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Corrosion Management System in China

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Abstract: Corrosion management is vital to safety production, national economy, ecological civilization, resource conservation, and national construction. Although a few industries have conducted some beneficial exploration and practice in corrosion management, the overall development of corrosion management in China is extremely inconsistent, and there exist problems such as poor awareness of corrosion management, shortage of professionals, and imperfect management systems. Therefore, it is necessary to further explore the concept of corrosion management and clarify the basic requirements for the systematic development of corrosion management in China to promote the sustainable and healthy development of the corrosion management system in China. Based on the major achievements of the Chinese Academy of Engineering consulting project, "Strategic Research on the Status and Countermeasures of Corrosion Management in China," this paper expounds on the corrosion management concept and significance of the systematic development, analyzes the current status and problems of corrosion management in China, summarizes the main points, and proposes the basic framework of the corrosion management system. Moreover, we propose several countermeasures to promote corrosion management, such as incorporating corrosion management into the national security strategy, strengthening the training of corrosion personnel, improving corrosion protection laws and standards, strengthening the construction of corrosion databases, building an information exchange platform, and creating a new mode of shared management.

Keywords: corrosion management; corrosion management system; corrosion protection; corrosion control; corrosion safety

1 Introduction

Metals play an irreplaceable role in various fields, including metallurgy, energy, transportation, and infrastructure, owing to their excellent physical, chemical, mechanical, and technological properties. However, corrosion is an important factor that restricts the service safety and service life of metal equipment and facilities. The investigation results of the "Research on Corrosion Management Situation and Control Strategy in China," a major consulting project of the Chinese Academy of Engineering, demonstrated that the cost of corrosion in China accounted for approximately 3.34% of the GDP in 2014, which was as high as RMB 2.1 trillion [1]. An approximation based on the 2020 GDP (RMB 101.5986 trillion) [2] is close to RMB 3.4 trillion. Material corrosion may cause huge economic losses, and severe corrosion may result in catastrophic accidents such as damage to equipment and facilities, leakage of toxic media, fires, and explosions, causing irreparable losses to the safety of human life, environment, and society.

Although material corrosion is inevitable, a solution to this problem is not implausible. It is estimated that 25% to 40% of corrosion losses could be avoided if effective corrosion control strategies are adopted [1]. A lot of practical

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experience has demonstrated that advanced anti-corrosion technology exhibits a good protective effect on equipment and facilities, and that effective management measures can reduce the loss of corrosion, which is equally as important.

Under the new situation in which China's economic development is shifting from high-speed growth to high-quality development, General Secretary Xi Jinping has issued important instructions on safety production and deeply discussed major theoretical and practical issues, such as safety production lines, safety development strategies, and safety production responsibility systems. Therefore, enhancing the protection of material corrosion, improving corrosion management methods, and promoting the systematic development of corrosion management for the sustainable and healthy development of the social economy and long-term stability of the country are essential.

Corrosion management is a means to reasonably control corrosion risks by comprehensively coordinating the management level of an organization, such as policies, objectives, and procedures, and the technical level, such as plans, standards, and protection technologies [3,4]. There is a sharp difference between corrosion management and anti-corrosion engineering. Corrosion management refers to technically controlling the occurrence and spread of corrosion, as well as generally cultivating corrosion management consciousness from the perspective of companies. This refers to comprehensively grasping the corrosion status of equipment during the entire lifecycle, properly dealing with corrosion accidents, deeply analyzing experience and lessons, and cultivating corrosion management personnel. Additionally, it refers to forming forward-looking, scientific, joint, sharing, and continuous management modes through scientific analysis of the return on investments and engagements in the management activities of assets during the entire lifecycle.

Through the forward-looking and scientific corrosion management, incidences of corrosion problems of equipment are significantly lowered, inspections and maintenance cycles are prolonged, working efficiencies are considerably improved, and corrosion costs are significantly reduced [5–8]. Corrosion management has achieved remarkable results in reducing corrosion costs, improving work efficiency, ensuring equipment safety, and saving energy and resources. However, corrosion management is still in its early stages in China, where no systematic management mode is observed; an extensive management mode makes it difficult to comprehensively manage the corrosion of equipment. Therefore, this study explores difficulties and pain points of corrosion management in China based on investigation and research, and analyzes the weaknesses and loopholes of corrosion management in China to identify the basic requirements for the systematic development of corrosion management in China and develop related policies, regulations, and standards of corrosion management; thus improving the corrosion management level in China.

