Operational innovation in the performance of the anti-corrosive protection process

Innovación operativa en el desempeño del proceso de protección anticorrosiva

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DOI: 10.35429/JIE.2022.17.6.13.21 Received July 20, 2022; Accepted December 30, 2022

Abstract

The present research is a study developed in corrosion protection operations with the use of chemical treatments, which consist of the transformation of steel corrosion products into more stable oxides, an alternative to protect against corrosion in materials that have already begun to degrade avoiding mechanical cleaning, in order to present the results of the experimental study generated in the factory laboratory, which consists of the analysis of the solution of the oxide converter, of the sealing substance and their respective photographic representations of the application, for the chemical development of an oxide converter generator against the deterioration of the metal by minimising the cleaning effort, improving the aesthetics of the affected surface of the metal by the phenomenon of corrosion for its domestic and industrial use in the field of innovation of the corrosion protection of technological services.

Industrial, Experimental, Innovation

Resumen

La presente investigación, es un estudio desarrollado en las operaciones de protección anticorrosiva con el uso de tratamientos químicos, que consisten en la transformación los productos de corrosión del acero en óxidos más estables, una alternativa de protección contra la corrosión en materiales que ya han comenzado a degradarse evitando limpieza mecánica, por el cual, se tiene el objetivo de presentar los resultados del estudio experimental generados en el laboratorio de la fábrica que consiste en el análisis de la solución del convertidor de óxido, de la sustancia de sellado y sus respectivas representaciones fotográficas de la aplicación, para el desarrollo químico de un generador de convertidor de óxido contra el deterioro del metal minimizando el esfuerzo en la limpieza, mejorando la estética de la superficie afectada del metal por el fenómeno de la corrosión para su uso doméstico e industrial en el ámbito de la innovación de la protección anticorrosiva de los servicios tecnológicos.

Industrial, Experimento, Innovación

Citation: RAMÍREZ-ROMÁN, Adolfo, RODRÍGUEZ-RODRÍGUEZ, Luis Alberto, CHABAT-URANGA, Jacqueline and SUÁREZ-ÁLVAREZ, Ángel. Operational innovation in the performance of the anti-corrosive protection process. Journal Industrial Engineering. 2022. 6-17:13-21.

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Introduction

In an environmentally sensitive environment, the use of oxide converters has been widely recognized in different sectors of daily life. The developed product (rust converter) will represent a sustainable saving for the customer, also, the implementation of the product will represent a technological improvement for the company, placing it in a market of greater opportunity and competitiveness. It is proposed to the consumer an alternative protection against corrosion in materials that have already begun to degrade in industrial, domestic or construction operations.

It is important for the contribution of technical knowledge of coatings to retard corrosion on metallic surfaces, being an electrochemical application in research. Incorporating equipment for the development of laboratory tests to ensure compliance with customer requirements, improve the competitiveness of the organization and contribute to increased customer satisfaction, as well as reducing the cost of maintenance and wear of parts or steel structures, to take advantage of the consequences of oxidation of metals in synergy for self-protection and allow customers to propose alternative corrosion protection systems. And, development of sustainable strategies to reduce the number of maintenance, and mitigate contamination with the use of other chemical products that deteriorate natural resources such as soil and water, contributing to maintain a sustainable environment in the coastal and industrial zone.

Therefore, this article mentions the studies related to the research, also, describes the benefits of the research study, the importance of innovation through the innovative environment section, then the images of the interior of the laboratory are identified, describing the laboratory META section, also, in the results section, the sequential process of the experimental study is described through images, and finally there are the acknowledgements, conclusions and references of the research.

Environment of disciplinary studies

The studies that are related to the present investigation, their contributions are briefly mentioned as part of the basis for the development of the experimental work:

For example, Integrating knowledge is the fundamental task of chemical education and it is in this context in which the research in corrosion inhibition of steel gives us the opportunity to integrate the knowledge of electrochemical kinetics with organic chemistry, instrumental analytical chemistry and electronics via the construction of a low-cost potentiostat and the use of this in the study of the anticorrosive properties of atropine sulfate against carbon steel in solution (Alfaro, M., 2017).

It is considered that, it lives in a world surrounded by moisture, being found free in a solid without difficulty, it is then established that it is a non-hygroscopic material as happens in glass (Ananías, R., 2020).

In an environment of steel corrosion in concrete, the determination of the corrosion rate of reinforcement is of fundamental importance when making a diagnosis and assessing the service life of a reinforced concrete structure (Arva, 2002).

Therefore, the term corrosion comes from the Latin word "corrodere" which means to gnaw. This term is commonly used to describe the process of deterioration by natural oxidation of metallic materials, manifested through their visible degradation that, in external cases, can be total.... (Godínez, 2003). And, new materials are sought to improve corrosion levels in its different types involving uniform corrosion, intergranular corrosion, galvanic corrosion, possible stress corrosion cracking, pitting and fatigue (Plaza Torres, 2015).

