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Hot dip galvanizing solutions to corrosive challenges stand the test of time and safely extend life-of-mine

The Hot Dip Galvanizers Association of South Africa (HDGASA) spends a significant amount of time liaising with the mining sector where the tough environment - characterised by acidic fissure waters, humidity, fumes and gases, as well as dust and abrasion - takes its toll on pivotal steel infrastructure.

HDGASA Executive Director Robin Clarke advises that, although hot dip galvanizing is primarily favoured for economic reasons, the collateral outcome is improved mine safety:

“The design criteria are largely economical: how long will a mine last and be safely serviceable? The key elements are cost to build, cost to operate and cost to maintain. Hot dip galvanizing is competitive across all these criteria,” Clarke points out.

The mining sector faces many challenges, including economic turbulence, fluctuating commodity prices, the entrance of new investors and skills scarcity.

“We can never assume that knowledge and experience are embedded. Much of what we do is informative and educational,” Clarke says.

Lessons from the past

While it has now really taken hold in the sector, hot dip galvanizing only began to gain traction within South Africa’s deep-level mining sector comparatively recently. During the 1990s, Clarke’s HDGASA predecessors set out to demonstrate that this was the best corrosion control mechanism for mining.

A forward-thinking engineer at a large mining house collaborated with the HDGASA and the South African Bureau of Standards (SABS) to scientifically investigate the impact of hot dip galvanizing over a 10 period.

Up until then, a tendency to over-design steel sections to compensate for probable levels of corrosion prevailed.

“During 1995 and 1996, various tests and simulations were performed to establish probable real-world performance outcomes for hot dip galvanized steel in deep-level mining applications. The South African Bureau of Standards (SABS) performed tests with both natural and service mine water, extracted from shafts in service.

Outperforming expectations and safely operating beyond LOM

The testing process occurred over a 500-day period. Steel test pieces, with a hot dip galvanized coating averaging 200µm thickness were used. The loss of zinc on the test pieces exposed to natural water equated to 4µm/per annum, which equated to a probable coating life of 50 years. The test pieces subjected to typical mine service water suffered a loss in the order of 8µm per annum, which translates into a probable service life of 25 years, easily meeting the 25-year life-of-mine (LOM) estimate that the design engineer was briefed to achieve,” he explains.

In January 2003 and 2006, further tests verified these original predictions. Corrosion levels remained low, with only some isolated spots (where the galvanized coating had been mechanically damaged during installation) showing marginal deterioration.

“On these spots, no corrosion creep was evident and a portion of the zinc-iron alloy - still at about 24 µm - provided corrosion protection. The bottom line was, that 10 years after being

applied, the corrosion control of zinc had outperformed expectations - except for a very particular application, where the vertically-oriented steel buntons had eroded, after being subjected to direct impingement of water droplets, dust and debris at high velocity."

Mining engineers undertook either to minimise this falling material or redesign shields over the buntons.

The HDGASA has subsequently published papers addressing corrosion challenges in deep-level mining, particularly in instances where corrosion cells develop due to the accumulation of debris at catch points in crevices, and surfaces of various hollow section components. However, even these illustrated the positive impact of utilising a corrosion control hot dip galvanized coating.

Clarke says lower levels of corrosion mean that many mines are now safely operating beyond their originally envisaged LOM. At the feasibility level, design engineers are even considering designing for durability beyond the original LOM specification - which is even more reason to hot dip galvanise.

"It is very gratifying that hot dip galvanizing has now gained traction to the extent that it has, with virtually all steel work either being galvanized or considered for galvanizing," he says.

'Hot' solutions to corrosive challenges

The HDGASA's role in the mining sector did not stop there: the Association recently addressed challenges in coal washing, due to the presence of high levels of extremely corrosive sulphur. The solution extended beyond merely galvanizing, with the HDGASA proposing a combination of galvanizing and paint, known as a duplex system.

"Pioneering work was done in response to engineering requests for solutions to extremely corrosive challenges. We therefore compiled operating procedures for preparation and painting, and we also collaborated with paint manufacturers. After 10 years, the duplex system which we recommended remains in exceptional condition - and is expected to provide another 15 years' service life," he advises.

"The HDGASA will continue to play an important role in mining, supporting what is now widely accepted in the sector as an embedded corrosion protection technology backed by sound science, and with a proven ability to extend life-of-mine and improve return-on-investment," Clarke concludes.