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Has the Critical Art of Surface Preparation for Pipecoating Been Forgotten?

Over the past few years, people in the pipeline industry from around the world have described failed or failing coatings on pipelines that have not been in the ground long. In many cases, these early failures have been attributed to poor surface preparation. But why? Surface preparation for pipecoating is not difficult, is usually well understood, and has long been detailed in many key specifications. Perhaps excessive familiarity with such a straightforward task has caused the pipecoating industry to forget the details.

Coming from the metal finishing industry, which relies almost exclusively on cleaning, deoxidising, and conversion coating chemical processes, I find it hard to believe that the aggressive surface preparation in pipecoating can go wrong. But it does seem to at times.

This article will examine the key features of surface preparation; identify and resolve problem areas; show how to achieve the right result consistently, cost-effectively, and more easily; and dispel misconceptions and even some traditional beliefs about surface preparation that may be the root cause of some of the problems seen recently.

What Is the Purpose of Surface Preparation?

It appears that many in this industry have forgotten the purpose—or, more correctly, the specific requirements—of surface preparation. This is most relevant in relation to the high-performance coatings such as fusion-bonded epoxy (FBE), epoxy-primed (FBE or liquid) 3-layer polyethylene or polypropylene (3LP) coatings, and other multi-layer coatings that use "epoxy" as the primer for corrosion protection. The operative word here is "epoxy," a coating that is sensitive to poor surface preparation and that benefits extensively from good surface preparation.

Surface preparation is doing what is necessary to a surface to accept a coating and to allow that coating to perform as well as possible. Different coating systems may require different degrees or types of surface preparation, but in all cases, the key needs are

- to clean the surface to a satisfactory level, removing all contaminants that can affect coating adhesion, and
- to provide a surface that the coating can adhere to correctly, effectively, and durably, whether by mechanical or chemical bonding or both.

Arguably, for those coating systems that rely predominantly on mechanical bonding (e.g., asphalts / bitumens, coal tar enamels, tape wraps), the level of surface cleanliness is less important than for chemically bonding epoxy-based coatings. A good anchor pattern, properly prepared, is usually considered sufficient.

Other systems require a higher level of cleanliness for long-term performance and might benefit from advances in surface treatment chemistry and developments in coatings technology over the last 20 years in industrial metal finishing. For instance, cars can have 6-, 10- or 12-year anticorrosion warranties, and aluminium-framed or clad buildings have a 25-year warranty on coatings 80 to 150 mm (3 to 6 mils) thick.

Translating such advances in surface preparation and coating technologies to pipecoating is difficult and not always possible or even relevant. To its advantage, the pipecoating industry utilises the mass and shape of the

Opposite page Fig. 1: Inside the acid wash applicator—acid washing is an important step in surface preparation of new pipe.
Photos and illustrations courtesy of the author.

steel pipe to provide fast and effective surface preparation and coating on relatively simple, moveable line that is reasonably easy to operate and control.

Additionally, the pipecoating industry utilises, as its first step, the one method of surface preparation not suited to the light gauge or non-ferrous metal finishers—abrasive blast cleaning, often referred to as shot and grit blasting. But is abrasive blasting always performed properly, effectively, and to specification? More importantly, what can it do and what problems does it solve or cause? These questions will be addressed later in this article.

Typical Pipecoating Plant and Process

Design and layouts of typical pipecoating plants for the production of FBE - or 3LP-coated pipe may vary, but such plants follow most or all of the following steps.

1. Pipe in
2. Initial cleaning and drying
3. Shot / grit blasting—a mixture of shot and grit
4. Shot / grit blasting—mostly grit
5. Decontamination / chloride removal—acid washing between or after the abrasive blast cleaning steps, as required
6. Inspection
7. Chromate treatment, as required
8. Pre-heat
9. Coating application
10. Inspection and testing
11. Pipe out

The steps from pipe in to chromate treatment will be described below.