2 Current status of corrosion management in China and other countries

2.1 Current status of corrosion management in other countries

Scientific researchers and technical management personnel of enterprises all over the world are actively engaged in the protection of materials against corrosion and the exploration of corrosion management methods. As early as the 1970s, some developed countries such as Japan, the United Kingdom, and the United States proposed their opinions and suggestions on corrosion management according to the results of corrosion investigations, and gradually formed effective corrosion management modes through practice and improvement.

In 1977, after conducting a domestic corrosion survey, Japan proposed suggestions to strengthen information dissemination, intensify the training of professional engineers, and improve the monitoring and detection technologies of corrosion protection. Subsequently, several corrosion investigations were conducted, and corrosion management methods were proposed regarding the establishment and improvement of the corrosion protection professional qualification certification system and implementation of the corrosion cost minimization strategy [1].

In the 1960s, the United Kingdom proposed four major reasons for serious corrosion problems in a report of corrosion investigation, namely, lack of foresight in management, poor information exchange, minimization of initial investment, and insufficient knowledge of corrosion protection. Various ideas and methods related to corrosion management were simultaneously put forward, such as increasing the investment in corrosion protection education, improving material design, predicting material durability, and promoting the standardization of components.

Since 1949, the United States has implemented various effective methods to reduce the cost of corrosion as a result of conducting several corrosion investigations. In 2013, based on the global corrosion survey, the National Association of Corrosion Engineers innovatively proposed the corrosion management system, which clarified the main elements involved in corrosion management work and the development principles and implementation methods of corrosion management work. In addition, financial tools such as "cost increase method," "lifecycle cost method,"

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"bundle optimization method," and "maintenance optimization method" were proposed to scientifically evaluate the return on investment of corrosion protection work, which further promoted the systematization of corrosion management [4].

2.2 Current status of corrosion management in China

China was one of the first countries to pay attention to the problems associated with corrosion. Since the 12-Year Long-term Plan for Science and Technology Development was formulated in 1956, China has considered the corrosion problems to be a topic of importance. In the mid-1980s, the China Industry Anticorrosion Technology Association proposed the concept of comprehensive corrosion control, which is centered around the organic combination of corrosion control technology and corrosion control management. This allows for comprehensive control of all types of corrosion from the five aspects of design, manufacturing, storage, transportation and installation, and operation and maintenance, and from the four links of education, scientific research, management, and economic evaluation [9].

As a typical example of corrosion control practice in an all-rounded manner, Sinopec Zhongyuan Oilfield, inspired by the comprehensive corrosion control theory, formulated the corrosion prevention work policy, established a system of rules and regulations, and facilitated the implementation, supervision, review, and improvement of the work, thus significantly reducing the frequency of corrosion problems and the resulting corrosion cost at the end of the 20th century [5].

After continuous exploration and practice, China has gradually established special corrosion research institutions and science and education units, and the scientific research teams have been developing and expanding, which has laid a solid foundation for the development of corrosion prevention work. Some industries that are heavily affected by corrosion have effectively controlled corrosion by developing special corrosion protection institutions, training professional corrosion technicians, building corrosion monitoring networks, and establishing corrosion protection files [6–8]. The railway system has significantly prolonged the overhaul period of vehicles through reasonable material selection and improvement of protection technology. A nuclear power plant in China has adopted microcomputer management, established corrosion and protection technical files, and used comprehensive anti-corrosion measures to tackle corrosion-related issues. Consequently, the corrosion control costs have been significantly reduced (accounting for 4%–6% of the maintenance cost of nuclear power plants), and the economic benefits have been considerably improved. The exploration and practice of comprehensive corrosion control has paved the way for the improvement of corrosion management, thereby accumulating valuable experience.

However, the development of corrosion management in China is in its early stage, in addition to being unbalanced. There are still various companies that are unable to put corrosion management into practice, or at an exploratory stage. The establishment and improvement of the management system still need to be further explored and implemented.

