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The Challenges of Neglect

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THE CHALLENGES OF NEGLECT

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Abstract

Reduction in the routine monitoring and maintenance of assets also affects cathodic protection systems on buried infrastructure. A general lack of monitoring and maintenance of pipeline cathodic protection systems can result in reduced protection of the structure. Consequently, this has an immediate impact on the integrity of the infrastructure.

In addition, however, are the less quantifiable series of challenges associated with a short-term “partial repair approach”. These occur when cathodic protection and AC mitigation are a contractual requirement during the replacement of portions of a pipeline. The challenges are increased when the pipeline in question forms part of a broader pipeline reticulation network.

This paper will examine some of the challenges associated with temporary and permanent cathodic protection systems for replacement portions of pipelines within a reticulation network, particularly where stray current influences are also encountered.

1 Introduction

Neglect can be defined as a “failure to care for properly”.

Similar to aging human bodies, aging infrastructure also requires more frequent “proper care” or maintenance. Unfortunately, this does not always happen timeously.

The neglect of energy pipelines tends to lead to environmental disasters. However, the neglect of water pipelines can result in humanitarian catastrophes.

In February 2021, the ongoing neglect of the water pipeline infrastructure left the municipality of Makhanda in Eastern Cape, a province of South Africa, without water for more than 7 days. A population of 60 000 people was impacted by a significant shortage of potable water for this period . Sadly Makhanda is not unique. A property on the southern Natal coast has been without municipal water since November 2020 due to failed water infrastructure.

In another instance, a 12km pipe segment was accidentally omitted from temporary cathodic protection for 3 months during the installation of a fuel pipeline. Pigging revealed 80% metal loss had occurred at coating defects, during the 3-month period without temporary cathodic protection. This resulted in costly repair work as the ILI survey was only conducted after the pipe was operational. Although deep, the corrosion pits were small enough that the pipe passed the pressure test. A hidden danger of high integrity coatings.

These are not uncommon occurrences. A brief internet search revealed that neglect of pipeline infrastructure is evident in numerous countries around the world.

Years of neglect exacerbated by nearly ten years of civil war have caught up with Libya's once formidable oil pipeline network. 2021 started with Libya’s oil production falling by approximately 200,000 bpd because a significant pipeline was identified as having numerous leaks. It was classified as “worn out," and had to be taken out of service.

In the United States of America, between 15 and 30 significant pipeline failures are experienced each year across the nearly 4 million kilometres of energy pipeline network.

In Sweden, a recent study revealed that few water utilities in Europe are implementing preventive maintenance in their pipeline rehabilitation policies. From the study, it was revealed that while most of the utilities are following a corrective maintenance strategy, only a few of them are concentrating on a rehabilitation strategy that maintains pipelines before they wear out.

This global culture of neglect and a lack of routine maintenance is creating a large gap between the required level of maintenance and the actual level of maintenance. This is being termed the “maintenance debt”. As this gap increases, the lack of maintenance as well as the aging of infrastructure can result in pipelines that can no longer be easily repaired or maintained, and replacement becomes the only viable option.

2 Problem Statement

One of South Africa’s primary water utilities has identified that pipeline repair is no longer economically or practically feasible. They have therefore embarked on an extensive programme of replacing leaking pipe segments completely.

Owing to cost, the replacement programme is not intended to replace pipelines in their entirety. Instead, this programme targets portions of the various pipelines. The portions earmarked for replacement have historically been the subject of multiple leaks. It is the Owner’s intention that the replacement segments should incorporate the locations where the greatest number of leaks have been experienced, thereby eliminating the future risk of leaks and associated problems.

At first glance, this “partial replacement” approach seems to be an optimal solution. However, from a corrosion perspective, the replacement of aging infrastructure can result in unforeseen corrosion challenges.

3 Pipe Segment Selection:

The selection of the pipe segments which need to be replaced appears to have been based on some or all of the following:

3.1 Each pipe segment identified has been subjected to numerous repairs for leaks and yet the pipes continue to experience leaks and bursts.
3.2 Oftentimes, the identified segments are in areas of significant stray current interference activity associated with the local DC rail network.
3.3 Cathodic protection and stray current mitigation on the affected pipe segments is non-existent or has been neglected and/or vandalised such that there has been no operational cathodic protection on the pipe segment for a significant period of time.

The Owner has earmarked these various pipeline segments for replacement. By replacing the identified pipe segments, the Owner is hopeful that the continual threat of leakages and bursts will be eliminated, and that integrity of the infrastructure is restored.

From a construction viewpoint, the intention is that these new segments are installed adjacent to the current infrastructure. Then, in an attempt to reduce downtime, these segments will be tied into the network in a single operation.

By electing to replace only portions of the pipeline network, the Owner can extend the reach of the refurbishment programme financially. This “partial pipeline replacement” approach is a practical solution to removing the leaky problems.

4 Cathodic Protection Requirement:

From past interactions, the Owner has now become convinced of the benefits of cathodic protection and is insisting that temporary cathodic protection be installed as soon as pipeline installation commences. Further, the Owner also requires permanent cathodic protection to be installed on the newly installed segment.