Pipe in—Received State

Before surface preparation begins, several variables could create difficulties or reduce quality. What is the grade of steel, its wall thickness and degree of variation? How old is it? Where did it come from and how was it stored / shipped? How will the surface condition of the pipe affect our thinking on and operation of the surface preparation procedure. Fresh, new, high-grade API steels may be free of most surface contaminants, but the tightly bonded mill scale will be the most difficult to remove by abrasive blasting. Too new and too cold steel and the problem of weld gassing can cause major pinholing in heat-cured epoxies. Older, weathered pipe with an even layer of rust and broken down mill scale will be the easiest to blast clean but may be heavily contaminated from weathering, storage, or transportation. Another problem, chlorides, will be discussed later.

Initial Cleaning and Drying

New pipe rarely needs initial cleaning if its provenance is known. Older, weathered pipe or pipe of uncertain provenance should be assumed to have unbound surface contamination, much of which can be removed by high-pressure water-based neutral or alkali cleaners or by flame cleaning. Removing general soiling, organic or oil residues, and general inorganic residues is necessary to protect the abrasive from cross-contamination and re-deposition of contaminants.

Before abrasive blasting, the pipe surface must be dry and, preferably, reasonably hot. Induction heating or direct flame heating (e.g., propane, LPG) that does NOT leave combustion residues on the surface is advised. The surface must be at least 3 degrees C (5 degrees F) above the dew point, and the relative humidity (RH) during abrasive blasting must be less than 85%. At high RHs, the dew point will often be quite high. Surface temperatures of 65–85 C (149–185 F) are often needed or specified before abrasive blasting. Scales and oxides are removed faster and more easily from heated steel than from cold steel.

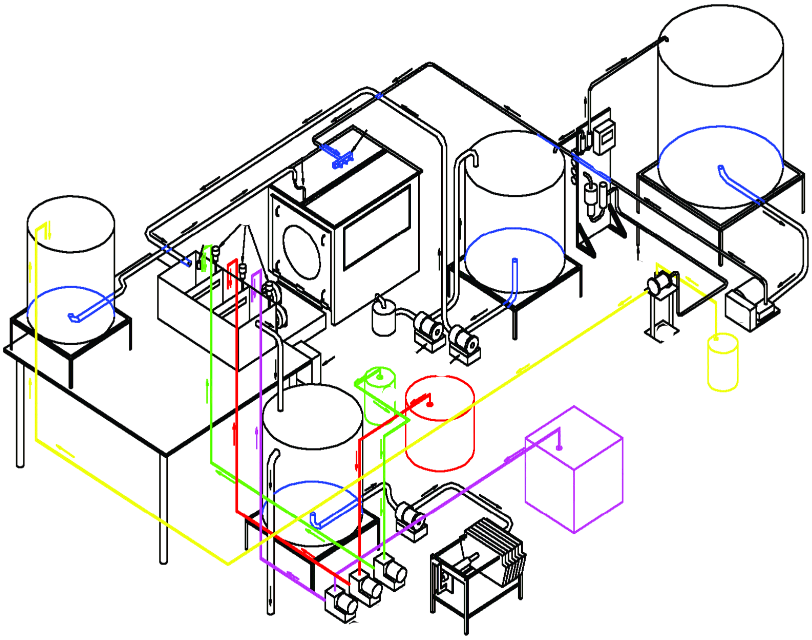

Fig. 2: Typical schematic of a complete acid wash facility, including automixing and dosing, pure water generation, and waste water treatment

Shot and Grit Blast Cleaning

Centrifugal wheelblasting with steel shot and grit is the principal surface preparation procedure that many would argue is sufficient to meet specification needs. Poor management of these units and the abrasives, overestimating their capability, and relying too much on their perceived effects can be disastrous. Two wheelblast units are preferable to one. Surface contamination is minimised, and the ability to produce the right surface profile is more easily achieved.

A single wheelblast unit has to do everything. Management of the shot / grit ratios, abrasive contamination and replacement, and the overall unit operation requires closer control and more frequent adjustments. Two units allow separation of the "cleaning" to be done mainly by the first unit (mostly shot) and the generation of the profile by the second unit (mostly grit).

The type and grade of abrasive depend largely on the type and grade of steel, its age, the degree of mill scale, the amount and type of corrosion products, and the efficiency of the units. Throughout a lengthy coating contract, these variables can change, often significantly. Changes to the abrasive mix, its management, and its type may be needed.

