Corrosion College

Preventive Strategies

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Why Do You Need A Strategy to Prevent Corrosion?

Because there is tough news about corrosion.

- Corrosion causes more than $1 trillion dollars of damage every year.
- Additional lost revenue and costs of corrosion damage — including system downtime and liabilities related to catastrophic failures including loss of life — are hard realities even when not statistically tracked.

Every dollar has to count or the problem will continue to grow. That's why a corrosion prevention strategy is necessary.

Because there is also good news about corrosion.

- A study by the Executive Branch and Government Accountability Office underscores the fact that although corrosion cannot be eliminated — it can be prevented — and doing so could eliminate more than 40% of the costs of current corrosion damage!
- A major part of prevention is proper product selection based on understanding the precise requirements of any given job and matching them with the best available anti-corrosion products. Proper specifications can help reduce downtimes by 50% or more and can contribute to extended service life. By eliminating product failure you eliminate the staggering costs of downtime, safety hazards, replacement costs, and related liabilities.

That's why you need a Corrosion Prevention Strategy.

The following paper: PREVENTION STRATEGIES by JOE H. PAYER, PH.D. AND RONALD LATANISION PH.D. was originally published by NACE and has been reprinted with their permission to help guide you toward a corrosion prevention strategy that will enable you to effectively fight the high costs of corrosion damage.

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Introduction

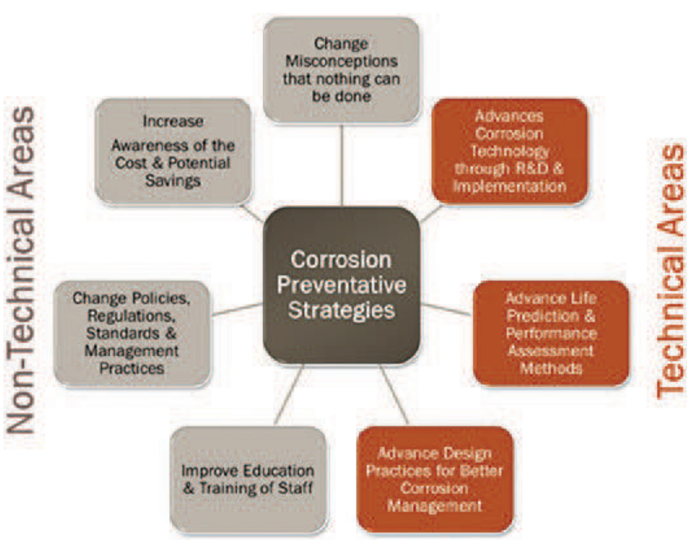
The goal of preventive strategies is to use the opportunities to improve corrosion control in all economic sectors, resulting in increased integrity, durability, and savings. Benefits, approaches, and some specific recommendations are made for the following opportunities for improved corrosion practices:

Preventive strategies in non-technical areas:

1. Increase Awareness of the Considerable Corrosion Costs and Potential Savings.
2. Change the Misconception That Nothing Can Be Done About Corrosion.
3. Change Policies, Regulations, Standards, and Management Practices to Increase Corrosion Cost-Savings Through Sound Corrosion Management.
4. Improve Education and Training of Staff in Recognition of Corrosion Control.

Preventive strategies in technical areas:

5. Advance Design Practices for Better Corrosion Management.
6. Advance Life Prediction and Performance Assessment Methods.
7. Advance Corrosion Technology Through Research, Development, and Implementation.



Preventive Strategies in Non-Technical Areas

Strategy 1. Increase Awareness of the Considerable Corrosion Costs and Potential Savings

Issue

A majority of studies regarding the costs of corrosion reveal that the costs of corrosion to the U.S. economy could be significantly reduced if available corrosion control technologies were implemented. Many corrosion problems go unresolved due to a lack of awareness from management and/or those responsible for operation, inspection, and maintenance of an engineering system. Today there is an even greater need for corrosion cost awareness given the rapid pace at which new engineering systems find their way into the marketplace.

Benefits

In addition to cost-savings, properly implemented corrosion prevention technologies can extend the life of engineering systems. The inefficiencies in corrosion management represented by poorly implemented corrosion control strategies can be substantially reduced with increased awareness.

