



Long term investment in corrosion management will generate greater rewards

By Dr Chris Fowler

The corrosion management industry faces tough and diverse challenges. Dr Chris Fowler, technical director, corrosion & protection at Exova, discusses the salient issues

Pipeline corrosion has enormous financial and operational implications for gas suppliers and distributors. As a result, the question of how best to tackle corrosion is beset by both cost and technical issues.

Businesses can achieve a great deal by implementing long term corrosion management strategies, but many are reluctant to spend money on projects that do not deliver an early return in investment.

Corrosion management translates directly into asset integrity and extension of useful life – in other words, operational effectiveness and cost-efficiency. If equipment can be made to last longer as a result of good corrosion management techniques, then this will create greater profitability for the operator.

The application of current technology can reduce corrosion losses by 30 per cent, which feeds back into an organisation's bottom line performance and boosts productivity.

The financial argument for life-cycle management

High-performance corrosion-resistant alloys are certainly available, but they are expensive and unlikely to make an immediate, significant impact on the enormous preponderance of carbon steel pipelines, which account for 90 per cent of the world's stock. These new alloys combine the strength of steel with the resilience of lining and, in an ideal situation, businesses would make increasing use of them as part of an effective life-cycle management programme.

The education of the industry's key players in life-cycle costing is an issue that must be addressed urgently. In some cases, costings can show that higher initial investment in better materials and technology can greatly reduce operational maintenance, and hence reduce overall costs over a project's lifetime. There are significant business benefits but sadly, many people simply aren't aware of them.

Short termism and the culture of instant returns is a serious problem. Prevention and mitigation of corrosion generates mid to long term returns, but governments and industrial investors are often more interested in quick wins, either for the next election or to satisfy shareholder demands for quick returns.

It's a matter of some concern that an increasing proportion of short term project schedules don't allow room for any problems in material qualification because everything is wanted yesterday. In truth, corrosion management translates directly into asset integrity and extension of useful life – in other words greater long term returns.

All too often rapid payback on investment is prioritised above preventing the corrosion of plant and equipment, because it is perceived as neither 'sexy' or immediate. Senior management need to have the financial benefits and savings explained in words they understand. Quite simply, their businesses will be much more profitable in the mid to longer term if they build corrosion prevention measures into their investment strategies.

On a more positive note, recent developments in coatings are helping the gas industry to manage corrosion issues more effectively and a Pipeline Protection exhibition in Edinburgh in October, which I chaired, featured full scale demonstrations of some of the many new coatings available.

Training the engineers and corrosion managers of the future

A recurring issue is the increasingly acute shortage of trained staff and it is disconcerting to note that the industry does not train anywhere near enough corrosion engineers as corrosion managers. The new engineers coming through do not have the mentors available to them, as we did in the past, and this will have serious implications for the future of a highly specialised profession.

However, this issue is something we are working on at Exova by nurturing engineering and management skills. In September I announced the expansion of our Corrosion Centre in Dudley, England, and the establishment of a Corrosion Academy.

The idea behind this venture is to train our own people, as well as offering training courses to the industry. There are insufficient numbers of metallurgists and corrosion engineers which makes proactive steps necessary. We are putting major investment into this initiative because we believe it is in the long term interests of our own business as well as the broader sector.

Taking corrosion to extremes in Brazil

Managing corrosion in new territories and extreme environments is an area in which the industry is struggling because we don't know how challenging these environments actually are. A lot of R&D work is currently being done to replicate these extreme conditions in the laboratory and the findings will be of great assistance, especially in relation to issues around Brazil's pre-salt layer.

The country has exploited its vast natural resources and huge labour pool to become Latin America's leading economic power and the discovery of several extensive gas fields in the pre-salt layer has opened a new chapter of growth opportunities.

I was in Brazil in September, when I delivered a paper entitled 'Pre-Salt Compliance With International Standards for New Corrosive Environments' at Rio Oil and Gas 2012, an event supported by UK Trade and Investment Brazil.

Perhaps the biggest challenges lie in ultra-deepwater exploration. The water depth challenges are complicated by high pressures and high temperatures, as well as by the difficulties of drilling through the salt layer. If these issues can be overcome, Brazil is on course to become one of the leading stakeholders in the oil and gas industry.

The pressing need to ensure longevity of pipelines

If equipment can be made to last longer as a result of good corrosion management techniques, then this will create greater profitability for the operator. If you use carbon steel, you must nurse it by using good welds, good coatings, good cathodic protection and good material.

One of the biggest challenges faced by corrosion and coatings professionals and the industry is how to transport sequestered (dense phase) carbon dioxide. It contains impurities such as nitrogen oxides (NO_x) and sulphur oxides (SO_x) which are produced particularly from coal-fired power stations.