To achieve the required level of (apparent) surface cleanliness (as measured in accordance with ISO 8501 Part A1: minimum Sa 2½ to Sa 3 [SSPC-SP 10 to SP 5]) and the required profile, the correct hardness and size of abrasive must be used. ISO 8501 Group E: Metallic Cleaning Abrasives, ISO 11124-1: Specification for Chilled Iron Grit, and ISO 11124-2: Specification for Cast Steel Shot and Grit are the relevant standards.

Shot and grit blasting, therefore, has two functions: to clean (descale / deoxidise) the surface and to provide the right surface profile for the coating.

For FBE and 3LP coatings, a dense, angular anchor pattern provides the most cleaned surface area for maximum adhesion.

In some ways, "anchor pattern" is misleading; it implies that the coating is anchored or bonded to the surface by virtue of its roughness. Only in severe deformation conditions could such terminology be relevant. The key phrase here is "surface area" and its maximisation. For coatings that bond mechanically, chemically, or both to a surface, the greater the (micro)surface area is, the more bonding sites there are, and thus the better the adhesion is. A rounded or dished profile is not acceptable.

Surface profile is measured in accordance with ISO 8503-1 C1 & C2: Surface Profile Comparators. But only the peak-to-trough height of the profile (the surface rugosity, R_A value, profile amplitude, surface roughness, or other descriptor) is actually measured or specified.

Profile density—the number of peaks per unit area (e.g., per mm^2 or cm^2) —is at least as important as, or more important than, the profile amplitude and should also be measured as a true assessment of profile quality and surface area increase.

Are the qualitative profile tape impression and 30X microscopic assessment of the profile sufficient for accurately defining profile sharpness, angularity, and density? Or do we need an addition to the ISO 8503 standard on profile density?

Shot and grit blasting is a destructive process that generates dust residues on the steel surface. Dust levels assessed in accordance with ISO 8502-3 must not exceed level 3 on the scale provided. Even this level of particulate residues on the surface can cause coating application or adhesion problems. Remove all such residues by vacuuming (not brushing) or by blowing with clean, hot, dry high-pressure air.

For individual or even most of the clean and properly profiled pipes, the level of cleaning achieved by abrasive blasting may meet the average pipecoating specification. But this level of cleaning is not sufficient on all the pipes throughout a coating contract or for very demanding coating specifications. For instance, if the abrasive blasting procedure magnetises the steel surface, only chemical cleaning can remove the dust residue magnetically bound to the surface together with any other particulates. Thus, a traditional belief about abrasive blast cleaning should be chal-

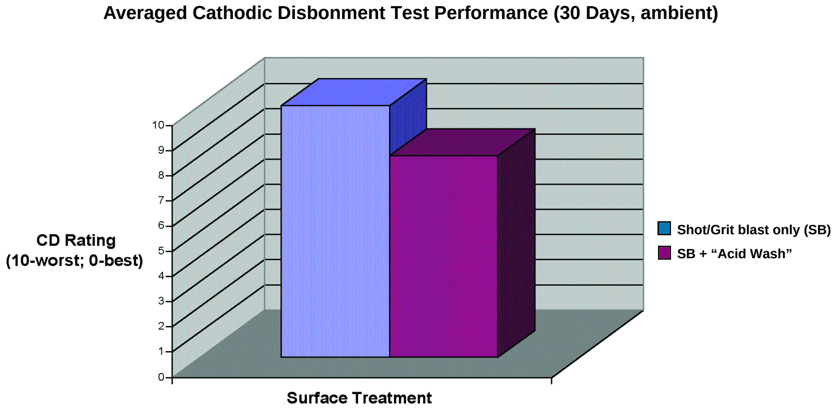

Fig. 3: Comparison of CD performance—Shot/Grit blast (SB) and SB + acid wash

lenged and two key misconceptions dispelled.

As noted earlier, the traditional phrase, "abrasive blast cleaning," is incorrect; it should be "abrasive blast deoxidising."