Approach

An important issue is to find ways of engaging those who have a "need-to-know" regarding corrosion engineering, but are not necessarily trained in this field. Historically, short courses are one method for such interactions to occur. The emergence of such tools as distance learning and interactive software present another dimension to training. Similarly, the formation of a corrosion engineering analog of the historically important agricultural extension stations may serve this purpose well.

Recommendations

1. Prepare and disseminate case histories and technology briefs that document corrosion costs and demonstrate the benefits of sound corrosion control practices. In addition to engaging the engineering community, the challenge is to engage policy-makers as well as

the general public. The latter should not be cast as warnings of impending problems, but rather as a deliberate attempt to express the reality regarding the lack of knowledge in corrosion control and costs. This has to be done at a level that stockholders and the public can understand and appreciate.

2. Inform the general public about corrosion costs and the nature of the opportunities for controlling corrosion, so that they will be able to make informed decisions themselves, where possible. The general public must also be alert to the potential possibilities of corrosion control and remind designers and maintenance managers about corrosion. Information on corrosion could encourage a change in public practice. For example, automobile coolants lose their corrosion inhibition characteristics after approximately 2 years of use. Car owners are likely to react to information that they would save themselves a great deal of trouble and money later by changing the coolant at regular intervals.

Strategy 2. Change the Misconception That Nothing Can Be Done About Corrosion

Issue

There is a widely held misconception that nothing can be done about corrosion. If progress is to be made, there not only has to be a greater awareness of opportunities for corrosion cost-savings, but there must also be a recognition that effective means are available to realize those savings. There are technical issues that require attainable advances in corrosion technology and more effective dissemination and implementation of available corrosion control technology. In addition, there are non-technical issues of perception, policy, and practices for improved corrosion control.

Benefits

The benefits include direct and indirect corrosion costsavings through more effective and widespread application of sound corrosion control. With a proper perception that opportunities for corrosion cost-savings exist, informed decisions can be made. Hence, viable options can be considered regarding corrosion-conscious designs and operating/maintenance practices to preserve and extend the life of structures.

Approach

As in the prior strategy, the approach is to find ways of engaging those who have a "need-to-know" regarding corrosion engineering. The programs are directed toward the education of several different constituencies, including policy-makers, operation and financial managers, technical and operating staff, and the general public. Multimedia delivery of educational pieces is recommended.

Recommendations

1. Prepare and disseminate case histories and technology briefs that document corrosion costs and demonstrate the benefits of sound corrosion control practices to policy-makers, management, and technical staff. In addition, well-documented cases supported by cost/benefit analyses demonstrate savings from proper corrosion control or excessive costs from inadequate corrosion control. The implementation methodology, as well as the technology, should be documented.

2. Prepare and disseminate effective public awareness pieces to document successes in corrosion control, such as the advances in corrosion resistance of body panels in automobiles. The public must be convinced of the benefits of corrosion control. A great deal of planning is required in order to portray this information to the public via media sources. Past successes with improved nutrition, cancer prevention, and similar campaigns show that public education is possible, but not easy.

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Strategy 3. Change Policies, Regulations, Standards, and Management Practices to Increase Corrosion Cost-Savings Through Sound Corrosion Management

Issue

There is a definite disparity in the application of effective corrosion control among industrial sectors and among entities within an industrial sector. When available corrosion control technology is not applied, opportunities for corrosion cost-savings will be missed. There is often a disparity between those who control corrosion costs and those who incur the costs. This can lead to a mentality of "build it cheaper and fix it later" and a disregard for lifecycle costs. The situation is further exacerbated when the builder is not made responsible for the "fix-it" costs.

Benefits

More effective corrosion control provides a safer and more reliable operation. The service life of structures and equipment is preserved and extended. These all result in significant cost-savings. Promoting sound technical practices along with corresponding management practices and policies will provide the driving force for implementing corrosion control procedures leading to cost-effective operations.

Approach

The approach is to identify the barriers that impede the application of sound corrosion control and stimulate more widespread use of effective corrosion control. The following criteria are suggested for the evaluation of current and proposed policies that can impact corrosion management.

1. Goal attainment - Does the policy achieve the goal?
2. Economic efficiency - Is the net benefit of the policy (benefit achieved by the policy minus the cost of implementing the policy) positive?
3. Equity - How does the policy affect income distribution?
4. Transparency - Do those involved understand the policy in terms of implementation and those who are affected by implementation?
5. Administrative simplicity - Is the policy feasible in terms of administration? Administrative work is examined for its cost complexity, elaboration, and/or level of confusion.