3 Problems in corrosion management in China

3.1 Poor awareness of corrosion protection

Awareness is a key factor in guiding practice. It has been determined that the weak awareness of corrosion prevention is the primary factor that hinders the development and improvement of corrosion management. Corrosion is a type of destruction that is carried out quietly, which is both dangerous and not easily detectable before a breakout occurs. The initial investment in corrosion protection is relatively large, and the return on investment is difficult to be observed in the short term. Therefore, the problem of material corrosion management is often not given due attention.

3.2 Lack of corrosion management systems or difficulty in implementation

The establishment of a corrosion management system is an important guarantee for the development of corrosion management. However, the establishment and implementation of an anti-corrosion system is not satisfactory in actual production activities. Most organizations are in a passive state of considering flexible countermeasures according to specific circumstances regarding the management of corrosion problems. The management method is relatively extensive, lacks an effective corrosion management system, or it is difficult to implement due to various constraints, which makes corrosion management unattainable.

3.3 Lack of corrosion monitoring systems, regular inspection, effective corrosion data management, and analysis

Optimal corrosion monitoring and detection could effectively prevent the corrosion of equipment and facilities. The monitoring and testing data could be collected, stored, and analyzed through the corrosion data management and analysis system, which could predict the corrosion tendency, evaluate the return on investment of the anti-corrosion project, detect and solve the problem of corrosion, and provide data support and reference for the corrosion management. It was previously determined that most organizations were not equipped with monitoring devices or if they were, blind spots existed and they were unsystematic, with low corrosion data collection and utilization rates, lack of scheduled detection and other problems, therefore resulting in difficulties in the timely detection of corrosion.

3.4 The urgency of establishing a database of corrosion failure cases

The corrosion of materials does not occur accidentally or individually; it is often universal. Corrosion accidents of similar equipment or equipment under similar service conditions are often of important guiding significance for the corrosion management of other equipment. It is observed that most organizations lack timely summary and continuous iteration of corrosion protection experiences, meaning instances of corrosion failure are perceived as an isolated accident in the entire lifecycle of the equipment.

3.5 Shortage of corrosion management talents

Skilled personnel are the primary resource. The shortage of corrosion management talents is an important bottleneck for the further development and improvement of corrosion management. Corrosion science, as an interdisciplinary subject involving multiple disciplines was developed late, implying the education and training of corrosion professionals was delayed; consequently, the professional team is small in scale. This has resulted in a certain talent vacancy. Conversely, various practitioners lack professional qualifications, resulting in significant uncertainties to corrosion management. Currently, there are relatively few organizations equipped with professional corrosion protection personnel. The corrosion management work of most organizations is concurrently performed by the equipment operation personnel and maintenance and production department, which has hindered the work efficiency of the organizations' corrosion management to ensure significant long-term improvements.

3.6 Lack of effective communication mechanism and information exchange platform

Effective communication is productive. It is observed that a breakdown of communication and information exchange is an important factor causing the barriers of corrosion management. Each link has its own role, and the lack of effective communication and comprehensive evaluation makes it difficult to form an organic, integrated, and linkage management mode, which is not conducive to promoting the development and progress of corrosion management. In addition, the shackles of communication and exchange have also caused the disconnection among production, education, and research, which hinders the promotion and application of new corrosion protection technologies, and is not conducive to the establishment and improvement of corrosion management systems.

4 Connotation and significance of corrosion management system

A set of improved and systematic management systems with wide applicability should be established to manage the corrosion problem through the objectives, systems, and procedures to better guide the corrosion management work of organizations. The corrosion management system should be rich in connotation and continuously developed and improved in the process of practice [1,4,5].

4.1 Forward-looking management

Forward-looking management is the core of corrosion management, and emphasizes initiative and prevention. "Safety first, prevention first, and comprehensive treatment" is the basic policy of the production safety management established in China. Systematic and comprehensive effective prevention measures could often eliminate corrosion accidents. The efficient development of corrosion management must be based on firmly establishing proactive management consciousness regarding corrosion prevention, comprehensively mastering the current situation of equipment, clarifying management objectives, taking overall consideration, comprehensively planning and taking active action, and forming an effective planning management mode.

