

In-situ cleaning and (cured-in-place) pipeline protection using heavy-duty glass-flake linings applied by pigging techniques

by Louis Pretorius, Corrocoat SA (Pty) Ltd

Introduction

Pipe pigging is a technique for the in-situ cleaning of *long* pipelines. In fact, cleaning by pigging only really starts to become economically feasible at pipe lengths of 300 metres or more, particularly for lengths of 1 km to 30 km.

The pigging technique for the cleaning of pipelines is therefore complementary to high-pressure water-jetting and vacuuming and is not directly competitive with these techniques. High-pressure water-jetting or high-pressure water-blasting is only effective on short pipe lengths, typically 100 to 300 metres maximum, depending on pipe diameter, water pressure, type of scale or debris to remove etc.

The pipe pigging technique to clean pipes and optionally coat them internally therefore overcomes one of the inherent limitations of the cleaning and lining technologies with which the TT fraternity is generally more familiar. Pigging provides remote access to longer pipe lengths, especially where the pipe bore is too small for safe man-entry.

Pigging can also be used for the application of coatings to create a seamless internal anti-corrosive lining of long pipelines.

Pipe pigging: the short version

The technology originated in the cleaning of pipes, and these proven cleaning methods continue to be used today. Firstly mechanical cleaning of the pipeline is performed, using a variety of wire brushes, called pigs, which are propelled through the pipeline using compressed air, nitrogen or water. This is followed by foam pigs and urethane blade scrapers to remove loose debris, residues and corrosion products from the pipeline. Part of the proprietary techniques and expertise is to ensure that these cleaning pigs do not get stuck.

Next chemical cleaning of the pipeline is performed, using repeated pig runs with detergents, solvents, corrosion inhibitors etc, consecutively batched between two pigs, to ensure a clean, dry metal finish to a visual cleanliness standard of ISO SA2½.

These in-situ techniques were developed 40 years ago to apply internal corrosion protection to pipes using a thin layer of epoxy based paint (50 to 100 micron). Although many thousands of kilometres of pipes were successfully treated, these thin paint films had shortcomings in weld coverage, and were also unable to fill pits caused by pitting corrosion, and unable to replace metal loss caused by channel erosion

Thin film epoxy paints may have application for low-corrosive fluids, such as drinking water supplies, sweet crude oil, and aviation fuel etc and despite the epoxy's shortcomings these paints have a track record of more than 20 years and many references of success.

New coating material developments, revised application methods and modified pigging equipment have now made it possible to apply thick-film coatings as internal corrosion barriers to pipes in the field. The thick coating films can be up to 1 mm thick in a single coating run over long distances. The thick-film coating materials and application techniques are similar to

continuous screeding, creating a robust seamless internal pipe lining. With thick-film polymers the option now exists to create a structural GRP pipe within a pipe, be it steel or concrete.

The pipe pigging process

Virtually any pipeline can be internally lined using pipe pigging techniques, including buried and submerged pipelines. The process requires a generous supply of compressed air, provided by a number of diesel compressors and air dryers/chillers. An alternative propulsion method is compressed nitrogen. The tools and polymer pigs are launched through specially designed launch and acceleration tubes and caught at the other end with custom-made deceleration tubes and receivers. If the pipeline is not regularly scraped clean or chemically cleaned it will probably not have launchers and receivers. In that case temporary pig traps are fitted at the beginning and end of the pipeline.

The pigging process has four stages:

- mechanical scouring by a variety of different scraper pigs
- mechanical cleaning of the pipeline using foam swabs, a variety of different wire-brush scraper pigs, and various urethane blade scrapers to remove all deposits
- chemical cleaning and chemical treatment of the pipe surface, using pairs of squeegee pigs or wiper tools, to ensure a clean, dry metal finish, including acid etching and corrosion-inhibition surface-treatment as part of the surface preparation
- coating-application pigs are used to screed-apply various coating polymers using specially designed flexible application pigs. These coating pigs are batched between screeding tools and make several runs, ensuring a multi-layer, continuous lining of the specified thickness, along the complete length of the pipeline.

In many applications, the requirement is merely that the pipe lines are mechanically cleaned. Typical pipe cleaning applications are:

- commissioning to remove construction debris/welding slag and welding rods
- dewatering/drying/draining
- chemical cleaning as a batched process, with the liquid moved between pigs
- removal of sediment, black dust, carbon etc.
- surface cleaning prior to use of intelligent pigs, ie magnetic-flux resonance and ultrasonics
- removal of wax build, grease, oils and sediment from sewer lines
- “cholesterol” scraping/unblocking of pipes, even where the position of the blockage is not known
- returning pipelines to optimum flow capacities.

The scraping and wire-brush cleaning can sometimes be done on-line using the pumped fluid to propel the scraper-cleaning pigs.

It is, however, not possible to do the internal corrosion protection while the pipe is on-line. The pipeline must therefore be decommissioned and taken out of service for the application of the corrosion barrier and/or structural lining.