It should be noted that the development of governmental and industrial policies can benefit and encourage sound corrosion control management and implementation.

Recommendations

1. Compile and disseminate the state-of-the-art information through federal government agencies such as DOT, DOD, and DOE, as well as through the state and local governments.

   These agencies regulate, finance, and provide information relevant to corrosion design and maintenance for structures in both the public and the private sector, and spend billions of dollars each year on structures that are subject to corrosion. With this type of action, these agencies will realize the savings and the improved services that result from designing for corrosion and managing it better.

2. Create accounts for maintenance and inspection that would ensure that corrosion maintenance and examinations were performed on time and effectively.

3. Change tax policies to eliminate bias against sound corrosion control practices. Current tax policies treat investment and maintenance costs differently. Investment costs are written off over a period of time, while maintenance expenditures are recognized as costs in the year that they are incurred.

   The intricacies of tax policies are rather complex; however, it is important to point out that the current tax policies bias decisions regarding corrosion control. Being able to expense maintenance expenditures while having to depreciate investment expenditures over many years wastes the nation's resources and at the same time imposes a significant inconvenience on the public due to premature corrosion-induced deterioration. The tax system needs to change in order to encourage more investment in improving the corrosion performance of structures and other capital items.

4. Critically review government regulations for their impact on corrosion costs. Myriad regulations at the federal, state, and local levels affect corrosion design and management. The regulations are intended to help the public; however, due to a lack of consideration of important factors regarding corrosion design and management, undesirable consequences may result. The impact of regulations on corrosion control practices and the costs of corrosion are often overlooked. With the added perspective of corrosion costs, the true cost/benefit balance of a regulation can be significantly changed.

   Regulations need to be reviewed and analyzed to uncover any and all implications for corrosion management. Those regulations that are outdated or skewed because they were formulated without considering their implications for corrosion need to be reconsidered. For example, the Environmental Protection Agency (EPA) has universally banned the use of chromates because of their threat to the environment and human health. However, chromates are also known to be among the most effective corrosion inhibitors. In fact, in some applications, there is no close alternative. Rather than an outright ban of these compounds (no-risk approach), the regulation should allow examination of specific cases using a benefit/risk framework. There are probably some applications where the use of chromates results in greater public benefits than its replacement. In these applications, the use can be controlled so that little or none of the compounds result in environmental discharge or human exposure.

5. For large federal programs, the regulations should be justified by cost/benefit analyses. For regulations relevant to materials and structures, the corrosion costs should be included in the cost/benefit analysis.

6. Many aspects of professional behavior are affected by voluntary standards, such as those by NACE, ASTM, and ISO. Corrosion design and management should be given greater attention in the development of voluntary standards. These standards often have a significant impact on regulations. For example, NACE developed a voluntary standard for cathodic protection of pipelines that was subsequently adopted by the Office of Pipeline Safety.

Strategy 4. Improve Education and Training of Staff in Recognition of Corrosion Control

Issue

Most engineering students have little or no exposure to corrosion science and engineering during their education. Despite broad recognition that engineering systems cannot be built without materials and that the performance of those systems are intimately associated with the chemical stability of the materials of construction in service environments, universities do not generally require materials science and engineering courses for their engineering students. In addition, courses on corrosion engineering are similarly not required for engineering majors. The same is true at the technical-staff level as well.

Benefits

A case could be made that, in terms of the technical literacy of an engineer (whether a chip designer or a bridge operator), materials are important and, therefore, belong as a course of study in every engineering discipline. The importance of corrosion science and engineering needs to be introduced as a corollary that affects the performance and the life of engineering systems of all kinds. Implementation of corrosion engineering into a core engineering curriculum would result in a greater awareness in engineering students of the benefits of corrosion engineering.

Approach

There is an opportunity in contemporary engineering schools to make the above case with particular reference to life prediction. Engineering systems of all kinds – from bridges, power stations, and other civil engineering structures to airframes and thin-film electronic and optical devices – are being asked to perform beyond their nominal design lives. The question of residual life is of increasing importance in our economy and political environment. Since materials corrosion (not just metallic corrosion) is a determinant in all such cases, a vigorous, well-planned campaign to engage engineering schools should be a top priority.

Recommendations

1. It is likely that the implementation stage would involve both initial correspondence and then follow-up visits with the leadership of a few targeted deans of engineering.