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4.2 Scientific management

Scientific management is important for effective corrosion management, and emphasizes scientific and targeted management measures. Monitoring, testing and forecasting equipment, studying the return on investment, and analyzing the feasibility of anti-corrosion measures require the support from scientific evaluation methods; effective anti-corrosion measures should be taken according to different materials, parts, and service environments of equipment and facilities.

4.3 Big data management

Big data management is the cornerstone of corrosion management, and emphasizes comprehensive and systematic data management. Big data management aims to build a corrosion data sharing platform by establishing standardized corrosion big data warehouses, data modeling, simulations, data sharing, and engineering applications to provide extensive corrosion information regarding prediction of corrosion failure and corrosion prevention design, creating a new mode of corrosion big data management [10].

4.4 Linkage management

Linkage management is the key to the orderly development of corrosion management, emphasizing the whole-staff, whole-process, and whole-range management. Corrosion management is not just a simple process and institutionalization of corrosion prevention methods, but a management system that serves the development strategy of the organization, runs through the development of the organization, and is integrated within the overall management system of the organization. Therefore, corrosion management needs to succeed in top-level design, and comprehensively analyze and make overall arrangements for the management of all links within the entire lifecycle of equipment, in a bid to achieve clear rights and responsibilities. The full mechanisms of participation should be established to break through communication barriers, realize the linkage of enterprises, industries and society, and promote the further improvement of corrosion management efficiency.

4.5 Continuous management

Continuous management is the ability to promote the development and progress of corrosion management, and emphasizes the management concept of continuous and constant improvement. Corrosion management follows the PDCA cycle, namely Plan, Do, Check, and Act. In management activities, according to the working mode of planning, implementing, and checking the implementation effect, successful methods should be summarized and supplemented into the relevant system and standards system; methods with poorer effects in practice, improvements should be made through the mode of re-planning, re-implementing, and re-checking, to form a continuous management mode of cycle and iteration. Ensuring the continuous enrichment of the corrosion management system and presenting a spiraling development trend are only possible if this approach is used.

4.6 Sharing management

Sharing management is an important factor for the systematic development of corrosion management, that can rapidly integrate corrosion management resources and improve the efficiency of corrosion management. Material corrosion and protection work is a fundamental task crucial for future generations, related to the national economy and people’s livelihood and national construction. The development of a corrosion management system is by no means an independent development of one or a few organizations, but an alliance of various industries and fields. In the era of knowledge economy, realizing the complementarity of advantages within enterprises, industries, and regions, through the experience of sharing the corrosion management practice and accident lessons, is significantly important to promote the positive development of industry ecology and achieve remarkable results.

5 Construction of corrosion management system framework

The construction of corrosion management system is a multi-link, multi-level, multi-organization, and multi-field work, which requires concerted efforts of governments, academic groups, industry associations, enterprises, and other organizations to continuously and effectively promote the systematic development of corrosion management. On the basis of summarizing and refining the corrosion management practice of enterprises in China [11–15] and drawing lessons from international management experience [3,4], the basic framework of the corrosion management

system in China has been preliminarily formed (Fig. 1). This aims to inspire and guide organizations to systematically develop their corrosion management in terms of strategic positioning, management target, planning, and process management, while internalizing the connotation and significance of the corrosion management system to externalize it in practice to gradually build an effective corrosion management system with unique characteristics and form a good mechanism of continuous iterative improvement.