The first misconception is that mechanical surface preparation will fully clean a surface. It will remove, almost completely, one of the key surface contaminants affecting coating application and performance, i.e., oxidation—scale and rust. But it cannot remove soluble salts, trace organics, and surface bound or chemically reacted residues.

The Sa 2½ minimum measure of (apparent) surface cleanliness is generally accepted as sufficient for the application of most heavy-duty or functional coating systems, but it can be improved considerably. Only performance testing shows how clean such a prepared surface really is. Different types or levels of residual surface contamination or lack of complete cleaning will affect coating adhesion, durability, and corrosion protection to varying degrees.

But unless tests for cleanliness, durability, and corrosion protection can realistically predict in-service coating life, slower-acting surface contaminants or less than ideal surface preparation does not immediately show up. The stories of field failures of coated pipe only a few years old may well be the result.

The second, potentially more damaging misconception is that mechanical surface preparation, such as shot and grit blasting, provides a consistent finish quality. The achieved surface condition after shot and grit blasting depends on the received surface condition of the pipe, which can vary from pipe to pipe.

The level of non-visible and potentially damaging contaminants is impossible to control with such surface preparation techniques, and, unless the whole surface of every pipe is tested, we do not know what the contamination levels are and what long-term effect they might have.

We rely on the pipecoating industry's extensive knowledge, experience, and prediction ability to prepare the surface of steel pipe using these techniques in a way that minimises the impact of potential problems. The quality and condition of the achieved surface finish and often the received pipe surface condition are constantly monitored. But cleaned surface is very fragile, degrading as we watch. It must be coated as quickly as possible—perhaps in minutes—to get the best results from it. This is because cleaned ferrous surfaces immediately and continuously try to revert to their natural state of iron oxide. In normal atmospheric conditions, a thin, non-visible oxide layer approximately 1 micron thick will form quickly. For chemically bonding coatings, re-oxidation is advantageous provided the re-oxidised layer is strongly adherent and uncontaminated. Left too long, the re-oxidation layer can become loosely adhered, too hydrated, and easily contaminated.

Fig. 4: Application of chromate treatment to profiled pipe

The four-hour maximum delay between abrasive blasting and coating is usually considered practical and reasonably safe in pipecoating but depends heavily on the atmospheric conditions. RHs above 65% will dramatically shorten this supposed safe period.

What is needed for proper coating performance, therefore, is a means by which a well-prepared surface can be properly cleaned of all potentially damaging contaminants and changed to provide a stable, non-degradeable surface condition.

The bonus, with measurable benefits, is coating quality and performance that easily meet or exceed the toughest coating specifications. Quality and performance translate into extended durability and long service life. Such surface treatment and finishing, and their effects and benefits can only be achieved with specialised chemical cleaning and conversion coating technology, which is well established and understood. For pipecoating, the process is not difficult or hazardous to use once the equipment is installed and operated correctly.

Chemical Surface Treatments for Pipecoating

Acid washing is effective for surface cleaning, decontamination, and chloride removal. Chloride contamination, which dry abrasive blasting cannot remove, can seriously damage coating adhesion and performance on steel. If chloride were present in simple free soluble salt form only, a thorough wash with clean water (hot and at high pressure) would seem to be sufficient to remove it.

Unfortunately, chloride is present in

both soluble and surface-bound forms, especially as the ferritic salt.

For many years, the evidence against chloride contamination has been building, and it is now generally accepted globally that if there is more than 2 μg / cm^2 (20 mg / m^2) of measurable chloride on a blast-cleaned (profiled) steel surface, subsequent coating performance or durability problems may be expected. It is difficult to measure chloride levels on profiled steel surfaces, and they can be difficult to remove to such a low level.

The only way to remove such contamination is by chemical cleaning; for chlorides, this means strong acid-based systems with specialised wetting agents and sequestering power (Figs. 1 and 2 on pp. 26 and 27). For the last 25 years, the pipecoating industry has had access to the metal finishing industry's second best kept secret: Phosphoric acid, combined with a special detergent, quickly and effectively cleans and decontaminates steel surfaces, removing all inorganic salts such as chlorides and sulphates (soluble or bound), trace oils and greases, light oxidation, dust and carbon residues, even magnetically bound ferritic particulates.