2. Develop and incorporate modules on corrosion prevention and control into engineering and management curricula. Knowledge regarding corrosion management, including designing for corrosion mitigation, should begin in the undergraduate curriculum and be part of the exam to become a certified professional engineer. Since there is typically no space in the undergraduate curriculum for additional required courses in corrosion, NACE (or other entities) needs to give increased attention to designing "modules" to be worked into the curriculum for awareness and treatment of corrosion. In addition to engineering knowledge, corrosion engineers need further training in engineering economics in order to be able to evaluate options for corrosion management designs, practices, and their consequences. Such training would allow corrosion engineers to advise decision-makers, both at the design phase and during operations and maintenance.

3. Incorporate a pilot program for the corrosion modules in a few specific universities. Efforts should be coordinated with the deans of engineering and the deans of business/management at these universities.

CorrDefense

The Office of Corrosion Policy and Oversight is responsible for addressing the needs and meeting the goals of the DoD's Corrosion Prevention and Mitigation Program. The Corrosion Office develops Corrosion Prevention and Control (CPC) strategies for the DoD, and oversees their implementation through the CPC Integrated Product Team (CPC IPT)

NACE® INTERNATIONAL

NACE International was established in 1943 by eleven corrosion engineers from the pipeline industry as the "National Association of Corrosion Engineers." The founding engineers were originally part of a regional group formed in the 1930s when the study of cathodic protection was introduced. Since then, NACE International has become the global leader in developing corrosion prevention and control standards, certification and education. The members of NACE International still include engineers, as well as numerous other professionals working in a range of areas related to corrosion control.

Preventive Strategies in Technical Areas

Strategy 5. Advance Design Practices for Better Corrosion Management

Issue

Design practices often fail to even consider corrosion; therefore, avoidable corrosion costs are incurred. There are two facets of the problem. First, design engineers, generally mechanical, chemical, and electrical engineers, have an inadequate understanding of materials/ environmental interactions and the various corrosion modes. Second, lifecycle costs or total ownership costs are often not considered in the design phase.

Benefits

Advance design practices increase reliability and safety, reduce costs, and conserve materials and energy.

Approach

Change the design paradigm. Make the currently "best practice" corrosion control technology available to the designers. Include corrosion performance in the design criteria, and promote life-cycle and total ownership cost analysis.

Recommendations

1. Provide designers with an understanding of corrosion performance and corrosion control methodologies. Develop and provide designers with effective databases and design tools for optimum corrosion management.

2. Educate current design engineers, corrosion engineers, and maintenance managers regarding the importance of and potential savings from proper corrosion management. A corrosion engineer needs to do more than offer the judgment that "corrosion management pays." The corrosion engineer must be prepared to demonstrate an attractive return on investment for designing for corrosion and corrosion management, as well as improving service and reliability. This requires knowledge of engineering economics that allows the corrosion engineer to perform economic calculations (such as a life-cycle cost analysis and a cost/benefit analysis). Corrosion engineers must be able to determine design and maintenance practices that reduce corrosion, as well as evaluate these practices to inform decision-makers.

ASTM International, formerly known as the American Society for Testing and Materials (ASTM), is a globally recognized leader in the development and delivery of international voluntary consensus standards. Today, some 12,000 ASTM standards are used around the world to improve product quality, enhance safety, facilitate market access and trade, and build consumer confidence.

Intertek is one of the world's largest testing, inspection, and certification organizations. Companies like Intertek create and regulate standards that help specifiers ensure products perform as expected.

Strategy 6. Advance Life Prediction and Performance Assessment Methods

Issue

At present, life prediction and performance assessment determinations are often uncertain because of the uncertainty of all variables that affect corrosion. Hence, the corrosion behavior can often not be adequately assessed or predicted with currently available tools. Inadequacies include the determination of the extent and severity of corrosion damage, the projections of the rates of corrosion, and the evaluation of the effects of alternative remedial actions.

Benefits

Life prediction and performance assessment methods can result in an increase in reliability and safety, a reduction in cost, and conservation of materials and energy. As a result, more efficient and effective life prediction and performance assessment analyses can be performed.

Approach

Technological advances in inspection methods and procedures are required to advance technology. In addition, accelerated test methods are required to test new materials in a short period of time. Improved understanding and modeling of corrosion processes are also required. Improved methods for monitoring service performance are required and experimental databases to support life prediction must be developed.