To bring the impurities down to levels below which they have a negligible effect on corrosion is currently not cost effective. However, considerable research in Europe is being conducted into managing this issue.

Carbon capture and subsequent storage is a European Union driven initiative, but we are lagging behind the USA, given that the transportation of Dense Phase CO₂ has been undertaken for some years. The difference in the UK and Europe is that the product contains acidic gas impurities, which increase the corrosion rate of carbon steel substantially.

One concept is to use existing pipelines to transport the CO₂ into spent aquifers. These existing pipelines are made of carbon steel and recent research in European laboratories has highlighted the important point in that carbon steel will require some form protection, probably a new form of coating.

The alternative could be to lay new corrosion-resistant pipelines, but the huge costs are likely to prove prohibitive. The European Union says any solution must be carbon neutral, and laying new CRA pipelines is certainly not that.

Why solutions must be found – and quickly

So what is the solution? For existing pipelines, could an in situ lining be installed? To my knowledge no such system has been used that can line an old pipeline of 10 kilometres or more. The liner would likely be in sections, which then poses the question how to join the sections remotely?

This is a cross-industry technical challenge, where coating manufacturers, applicators and users need to join forces and pool knowledge to develop a solution.

In my opinion, this is a high priority concern. Both NACE International and the European Federation of Corrosion have set up working parties and groups to provide forums for discussion and exchange of information. There is an urgent and pressing need for the industry to engage and move swiftly forward. Perhaps a European joint industry project could be the solution.

The BSI, of which I am a member and represent NACE Europe, recently formed a Carbon Capture, Transport and Storage Committee. ISO has a similar committee which the BSI group will interface with, but ultimately the intention is to produce a report outlining the way forward. I very much hope this is published sooner rather than later and can be shared with the industry to deliver a much-needed route-map to address this crucial issue.

New developments in the industry

The latest innovation in pipelines is the development of sour-resistant high-strength carbon steel. This needs a great deal of serious work to establish if these grades can ever be resistant to sour service. The advantage of high grades is that they are lighter, which means substantial cost savings can be made. The downside is that they are susceptible to cracking.

Vital areas for testing

An issue that must be addressed urgently is Stress Orientated Hydrogen Induced Cracking (SOHIC). Alarmingly, the Standard's guidelines set out a wide variety of tests that do not include SOHIC, and the relevant section finishes with the phrase 'and others under development'. This Standard was first published in 2003 after nine years' hard work between ISO work group 7 members and the industry itself. Now, for the first time, a dedicated test method is available.

SOHIC is a cracking mechanism that only affects carbon and low-alloy steels in wet sour service. At least nine pipelines over the past 20 years have failed as a result of SOHIC and the mechanism has been evident in numerous pressure vessels. In addition, this type of crack has been found largely, though not exclusively, adjacent to a weld. One reported failure was in a seamless pipe and residual stress is thought to have played a key role in the crack's initiation.

This form of cracking is characterised by a through-wall stacked array, resembling a ladder, which is why its early name was 'ladder cracking'. First seen in the early 1980s it is only fairly recently that a test method has been defined that can effectively determine a material's susceptibility to this type of mechanism.

This means work to determine which variables are important can begin. It had been thought for many years that SOHIC testing required a new method and sample configuration.

Answers are in the pipeline

Exova has now completed a project that began eight years ago, with the aim of finding a solution to this problem. Put simply, a pipeline sample has to be bent and twisted to simulate the residual stress next to a weld. The control and level of the loading has also finally been solved, which means we can reproduce a 'live' environment producing test results that are even more robust.

It has been shown that materials susceptible to SOHIC do, indeed, crack in this way, and materials that are resistant to SOHIC do not crack, ultimately resulting in a go/no-go test being developed.

So, what are the variables that now need to be considered? The obvious starting point is microstructure. We can probably point to a number of microstructures that are more susceptible than others – but which ones? Next to consider is steel chemistry. Do additions of micro-alloying elements help or hinder? One variable that should never be overlooked is hardness. For example, is there a ceiling or even a lower limit of hardness where SOHIC does not occur?

These are questions that can now be addressed, and ones that my team is now working on, to provide the oil and gas industry with much needed answers. It looks as if we are 18 months away from finding out. However, some of the initial results will be presented and shared at the NACE Conference in Orlando, Florida, in March 2013 at the Oil and Gas symposium.

The long term outlook for corrosion management

I firmly believe prospects for our industry are bright – providing we can persuade people at board room and government levels of the compelling need for long term approaches, as opposed to quick win returns. Equally importantly, the future prosperity of our sector hinges on our commitment to educating coming generations of metallurgists, corrosion engineers and – vitally – corrosion managers. If we can go some way to accomplishing these aims, we can look ahead with justified optimism.