The screeding tools which apply the coating are pushed through the pipeline using controlled air pressure before and behind the pig. The slug of liquid polymer is trapped or plugged between the screeding tools.

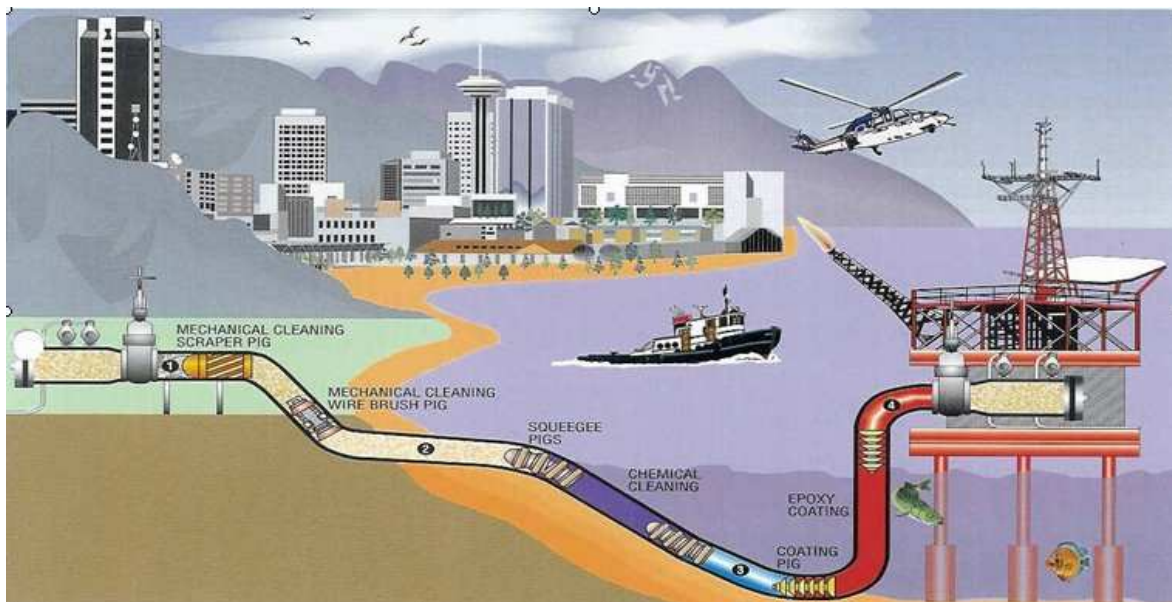
The typical duration of a project is one to six weeks for pipe cleaning (on-line or off-line) and one week for application of the corrosion barrier. These time scales are typical, regardless of the length of the pipeline and apply to diameters of 150 mm to 900 mm, but vary depending on sediment type and hardness, as well as level of cleanliness required. Often the pipe flow is maintained during cleaning or only interrupted for very short periods (hours).

Many different pipe configurations can be corrosion protected internally using the pigging technique. Continuously-welded and flanged pipe, slip couplings, male/female collars and bell-and-spigot pipe-connections can all be dealt with.

Prior to cleaning and/or coating all valves and devices that can block the passage of the remote tools must be removed and replaced with temporary spools (short pipe spacers). T-pieces, nozzles, spigots and branches are temporarily plugged with custom-made saddles.

Cases where the internal pipe-diameter changes, cannot be accommodated, unless they are cut at the diameter change. Restrictions for pigging are short pipes or pipes with tight or short-radius bends.

This new technique gives the pipeline engineer the ability to deal with the most difficult internal anti-corrosion applications, such as where existing pipes cross under busy roads, or where the pipes cross under or over rivers and estuaries; where new urbanisation has resulted in buildings on top of old pipelines as well as in ecologically sensitive areas where digging up the pipeline is environmentally or socially unacceptable.



Development of the technique

Currently, the internal corrosion protection is predominantly glass-flake reinforced coating material applied to pipelines, as well as other industrial plant. In addition, materials based on modified thick-film viscous GRP-type resins, were developed, that can add structural strength back to pipe internals and even seal certain types of leaks. These materials behave very differently to the solvent-based epoxy paints. These modified coating materials and application processes are acknowledged as offering a significant improvement over previous coating materials.

The traditional solvent-based epoxies have a low viscosity. It was perceived that viscosity was the most important aspect of coatings and that viscous fluids could not be applied using screeding techniques. It has since been demonstrated that the thixotropic index and thixotropic rate of recovery for these non-newtonian fluids is far more important than the simplistic viscosity definition, especially when doing film builds in excess of 1 mm per application run. By modifying the thixotropic properties, the viscosity and the cure system of the coating formulations, a long life before curing was enabled, allowing the liquid materials to be used for practical pigging applications.

The option exists for heavy-duty anti-corrosion applications, to build a thick wall GRP composite pipe within a steel pipe, not only giving corrosion protection but also mechanical reinforcement. The application technique and lining can be used to recover pipe integrity. The technology, using the specially developed lining materials, has demonstrated the ability to fill several 12 mm deep channel-erosion gouges, in only two coating runs, and channel corrosion with as much as 20 mm metal loss has been filled.