Recommendations

Carry out coordinated programs to address life prediction and performance assessment in high-priority areas, such as highway bridge structures, pipelines, and aircraft. Provide sufficient resources for technological advances and for transferring the technology and the methodology into practice.

Strategy 7. Advance Corrosion Technology Through Research, Development, and Implementation

Issue

Many of the industrial establishments that have been historically known for materials research in terms of the basic industries, including corrosion-resistant alloys, have abandoned their research and development programs. On the other hand, emerging industrial sectors, such as electronics, opto-electronics, biomaterials, and waste treatment, put high structural and environmental demands on materials of construction with low levels of corrosion tolerance.

While this presents opportunities for proper corrosion management, the reality is that many of the emerging industries are populated by people who are unaware of the limits of materials in engineering service. Hence, there is a need to support the corrosion engineering research and development needs of the basic industries, to cultivate awareness through education and training, and to encourage a critical-mass research and development effort in certain emerging areas of technology.

Benefits

Some emerging technologies cannot be commercialized without success in solving corrosion engineering problems. For example, before supercritical water oxidation of chemical wastes can be implemented, corrosion issues with container materials need to be resolved. Another example where corrosion issues played a major role in the implementation of a new technology is the now-defunct work on magnetohydrodynamic (MHD) energy conversion. This initiative will permit implementation of useful and necessary advanced technologies that are otherwise restricted by unsolved corrosion problems.

Approach

The need for a critical mass effort, whether in terms of the basic industries or in terms of emerging technologies, suggests the value of the formation of industrial organizations that could serve to sponsor research and development work that no single company could afford to take on by themselves. Examples of such organizations are the Electric Power Research Institute (EPRI) serving the electrical utility industry, Gas Technology Institute (GTI) and Pipeline Research Council International (PRCI) serving the gas transmission industry, and the Material Technology Institute (MTI) serving the chemical process industry. For highway structures, the National Cooperative Highway Research Program (NCHRP) performs research funded by the states in cooperation with the Federal Highway Administration (FHWA).

Recommendations

1. Other industries that could also benefit from "joint industry" programs include the automotive, aircraft, and electronics industries. Although it has been shown that improved design and maintenance practices have significantly reduced costs and disruptions due to corrosion, these industries would greatly benefit from joint industry programs to develop and implement new technologies. Specifically, significant benefits will be gained from a joint industry program to develop technologies for improved corrosion resistance of electrical and electronic equipment, which would benefit a broad range of industry sectors, notably the automotive and aircraft industries.

2. Corrosion research has, over the years, suffered from inadequate industry and government funding, especially given the cost and the inconvenience associated with corrosion of water mains, bridge structures, automobiles, airplanes, and pipelines. In contrast, physicists and biologists have captured the attention of the public and Congress by describing the dynamics of high-energy physics and biotechnology. While not as noteworthy to the popular press as some other technologies, corrosion research has much to contribute to delivering social services more efficiently and more reliably while lowering the costs of many of the products and services purchased by the public. It is therefore recommended that in addition to the above recommended joint industry programs, more government funds should be made available for corrosion research. This report has shown that devoting more resources and more attention to corrosion research and practices results in a high return.

As cited in the Federal Highway Administration report, one of the major reasons for the corrosion epidemic that we now face is that most engineering and science students have little or no exposure to corrosion science and engineering during their education. Only in the last few years have academy added programs on Corrosion. Currently, there are four graduate level academic corrosion centers in the U.S.: 2 in Ohio, 1 in Pennsylvania, and 1 in Virginia. There is one undergraduate corrosion center in Ohio and one graduate level center abroad located in Manchester, UK. Other means of training have come from a two-year training program for corrosion at Kilgore College in Texas and several training courses and certifications offered by the National Association of Corrosion Engineers (NACE).

Corrosion College Can Be Your Partner In Achieving An Effective Corrosion Prevention Strategy!

Corrosion College is a hands-on short course that provides proven solutions for the prevention of industrial corrosion through classroom and hands-on experience. Grants of 1.5 CEUs are available to participants upon successful completion.

Corrosion College provides hands-on experience in understanding the process of corrosion through two days of intensive instruction conducted by professionals in the field of corrosion protection. Corrosion College helps participants explore and understand proven strategies for combating corrosion. ♦

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