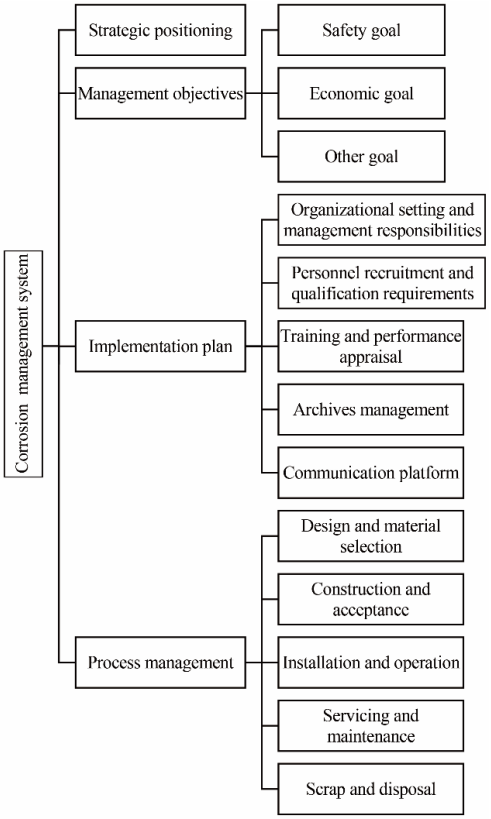

Fig. 1. Basic framework of the corrosion management system.

5.1 Strategic positioning

Strategic positioning is the lighthouse of organization development and the key to determining the direction and prospect of the future development of an organization. An organization should integrate corrosion management into its overall development strategy, based on its overall strategic positioning and development plan, to strengthen the importance and strategic positioning of corrosion management and promote the sustainable and healthy development of the corrosion management system.

5.2 Management objectives

Corrosion management objectives are a specific action guide for corrosion management. The organization shall identify tasks and risks, and formulate the overall and specific objectives of systematic corrosion management on the basis of fully considering and understanding the strategic positioning of corrosion management. Corrosion management objectives should at least include safety objectives and economic objectives, among other objectives. Objectives should be set according to SMART principles, i.e., Specific, Measurable, Attainable, Relevant, and Time-based [16].

5.3 Implementation plan

The implementation plan of corrosion management is crucial in promoting the orderly progress and continuous development of corrosion management, and is also a powerful tool to achieve the objectives of corrosion management. Important components of the corrosion management implementation plan include organizational setting and management responsibilities, personnel recruitment and qualification requirements, and training and performance appraisal.

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5.3.1 Organizational setting and management responsibilities

The setting of corrosion management organization and the definition of management responsibilities form the basis of corrosion management. Top-down division of management responsibilities could often provide the links to form a management network that fixes management loopholes and blind spots. For instance, the stepped structure of specialized corrosion management institutions and posts, part-time posts, and information personnel could fully mobilize the subjective initiative of the organization and form a good ecology of full participation in corrosion management.

5.3.2 Personnel recruitment and qualification requirements

Talent is the first resource, which is the basis and prerequisite to ensure the effective development and continuous iteration of corrosion management. Personnel recruitment should be regarded as the key link of corrosion management, and the recruitment process should be improved, employment conditions refined, and qualification requirements clarified, to build a good personnel structure and management echelon for the development of a corrosion management system.

5.3.3 Training and performance appraisal

Corrosion management is a highly specialized work, and the planned organization of corrosion management training is an important way to cultivate corrosion management personnel and improve enterprise management ability. Reasonable training plans and schedules should be developed according to the actual production and current working ability of personnel, and corrosion management training should be organized for internal employees, third-party organizations, and others, with various organizational forms and a combination of theory and practice. The organization should establish a reasonable performance appraisal system, follow the principle of quantifiable and grading appraisal to set reasonable appraisal indicators for the economic benefits, problems, and disposal of corrosion management and post competency, should specify appraisal procedures and methods, and establish the performance appraisal, supervision, and feedback mechanism so as to provide anchor points for improving the corrosion management work.

5.3.4 File management

File management is an important way to streamline, standardize, and systemize corrosion management work, and is also the basis to ensure the continuous improvement of the corrosion management work. In corrosion management, full attention should be paid to all kinds of documents and data generated within the management process, such as equipment lifecycle files, accident handling records, corrosion failure case analysis files, equipment monitoring data files, and equipment operation specifications related to corrosion management, meetings, training, and system changes. Emphasis should be given to the standardization and timeliness of files, and relevant files and records should be summarized and analyzed regularly, so as to accumulate data and experience for corrosion management, and gradually form an optimal corrosion management mode.