Acid washing must be carried out correctly to gain the benefits. The detail of how to employ the definitive acid wash technology would fill another article.

Users must be provided with all the expert advice, documentation, method statements, operating manuals, and health and safety information by the process supplier as well as advice and recommendations in preparing specifications that include or recommend acid washing.

When, How, and Why Is Acid Washing Used in a Pipecoating Plant?

The "when" is determined by its function: Acid washing is a means of cleaning profiled steel so the operation needs to be scheduled after abrasive blasting, usually before transfer to the coating line. It has little or no effect or benefit if used before abrasive blasting.

Alternatively, it can be used between the first (shot) blast cleaning and the second (grit) blast cleaning if the plant layout allows.

Fig. 5: Another view of application of chromate pretreatment to profiled pipe

Decontamination of the steel surface after blast cleaning is often considered easier and faster than if the full profile has been developed—provided the pipe is fully descaled and the second blast cleaning does not cause any recontamination of the surface.

There is a secondary benefit to this in-between operation. If the acid wash is allowed to react with the steel surface too long, a passive phosphate layer might form on the steel surface (visible as a light blue colouration of the surface or trace white powder deposits). The second (grit) blasting will remove this.

The "how" of acid wash treatment has three steps.

1. The diluted acid wash chemical is applied at the prescribed concentration to the pipe's heated steel surface by low-volume, low-pressure spray or flood to fully wet the pipe surface within 1–2 revolutions.
2. A short period of solution contact (reaction) time is determined by the combination of surface temperature, solution concentration, and line speed—typically 20 (15–30) seconds, but without the formation of any visible passive layer.
3. High-pressure, clean water rinsing removes all traces of the acid wash chemical before the formation of any visible passive layer and provides a pH-neutral surface.

The next part of the question is "why" use acid washing. Its use is now considered almost mandatory if measurable chlorides are present after abrasive blasting. But this is only part of the story; the real benefits of acid washing are in providing a truly clean surface for coating, and one that is more stable and consistent than a mechanically cleaned surface. The result is a slight but noticeable improvement in coating quality and performance achieved at low cost and little effort.

Regular but not excessive assessment of surface cleanliness after acid washing will be all that is needed to confirm the elimination of all surface contamination problems—real or assumed.

To dispel another misconception: Acid washing is strictly a surface cleaning process, not a surface treatment and coating process, as some would have it.

Extensive performance testing in the past has shown that an iron phosphate conversion coating does not benefit the cathodic disbondment (CD) performance of FBE coatings. In fact, it can actually make the FBE coating's CD performance worse.

After acid washing, the profiled pipe surface is thoroughly clean, more stable (but still somewhat fragile), and—for many coating specifications—ready for coating. It will provide generally consistent, even slightly improved, coating performance. Figure 3 on p. 28 is an average assessment of many CD test results (TRANSCO / British Gas CW6 30 day, ambient test) over many years from different plants and test programmes showing the typical performance of FBE with and without acid washing.

Chromate Pretreatment—Conversion Coating Process

But, for the more demanding coating standards and specifications, even this level of coating performance and quality may not be enough. To further improve consistency, quality, and performance, another (final) step in surface preparation is needed—changing the steel surface to a truly stable, inert, adhesion-promoting and corrosion-resistant condition by using powerful conversion coating technology to "replace" the thin iron oxide layer with an alternative, beneficial, complex oxide layer. This technology is the dry-in-place chromate / silica conversion coating, commonly referred to in pipecoating as chromate (pre)treatment (Figs. 4 and 5 on pp. 29 and 30).

For the last 20 years, the pipecoating industry has been selectively using the metal finishing industry's probably best kept secret—chromate surface treatment chemistry. Widely used on aluminium, zinc-coated steels, many other non-ferrous metals, and iron and steels—even stainless steels—chromate pretreatment provides unrivalled coating adhesion performance and long-term bond strength, corrosion resistance, and long-term corrosion protection performance of any applied coating.