5 Some of the Challenges:

5.1 Coating:

Most of the pipelines are between 15 and 60 years old. It is therefore anticipated that majority of the coatings of the original pipelines are completely degraded. This is in stark contrast to the new pipe segment being installed which will inevitably be coated with a polymer modified bitumen (PMB), a rigid polyurethane (RPU) or a 3-layer polyethylene (3LPE) coating.

It is clear that once the new pipeline segment is tied into the existing pipelines, a galvanic cell between the new and the old pipeline segments will be established.

Of further concern is that any small defects in the new, well-coated replacement pipe segment will be more vulnerable to the higher current densities. In addition, any stray current interference will override any local cell effects.

5.2 Electrical Isolation:

The option of installing electrical isolation between the old and new pipeline segments has been considered.

However, in the presence of the significant stray currents experienced in the vicinity, the installation of electrical isolation can create another challenge. The stray currents will not be restricted by the electrical isolation and will readily jump across the interface resulting in corrosion at the isolation joints.

This challenge may not be not immediately apparent. Although stray current interference is significant on many of the pipelines, the replacement pipe segments are usually fairly short (<2km). No significant interference is detected along them during construction. This can result in a false sense of security during the construction period and can instill the belief that the pipeline is free of threats or challenges. This can cause unexpected consequences when the replacement pipe is tied into the original pipeline.

5.3 Temporary and Permanent Cathodic Protection:

Applying temporary cathodic protection during construction is easily achieved by means of sacrificial anodes. The new pipeline segments, have been successfully protected during the construction period, despite being distributed across a variety of terrains and environments,

The challenge arises once the systems are tied in electrically.

The contractual documentation indicated that permanent cathodic protection systems should be designed for each replacement portion. However, once the systems are interconnected, the “permanent” cathodic protection system, designed for the protection of a 2km replacement pipe with an excellent coating, is completely overwhelmed by the demands of a complex interconnected pipeline network. The nett result is that the cathodic protection is inadequate to meet the demand.

5.4 Network Cathodic Protection:

Each pipeline is tied into several other pipelines in order to form the extensive water pipeline network. The entire network may not have adequate cathodic protection. There are significant budgetary constraints that prevent the installation of cathodic protection along the entirety of the network.

Another challenge that is evident is that the replacement portions are often situated in vulnerable locations. Previous cathodic protection systems have often suffered vandalism and there is no evidence that new installations of impressed current cathodic protection systems and suitable stray current mitigation systems will fare any better.

6 What is the Optimal Solution?

6.1 Total Pipeline Replacement?:

The pipeline network comprises approximately 3500km steel pipelines with an average of 1m diameter. The costs associated with either steel or plastic piping as well as the pressures (40 bar) make complete replacement an unrealistic consideration. The fact that the pipeline network traverses extensive high-density urban areas and the practical constraints associated with construction in built-up areas further highlight the impracticality of total pipeline replacement as a solution.

It may be feasible to embark on a selective "excavate and rewrap" exercise. This may be practical in those areas where coating defects have been identified but where pipe perforation is not yet evident.

6.2 Complete Network Cathodic Protection?

It may appear that the ideal solution would be to install a new cathodic protection system across the entire network. Aside from the significant costs, the complexities due to the proximity to stray current inducing rail infrastructure as well as the number of foreign services crossings and parallelisms cannot be underestimated.

6.3 Is there Another Way?

Perhaps a more practical approach would be to optimise the use of information gained through routine monitoring with a "Big Picture" evaluation of the corrosion risk at key locations throughout the pipeline network.

Based on this information, it may be most cost-effective and practical to install localised cathodic protection at anodic sites combined with the functionality to drain stray currents at appropriate strategic points throughout this network. This tactic, coupled with ongoing potential monitoring and a commitment to installing vandal-resistant cathodic protection infrastructure could go a long way to overcoming the challenges which arise from systemic neglect.

7 Bibliography

Dill, E., 2021. *5 Causes of Pipeline Accidents and How to Prevent Them*. [online] Info.goaptus.com. Available at: <http://info.goaptus.com/blog/5-causes-of-pipeline-accidents-and-how-to-prevent-them> [Accessed 27 March 2021].

Garmabaki, A., Marklund, S., Thaduri, A., Hedström, A. and Kumar, U., 2019. Underground pipelines and railway infrastructure – failure consequences and restrictions. *Structure and Infrastructure Engineering*, 16(3), pp.412-430. DOI: 10.1080/15732479.2019.1666885

Pipeline-journal.net. 2021. *Libya's Oil Pipelines Are Falling Apart | Pipeline Technology Journal*. [online] Available at: <https://www.pipeline-journal.net/news/libyas-oil-pipelines-are-falling-apart> [Accessed 27 March 2021].

Webb, N., Bradfield, F., 2016. *Accelerated Corrosion Under the Combined Influence of SRB and Anodic Interference – A Case Study*. CeoCOR. [online] Available at: <https://ceocor.lu/download/2016_slovenia/2016-WEBB-BRADFIELD-Accerated-corrosion-under-the-combined-influence-of-SRB-and-anodic-interference-a-case-study.pdf>