

Pipeline Coatings, Key Points Specifically for Transmission Pipeline Coating

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ABSTRACT

This paper will address common issues facing inspectors that are specific to the pipeline coating community. Much of the coating inspection reviewed in NACE Coating Inspector Program (CIP) courses are geared much more toward liquid coatings for structural applications. This leaves many pipeline issues that aren't addressed resulting in CIP inspectors who are untrained regarding the pipeline coating types and what to watch for.

Key words: Pipeline Coating, Coating Inspection, Field Joint Coating, pipeline rehab, Field Applied, FBE, infill

INTRODUCTION

The bulk of a pipeline coating is shop applied and those processes are typically automated. Because the automation of pipeline coating has so many controls, there is little need to address the inspection on the body of the mainline coatings. As such, this paper will address inspection of pipeline specific coating types and their unique considerations in a field environment. It will address concerns around tie-ing into other coating types and compatibility. Field joint coatings that will be addressed include Fusion Bonded Epoxy (FBE), 2 Part Epoxy, Flame Sprayed material, Injection Molding, Heat Shrink Sleeves and tape wrapping, all issues not typically addressed in CIP.

This paper will give an overall guide for pipeline inspectors to have some basis for inspection and questioning while in the field.

SURFACE PREPARATION AND HEATING

As is common knowledge in the pipeline industry, the best coatings always start with good surface preparation. Surface preparation in the field can be a difficult task depending on the environment and the starting condition of the pipe surface. The first obstacle to overcome when performing surface preparation in the field is the environment. Surface preparation is more than just cleaning the pipe it also includes preparing the main line coating that will be tied into as well as removing surface contaminants such as soluble salts, commonly referred to as chlorides and sulphates. Surface preparation also involves creating the proper anchor profile for the coating system that will be applied. Regardless of the details related to the coating requirements for surface preparation the resulting work will typically produce an area of bare steel which will for some duration be exposed to the elements in the environment. Environmental conditions which need to be addressed prior to performing surface preparation include monitoring the dew point, avoidance of rain or moisture in the air, possibly mitigating the wind to prevent contamination and on occasion reducing the heat exposure from the sun to create a more uniform substrate temperature. These environmental conditions are typically covered in a standard coating application course thus this paper will not dive too deep into these components; however, they are very critical and need to be addressed prior to commencing any field joint coatings.

One component of surface preparation that will be addressed is the removal of soluble salts. This activity is often not addressed in the field and many times when it is addressed it creates contention between the applicator, inspector, and operator. There may be times when soluble salt removal is not an issue of concern. This may be due to the fact that the main line of the pipe is likely to have already undergone salt mitigation when the body of the pipe was coated. If that was recent enough and the pipe was stored properly there is a good chance that level of contamination is still very low and within acceptable limits. This does not mean cleanliness is guaranteed and if it is assumed that the soluble salts are not going to be an issue it is recommended that several tests are taken on a representative sample to ensure that is indeed the case.

Should a project call for removal of soluble salts there are two schools of thought, one is that mitigation should occur prior to blasting or sanding and another line of thinking is that blasting will remove a great deal of contamination. Both ways of thinking have merit however the objective is to have a clean and dry substrate once the surface preparation is complete. For those that prefer cleaning the substrate prior to surface preparation this will typically prevent the need for exposing bare steel to water thus lowering the risk of flash rust. In this case it is still recommended that some soluble salt readings are taken on the blasted steel to ensure the cleaning process has been working. On projects where the line of thinking is that preparation will remove much of the contamination it will again become necessary to check that procedure to make sure the surface meets the proper level of cleanliness before commencing any coating. In either case if the prepared area does not meet the required level of cleanliness from soluble salts, further mitigation will be needed and additional steps will need to be taken in order to avoid flash rusting on a newly prepared surface. Neither method is right or wrong; the objective is removal of soluble salts, while a contractor or an operator may have a preference either way is suitable provided the prepared area is free from contamination.

In some environments it may also be necessary to heat the pipe prior to either performing surface preparation or possibly for the application of the coating system. There are some key elements when it comes to heating a pipeline that should be addressed. It is important to understand why the heating is taking place, as intention will gauge the level of heating necessary or possibly to select the heating

method. Common heating methods used in the pipeline industry include weed burner style torches, heating blankets, and induction heating rings. Any one of these heating methods can be utilized for the purpose of raising the temperature of the steel. However care should be taken when using an open flame as the method of heating the pipe as it may burn the surrounding coating. On occasion there will also be concern about contaminating the substrate with petroleum products from the flames being directed at the bare steel, if this concern cannot be overcome there are other methods of heating such as induction or a heating blanket. Heating blankets can be very useful tools for preheating before surface preparation. They might be used in very cold environments to raise the steel above the dew point or to elevate the temperature to induce a faster cure from some of the coating systems. Heat blankets are best used for preheating or maintaining heat prior to blasting do to their potential for contaminating the surface as well. By far the fastest and most effective method of heating a pipeline section is induction heating however it is also the most misunderstood method. Induction will be discussed further in the section covering FBE coatings.

Regardless of which system is used to heat or preheat there is a key component that is necessary to understand, which is measurement of the heat in the pipe. Very often inspectors and even applicators will attempt to use non-contact digital laser infrared thermometer guns as a way to measure the surface temperature. Unfortunately, most of the time the users of these devices don't understand the science behind them or the limitations associated with these types of measuring devices. These devices have a specific area that they can read and are accurate at specific distances from that area and only when used on smooth, low gloss, non reflective surfaces. The limiting factor when using these tools is related to a term called emissivity. As you can see in **Figure 1** having a shiny surface or an angular surface which reflects the infrared back in an unusual pattern will greatly affect the accuracy of these tools. Because of the number of factors which can produce incorrect readings from these types of tools it is recommended that contact thermometers or temple sticks which are rated for the target temperature are used as a means of determining the surface temperature of the pipe.