For pipecoating, however, the rarest and most unusual chromate treatment process—the dry-in-place chromate / silica complex oxide conversion coating is the only type of chromate chemistry that will work on steel surfaces. It is the simplest form of chemical conversion coating technology to use.

Again, correct application and process management is needed to release these benefits and avoid any possible disasters. The details of how to employ the definitive chromate treatment for pipecoating would also fill another article. Pipe coaters should take advantage of the extensive industry experience with chromate treatment, and seek help and advice from the experienced pretreatment supplier.

When, How, and Why Is Chromate Treatment Used in a Pipecoating Plant?

The "when" is, again, determined mainly by function but also by method of application: Chromate treatment is essentially part of the final coating procedure, not the surface preparation procedure. Its operation, therefore, needs to be sited on the coating line as close as possible to the pre-heat prior to (FBE / 3LP) coating application. The reasons for this have to do with the method of its use and the need to dry the applied coating in place with heat.

"How" the chromate treatment is used in a pipecoating plant can be considered a one-step process during which a number of actions take place in rapid succession in a very short length of space on the coating line.

The procedure can be broken down as follows.

- The unheated, diluted chromate treatment chemical is applied at the prescribed concentration to the rotating pipe steel surface that is heated to the required and controllable temperature. The application method is low-volume, drip feed to start to wet the surface. Spray application is not permissible on safety grounds.
- The applied solution is immediately spread over the surface by means of any suitable prescribed wiping technique, such as rubber squeegee blades, to give an even, thin wet film on the surface within 1–2 revolutions of the pipe. Application can be monitored and assessed visually because the resulting coating will be light to medium golden bronze, and defects such as runs, sags, and poor coverage will be apparent.
- This thin film will begin to dry immediately from the steel surface heat.
- To complete the chemical reaction of the chromate treatment with the steel surface, the treated surface needs to be heated to 120 C (248 F) or more for at least 20 seconds. In FBE / 3LP coating operations, this happens automatically as part of the pre-heat cycle before coating application. No other actions are necessary. (Coating systems that do not require a surface temperature of at least 120 C [248 F] will not benefit from chromate treatment.)

The result of chomate treatment is to change the cleaned, somewhat unstable, invisibly oxidised steel surface to a complex mixed oxide conversion coating of chromium, silicon and iron, 1–2 microns thick, integral with the steel itself and visible as a golden-bronze colour. This surface is now extremely stable, highly resistant to degradation and will provide the maximum adhesion and corrosion resistance possible from the applied epoxy layer.

Chromate treatment will improve coating performance, easily meeting or exceeding the most demanding of coating standards or specifications. Dramatically improved CD and hot water (HW) performance test results may be the easily measurable benefit.

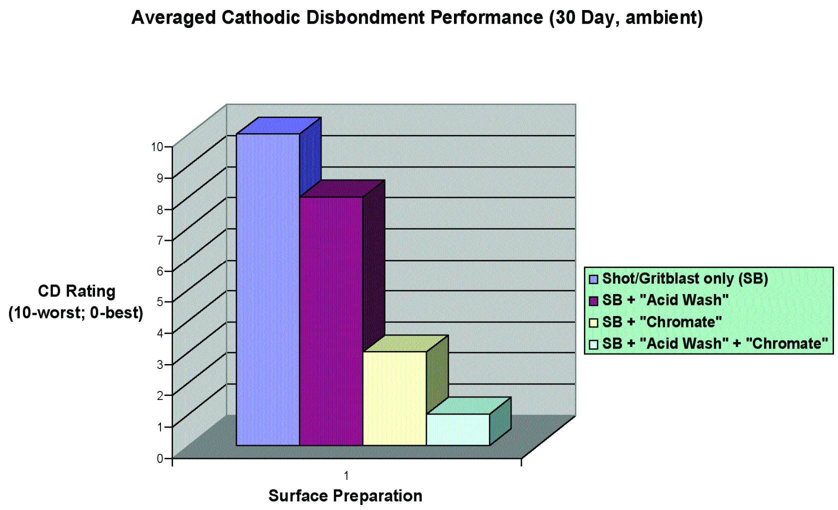

Fig. 6: Comparison of CD performance—All surface preparation variants

Figure 6 is an extension of Fig. 3, showing the typical performance of FBE with all these various forms of surface preparation.