5.3.5 Communication platform

The establishment of appropriate communication platforms and mechanisms could strengthen communication and feedback within the organization and break down communication barriers. Organizations should be dedicated to building a comprehensive management communication platform, which should not only include the communication within the organization, but also communication with the related government departments, scientific research institutions, industrial associations, contractors, suppliers, and other organizations, to obtain external insights through various forms of communication, draw upon all useful opinions, improve utilization of information resources and working efficiency, explore ideas and methods of corrosion management, comprehensively and scientifically evaluate the corrosion management work to guide the adjustment and continuous iteration of the work, promote continuously relevant corrosion management, reform and innovate, and create a new mode of sharing management.

5.4 Process management

The process management that corrosion management advocates involves the whole lifecycle management of the equipment, including design and material selection, construction and acceptance, installation and operation, servicing and maintenance, and scrapping and disposal, so as to form an optimal management mode without blind spots, to grasp the whole lifecycle management of the equipment, and implement the most economic and effective

anticorrosion measures according to realistic circumstances.

5.4.1 Design and material selection

For the research, development, and design of new equipment, it is necessary to make reasonable material selection and refine the design, preset engineering that supports anti-corrosion, formulate the evaluation system for the design scheme, comprehensively evaluate the rationality of the design scheme, strictly control, and successfully manage the corrosion of the equipment from the source.

5.4.2 Construction and acceptance

Organizations should strictly standardize and review the construction process of equipment, formulate detailed construction plans, propose reasonable acceptance criteria, supervise the whole construction process, organize a comprehensive review after the project is ended, and control the whole process of construction to avoid secondary damage to the equipment in the construction process and reduce additional corrosion risk. All processes related to the construction of the equipment should be recorded and documented in detail as part of the entire lifecycle files of the equipment, so that problems can be traced to the source in a timely manner.

5.4.3 Installation and operation

The installation and operation of the equipment must be subject to the transmission medium corrosion, working stress, environmental corrosion, and other factors. Improper operation or protection delay would aggravate the occurrence of corrosion problems. The organization shall establish strict operation and safety standards, organize skill training regularly, prepare an equipment operation management ledger, record in detail the execution and changes of various parameters during the operation of the equipment, and grasp the operating status of the equipment.

5.4.4 Servicing and maintenance

The servicing and maintenance of equipment depends on the timely discovery of corrosion problems, that is, the inspection and monitoring through equipment, such as through the corrosion monitoring system, manual inspection, and special inspection, to form the corrosion inspection ledger of equipment, and obtain first-hand information of the equipment operation status and corrosion status, to the extent possible. Conversely, this relies on optimal and targeted anti-corrosion measures. In addition, the summary and extraction of accident analysis processes and treatment methods, and the establishment of corrosion failure analysis files, are indispensable for the construction of the corrosion management system, which could provide an important reference and basis for the follow-up work to avoid repetitive work.

5.4.5 Scrapping and disposal

The organization shall formulate a detailed equipment scrapping and disposal plan, properly dispose of the scrapping assets, and avoid environmental pollution and safety hazards. Before the equipment is scrapped, a comprehensive inspection should be conducted to analyze and summarize the failure causes, management defects, and other experiences and lessons. The inspection data, analysis and evaluation, experience summary, and other processes involved in equipment scrapping should be recorded in detail to play a guiding role in the follow-up work of the scrapped equipment.

6 Countermeasures and suggestions

6.1 Incorporating corrosion management into the national security strategy and establishing a permanent organization for corrosion management strategy research

Corrosion management is a long-term process that involves a wide range of factors and has a significant impact, and therefore it is necessary to comprehensively plan and simultaneously promote the systematic development of corrosion management. It is recommended that the state establish a permanent organization for corrosion management strategy research, corrosion management committees, and top-down corrosion management institutions, while regularly conducting special corrosion investigations for major projects, comprehensively determining a list of corrosion problems, developing targeted policies, and uniformly compiling and publishing guidance and plans for corrosion management of infrastructure and major equipment. Middle-term and long-term development plans and short-term objectives for corrosion management should subsequently be established, as well as national standards for corrosion management. Further, investment and supervision in the field of corrosion management should be increased, and the corrosion safety management should be incorporated into the national security strategy. It is

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essential to coordinate corrosion management institutions at all levels, establish a database of corrosion failure cases, to popularize and apply advanced anti-corrosion technologies, conduct corrosion training and certification of corrosion qualifications, hold academic exchange conferences, and publicize and popularize anti-corrosion knowledge, which will speed up the circulation of corrosion safety information technology and the transformation speed of production, education, and research.