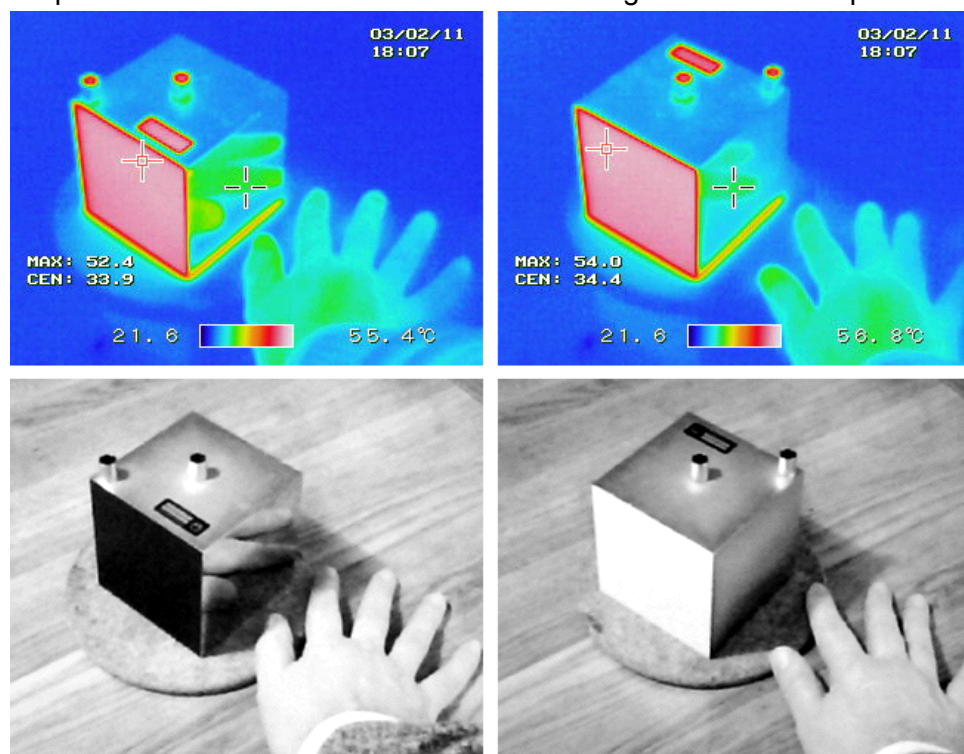


Fig. 1 visual representation of the effects of emissivity

The final component of surface preparation that we will cover is the measurement of cleanliness. There are multiple systems for determining the cleanliness of a substrate which include visual guides, coating standards, physical representations and others. The important factors are the visual level of cleanliness, the depth of the anchor profile, and the allowable range for each. Oftentimes the parties involved will forget one of those components and it can lead to issues for inspection in the field. How clean something looks does not address how deep the profile is nor does the depth of the profile necessarily indicate the level of cleanliness. Both these items should be addressed when evaluating the performance of a surface preparation.

FUSION BONDED EPOXY

Fusion bonded epoxy is the most prolific coating on the pipeline in the world. In North America it is undoubtedly the most common standalone coating used for buried pipelines, but even in other places where three-layer systems are far more prevalent the base layer of a three-layer system is FBE. The interesting part about this is that most coating inspectors don't know anything about FBE unless they've spent their career on pipelines. FBE has some unusual challenges when it comes to application. For instance, most inspectors are used to using a wet film thickness measurement in order to gauge the final dry film thickness of the coating system. FBE goes on as a powder, then gels for 6 to 15 seconds depending on the chemistry, there simply isn't time to get a wet film thickness without creating a holiday. This means that FBE application must be performed in a way that produces the desired coating thickness in a single application without measurement before the dry film thickness (DFT) reading. Because of this fast cure time it makes the chance of right of way contamination in the coating very minimal.

Another fairly unique aspect of FBE is the required application temperature. Most FBE's are applied between 400 - 480° F(204-249° C). These temperatures are required in order for the FBE to cure properly. That is a very important thing to understand because many of these powders will gel at a much lower temperature than that. Even though the coating gels enough to the point where it flows together and hardens, that does not mean the coating will cure. There are plenty of instances where FBE was applied at too low of a temperature and then the uncured coating cracked the following day or week. An uncured FBE often has a very good aesthetic appearance for a day or so but as temperatures change that coating quickly fails.

Because the higher temperatures are required for FBE to cure, it is necessary to use induction heating for its application. Induction heating coils are designed to heat uniformly across a specific width, an applicator must understand what that width is, so that the heating takes place centered on the field joint to be coated. Additionally, the heat is designed to increase uniformly around the circumference of the pipe meaning that if the temperature goes up 50 degrees on the top it should go up by 50 degrees on the bottom as well. Understanding that the induction heating occurs uniformly will explain why in some cases it is necessary to shield the pipeline from the sun. When the pipe is in direct sunlight, the top of the pipe may be at 120 degrees while the bottom of the pipe could be at 80 degrees. This 40 degree variation could be the difference between the top of the pipe curing and the bottom of the pipe not curing. Every effort should be made to keep the starting temperatures around the circumference of the pipe fairly uniform so that the heating process will result in a uniform temperature around the pipe to cure the FBE. As a reminder from the previous section when measuring the temperature of blasted steel at elevated temperatures it is necessary to use a contact thermometer or temple stick, as a common IR temp gun will be wildly inaccurate.