During the pigging run, each layer is seamlessly liquid-applied with the screeding pigs and then cured without the need for heaters or hot air blowers. Single-pass wet liquid thicknesses of up to 1,9 mm have been achieved around the circumference of the pipe without slump. However, cost is a concern and for most structural lining applications, a bonded GRP pipe lining thickness of around 5 mm is considered sufficient. However, where there is concern over structural integrity of the pipe, the thickness can be built to whatever is required within commercial limitations. A bonded GRP pipe within a steel pipe is therefore a viable engineering alternative to pipe replacement.

Why do glass-flake materials give a considerably longer life?

There are no organic linings which are completely impermeable. The level of osmosis or rate of gas diffusion will vary depending on many factors including type of resin, type of fillers and the cure of the system. The purpose of the glass flakes is not just mechanical reinforcement, but also to significantly improve the resistance to moisture-vapour transmission through the lining.

The thick-film viscous pipe pigging grade materials are filled with glass, both glass platelets (flakes) as well as short polyethylene fibres or glass fibres. The glass flake is orientated within the resin in multiple layers, generally parallel to the steel surface. They offer high quality barrier properties coupled with reinforcement benefits and superior corrosion protection performance. Glass flakes or platelets have a lamella structure, characterised by their high aspect ratio (low thickness to large surface area).

Fibres add structural strength according to the direction of orientation, but at 10 to 15 micron diameter, glass fibres offer very little resistance to diffusion/permeation.

The properties of the lining can often be optimised by blending different types of flake, sizes and quantities with the resin binder, which can also be of various types. The improved properties can be achieved not only in thermoset materials but also in thermoplastic materials such as polypropylene and PTFE.

What SASTT standard?

Many members of SASTT will no doubt recall the correspondence between Gavin Nunn and the director of SASTT, some of which was e-mailed to the SASTT members at large in the course of December 2006. In the letters Gavin had vented his exasperation with a tender enquiry issued by a metropolitan council. The council had specified a “reporting standard” going by the name of *SASTT manual of sewer condition classification*.

A client of Gavin's had approached him for help with the tender to be submitted to the metro. Gavin had not previously heard of the sewer classification manual, but had duly approached a board member of SASTT, asked for the "standard" and had been provided with a copy of the manual. When he studied it, Gavin had found that the manual did not contain a scoring system, which his client would need to execute the work if his tender were successful. He would find it really difficult to service his client's needs and Gavin was understandably disappointed.

The board of SASTT decided that in order to resolve this matter, it would invite Gavin to attend the board meeting held in January 2007 so that the issue could be discussed openly.

During this discussion, it was explained that the manual had been made available to interested parties.

In a similar manner, municipal engineers of Johannesburg and Tshwane had, through the medium of SASTT, offered certain of their specifications as guidance for professionals when drawing up their own specifications. This had been reported by Johann Wessels, of the City of Tshwane, in his presentation to *International No-Dig 2001* in Prague, as well as at SASTT seminars.

However, at no stage had the manual, let alone a "standard", been published by SASTT, just as the specifications offered for guidance had not been published by local authorities.

It was therefore a misnomer to specify the manual as the reporting "standard", as the metro had done in its tender enquiry.

It was agreed that:

- the manual was not an official standard, but a guideline for information and guidance
- the president in consultation with Gavin Nunn would draft a letter which would be sent to the metro to inform them that the manual would have been useful for drafting a specification, but that it was not suitable to be used in the manner of a "standard"
- through the medium of the SASTT newsletter the members of SASTT must be informed of the outcome of the discussion.

In addition, SASTT must look into publishing a bibliography of useful specifications etc on the website, together with the sources whence prospective users could request copies.

Members who wish to offer relevant information for this bibliography, can contact Joop van Wamelen on director@sastt.org.za.

The SASTT board for 2007

Following the election held late in 2006, the following members have been selected to the board of SASTT:

Craig Burnie, Vermeer Equipment Suppliers (Pty) Ltd, president
Glen Derman, Sight Lines Pipe Survey Services, immediate past president
Mike King, Vela VKE Consulting Engineers (Pty) Ltd
Andries Löt, Johannesburg Water (Pty) Ltd, treasurer
Justin Spreckley, TT Innovations (Pty) Ltd
Joop van Wamelen, ex officio, honorary director
Ian Venter, Petzetakis Africa (Pty) Ltd, secretary
Johann Wessels, City of Tshwane, vice president.

Papers from *International No-Dig 2006*

The papers presented in Brisbane have been published on the relevant website, viz <http://www.nodig06.im.com.au/papers.htm>

However, especially if you do not have a broadband connection, it takes the proverbial month of Sundays to download them.

SASTT has saved you the trouble – the papers are available on CD. If you would like a copy, please contact Joop van Wamelen at director@sastt.org.za.