energy efficient, requiring only air and electricity. It is portable to go where needed to perform precision surface preparation in challenging locations and harsh environments.

PlasmaBlast Technology in Pipeline Inspection and Surface Preparation

Cold plasma technology offers immediate benefits to pipeline inspection and surface preparation processes. There are many applications for which precise coating removal and surface preparation are needed. PlasmaBlast 7000 Mobile is proven to deliver a true, non-destructive surface preparation that significantly improves the performance of precision surface repairs. Use it in concert with conventional surface preparation methods or on its own.

For more about PlasmaBlast 7000 Mobile

See this technology in action and access the full engineering report at www.apsplasma.com/pipe

Contact us now for an in-person or online demo: **+1 919-341-8325**.

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