Various industry associations should set up anti-corrosion science and technology centers to guide and supervise the corrosion management work of organizations, report and exchange common issues to integrate industry resources in a timely manner, regularly organize and summarize corrosion management experiences and lessons which may be disseminated and communicated via reports, documents, and other media, and continuously promote the development and improvement of corrosion management through industry alliances.

6.2 Strengthening the development of corrosion disciplines and intensifying the talent strategy

It is crucial to improve the development of professional disciplines of corrosion protection in colleges and universities to strengthen the development of professional teachers of corrosion management, and intensify the training of personnel for corrosion management with more novel cultivation modes, so that the availability of highly skilled personnel to all industries and fields is facilitated. It is also essential to improve the corrosion management qualification assessment and certification standards to organize the corrosion management training classes, and strengthen the theoretical learning and exchange of experience for improving professionalism of corrosion management personnel continuously, and further promoting better and faster development of the corrosion management system.

It is necessary to establish and improve the multi-party communication mechanism among higher education, scientific research, and practical work regarding corrosion management for vigorous improvement in basic-theoretical knowledge and business work abilities of the corrosion management working team to promote the efficient integration and transformation of production, education, and research, and jointly build a high-quality personnel team of corrosion management with integrity and ability.

6.3 Establishing and improving the construction of relevant regulations and standards for corrosion protection, and strengthening the awareness of standards

It is necessary to strengthen the construction of standards and norms to integrate, revise and supplement existing technical standards, quality standards, and management standards on corrosion protection, formulate regulations on corrosion management of equipment and facilities, and clarify institutional requirements for long-term, safe, and economic use of equipment and facilities. National, local, and industrial standards for corrosion management should be gradually established and improved throughout the lifecycle of corrosion engineering design, material selection, construction, operation, maintenance and scrapping, while implementing a responsibility system of the entire lifecycle of the equipment. Further, the implementation and supervision of corrosion management should be enhanced, and a review mechanism should be established so that corrosion management will gradually be normalized, standardized, and institutionalized, to promote the safe operation of major facilities and the sustainable development of social economy.

6.4 Strengthening the construction of the corrosion database and creating big data management

It is necessary to establish a corrosion database and information management system to coordinate the collection, management, and utilization of corrosion data. From a national perspective, a corrosion big data center should be established to improve the sub-module functions of data collection, storage, evaluation, forecast, and update. In addition, a partitioned database should be established by industry and region to realize the bottom-up accumulation and top-down use of corrosion data. It is crucial to link the individual corrosion management factors into a connected network, which will help enhance information circulation and communication, improve data utilization, fully grasp the current status of corrosion in various fields, and provide a data basis and decision-making basis for the development of systematic corrosion management.

Association of various industries or relevant academic organizations should be actively committed to the construction and maintenance of the equipment corrosion data monitoring and collection system, simulation, residual life assessment technology system, material selection database, as well as other big data. Additionally, the corrosion monitoring system of existing equipment and new equipment needs to be continuously expanded and improved to

accumulate more valuable data for corrosion management. The database of corrosion problems and countermeasures has been continuously accumulated and expanded through abundant work practices. Considering the overall planning of the national corrosion data system, system improvement and technical innovation have been continuously led by concrete practices, so that the corrosion database could guide and promote the development and improvement of systematic corrosion management to the maximum extent.

6.5 Building a smooth communication mechanism and information exchange platform to improve information utilization

The development of corrosion management in China is still in its infancy. The improvement of the corrosion management system, revision of standards, accumulation and exchange of experience, and systematic development require a comprehensive communication and exchange platform. Relevant industries and departments should be committed to building a comprehensive corrosion information exchange platform, forming an effective communication mechanism, and improving the sharing and utilization of corrosion data, industry experience, accident response, and other information. It is necessary to improve the effective connection of supervision, before, during, and after the processes, information interconnection and sharing, and coordinated and cooperative working mechanisms to continuously promote the systematic development of corrosion management.

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