But this largely misses the point of using such technology and highlights more information about chemical treatment that needs to be clarified.

- Chemical pretreatment provides better, more consistent surface preparation, with its results measured by the performance testing of the finished component. Chemical pretreatment is not a means of overcoming deficiencies in the surface preparation or a shortcut to finish the job.
- Chromate pretreatment will not turn a sow's ear into a silk purse. Using this technology to mask the poor performance of low-quality coating systems is a recipe for disaster.
- With such a stable and consistent surface that is guaranteed, the level of consistent coating quality, performance, and ease of obtaining it become the norm rather than the exception.
- By concentrating on the achievable end result—a certain surface finish that can be guaranteed—the emphasis is no longer on concerns over the condition of the received steel but on confidence in achieving the right result, almost regardless of variation in the received pipe's condition and the mechanical surface preparation procedure.

The real benefits of chromate treatment are almost hidden.

- Elimination of rejects for surface preparation problems
- Higher quality and consistency of the coating operation
- Easier, faster, less troublesome coating operation
- Potential for lower temperatures of cure of the epoxy
- For preheat systems that work by infrared heat absorption by the steel, e.g., direct gas-fired ovens, the darker surface of the chromate-treated pipe will absorb the heat faster, reducing heating costs.
- Reduction in overall pipecoating cost

A significant amount of evidence confirms that the consistently high performance results regularly achieved in production translate directly into greatly extended durability and retained pipe coating performance in the ground.

But this also begs a further question: how does chromate treatment actually influence coating performance? The answer is the subject of several major technical papers, articles, and discussions presented many years ago. Their theory of CD and the reasons chromate treatment so effectively combated it are still unchallenged. It is not possible to prevent CD but it is possible to interfere with its mechanism and "slow it down" so significantly that it appears to be prevented.

The application of the coating that follows acid washing and chromate pretreatment is a whole other story but inextricably linked to this one.

However, there are still questions and actions outstanding to complete the full picture of modern surface preparation of steel pipe.

Chemical Pretreatment—The Disadvantages

To benefit from chemical pretreatment, one must use strong, potentially hazardous chemicals. For the pipecoating industry, the growing concern is the hazard of using such chemicals and the disposal of waste.

No national or international occupational health or environmental regulations *prohibit* the use of these processes, even the chromates. Many countries do, however, regulate these materials heavily, setting stringent limits on how they may be handled, used, and disposed of.

The key hazards related to the chromates—inhalation of hexavalent chromium in vapour or atomised form and the environmental impact of chromium—do not effectively apply to chromate treatment in pipecoating. As a dry-in-place process, proper use and management mean that there is virtually no waste to affect the environment. It is prohibited to spray chromate, and the temperatures involved are nowhere near enough to generate a chrome-containing vapour, so the inhalation risk is virtually nonexistent. Once the applied process has been through the preheat cycle and fully reacted with the steel, the chromate is present as an inert, insoluble and non-hazardous oxide layer, integral with the steel surface.

The experienced pretreatment process supplier will provide all the information and assistance to allow any coating contractor anywhere in the world to utilise both chromate and phosphate technologies with confidence and safety, both for the operators and the environment.

The Pipecoating Plant

Features and needs of the plant itself can actually make or break a job. The impact of the services used on the plant—water, air, heating, and materials in constant or regular contact with the pipe—need to be addressed after the achievement of the profile.

- Water—All water used in contact with the cleaned pipe surface should be of the following quality.
  - Maximum anion content—100 ppm total chloride and sulphate where each anion shall not exceed 60 ppm
  - Conductivity—MAX 100 µS

  Where there is any doubt concerning water quality, use treated water.
- Air—Any blown or compressed air used on the surface of the cleaned pipe must be dessicated and oil-free; if used for drying, the air should be heated by any means that does not contaminate it. A dewpoint for compressed air of -40 C (-40 F) has been suggested in recent specifications.
- Heating—Indirect (induction) or direct (hot air, indirect or direct gas flame) heating methods must not contaminate the pipe surface or leave combustion residues on the pipe surface. Direct, residue-free gas flame (i.e., “blue” flame), such as propane or LPG gas burners, may be used to provide low levels (up to 90 C [194 F]) of heat input into the pipe surface.
- Materials used for wiping / spreading chemical solutions on the pipe surface should not shred or leave residues on the pipe surface. Typically, the same material used as circular flanges at the entry and exit ends of the wheelblasting units is recommended, e.g., hard or reinforced rubbers, neoprenes.

Brushes, rollers, matting, etc., made of inert but flexible, non-shredding materials, non-reactive with the chemical processes, are also considered suitable.

Regular housekeeping and plant maintenance can eliminate many potential causes of cross- or re-contamination of the prepared pipe surface.

Cost

The installation and use of these surface preparation methods and procedures imply additional cost. One can also argue that the short-term benefit of a simpler operation and reduced prices is quickly lost with the long-term cost penalty of poor quality and performance—and loss of business.

Investing the time, effort, and, if necessary, the money in setting up such a surface preparation plant as described herein and establishing proper procedures and management will soon be rewarded with a low unit cost of operation. A cost study is perhaps in order.

Some Tips

Surface preparation for pipecoating perhaps needs to be reconsidered to obtain the results now expected. For many coating systems, especially the increasingly demanding coating standards and specifications employing the latest high-performance coatings such as FBE and 3LP, the following points can be made.

- Know what condition the received pipe is in and what impact that can have on the surface preparation.
- Know what can be done initially to reduce any such impact on the subsequent procedures, or to predict what needs to be done.
- Know the grade and hardness of the steel and choose the type and size of the shot/grit mixture accordingly.
- Use and manage the shot/grit blasting operation effectively and pre-emptively to minimise the impact of received steel condition variation. Separate shot blast and grit blast units are preferred, but single units, managed carefully, can be as effective.
- Control and manage the abrasives mix ratios and their cleanliness properly.
- Concentrate on achieving the correct profile amplitude and density. The acid wash process can complete any residual or additional cleaning.
- Use acid washing to guarantee surface cleanliness and to remove all damaging contaminants, especially chloride, regardless of whether the received pipe surface condition predicates its use.
- Set the target for cleanliness and profile to be achieved, inspect and measure it at the end of these procedures only, and adjust the procedures if necessary.
- Use chromate treatment to provide total consistency of coating quality, not simply to optimise the coating performance or to meet certain coating specification requirements. Such performance needs will be met as a matter of course anyway.
- Maintain and look after the plant, its materials, services, and operation, and be aware of their impact on the effectiveness of the surface preparation, including atmospheric conditions in the facility.
- Plan and implement a complete surface preparation procedure that can be controlled and managed easily and is preventative rather than curative in its approach to possible problems. Prove it with qualification trials (including qualification of the coating system itself), and stick to it.

Saving just one reject pipe a week would more than pay for the extra technology and procedures.

Conclusion

In the high risk world of pipelines and high cost coating contracts, the small matter of surface preparation may not seem that important, but its impact on the service life of a pipeline can be dramatic and costly if poorly done. Done well and coupled with the best available coatings, it can also be significant in reducing pipeline corrosion protection operating costs in service.

Where does CP fit in? CP and protective coatings are effectively mutually incompatible because the CP system is continuously trying to disrupt the coating from the steel surface. This brings us back to the beginning: surface preparation and its effects on coating quality and performance. Utilising these best practices with these high-performance coatings will result in an in-service pipeline drawing the minimum protection current from the CP system. Its life cycle protection costs will be minimised and this alone justifies the rationale behind this article.

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For the past 27 years, Chris Bates has been involved in most aspects of the surface finishing of metals for painting and corrosion protection by chemical pretreatment processes. Originally with Pyrene Chemicals (part of Brent International and now owned by Chemetall), he was responsible for the key development work that resulted in the chromate pretreatment system for pipecoating. He joined the Chemetall Group in 1991 and is currently global technical coordinator for all the CM Group's pipecoating interests worldwide.

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