On the inhibitors side, the evaluation of the anticorrosive effect of an oxide converter obtained from an extract of the Mimosa Tenuiflora plant, applied on 1018 steel corrosion products, has been documented (Enrique Arceo-Gómez, 2021). However, corrosion studies have been carried out with a mathematical approach that allows the development of the discipline in the field of innovation in the industrial sector of corrosion protection (Escobar Jiménez, 2022).

> ...it is important to have a risk management plan with a methodology, along with a format to take into account the different events and how to generate a solution to these, after this in case of any unforeseen event it is necessary to make an assessment of the situation either through regulations, contracts, project schedules and generate a risk report to have concise information according to the needs already identified in the risk plan. From this plan, the probabilities and priorities can be seen, in order to generate a response to the problem in order to improve or mitigate, and to have a follow-up of the problem with records, updates and lessons (Ayma, 2022).

However, poor organization of materials, spare parts and tools in the area leads to setbacks, unsynchronized work and delays in delivering work to customers, who are dissatisfied with the lack of punctuality and commitment to them, thus creating mistrust and a poor image of the companies (Castillo Rivas, 2022).

It is considered that, in 1905 Tafel discovered an empirical relationship between the increase of power and the total current intensity with which the curtain of the corrosion mechanism began to be drawn, but it was not until 1938 when Wagner and Traud with the publication of their article "Concerning the evaluation of corrosion reactions by superposition of electrochemical partial reactions and concerning the potential formation on mixed electrodes", laid the foundations of the mixed potential theory, which postulates that even without assuming the existence of local anodes and cathodes, corrosion reactions can be explained by assuming that partial oxidation and reduction reactions occur at the metal/electrolyte interface and that these reactions are constantly changing under a statistical distribution of time position (Yunny Meas, 1991). Subsequently, evaluation studies were developed through the electrochemical modular frequency technique (Esra Kus, 2006); and, velocity study in steels for construction (Martí, Marc., 2011).

Also, there are analyses of corrosion products of steel, zinc, copper and aluminum formed in the Antarctic polar climate, analyzing the influence of the singular characteristics of this climate on the formation of these products (Fuente, 2002). Also, there are the applications of electrochemical techniques (González-Masí, 2014), as a complement, there are velocity analyses through the studies of the description of the electrochemical frequency modulation (M. Mora, 2007). Likewise, with the studies of the determination of the corrosion rate in AISI SAE 1010, 1020 and 1045 steels implanted with titanium ions around the hydrocarbon industry (Valbuena N., 2012).

It is highlighted that Ni coatings present better resistance to corrosion-erosion than the steel substrate, the most corrosion resistant coatings and with higher microhardness were those obtained at higher agitation speed (Henao, Johny, 2011).

Regarding innovation to preserve materials from corrosion, there is a feasibility study where a series of strategies are established which would mitigate this impact in order to achieve a successful painting process and also help preserve the environment and generate different competitive capabilities about environmental care through the different production processes within the company (Castro Garzon, 2022). Therefore, it is important to study localized corrosion and passivation phenomena (Gómez, 2021).

Benefits of an anticorrosive system

An anticorrosive system that could be conformed by a plastic, chemical or metallic coating has the function of preserving the useful life in a time proportional to the quality of the cleaning and thickness of the coating. Therefore, they could provide ten benefits, according to the studies carried out and indicated by the company Metalyzinc (Cobo-Losey, A. 1989) in their systems of Hot Dip Galvanizing, Thermorroding among other industrial coatings, we have that:

- For the most part, they assure corrosion-free durations from 10 to more than 100 years.

- They can achieve that corrosion does not lower their productivity from 100%.

ISSN 2523-0344

- They have produced maintenance savings of up to 90%.

- They have achieved a return on investment with real rates of more than 50%.

- They can reduce their level of hidden corrosion insecurity to 0%.

- They can extend rod life in concrete by more than 500%.

- Most of them can protect even after some abuse.

- Many of them are compatible with each other, mutually reinforcing and repairable.

- They are applied with attention to detail by qualified personnel.

- They are applicable in thousands of different cases and parts.

Benefits of an oxide converter

According to the technical data sheet of CORTEC Corporation (Cortec vci, 2022), in one of its products, CorrVerter®, allows sustainable and innovative savings by taking advantage of the degree of oxidation of the parts as part of its protective layer, stopping pitting corrosion (hole by deterioration of the degraded surface). These applications are subjected to Salt Fog tests (ASTM B 117) 1000 hours (see figure 1), as a characteristic is non-toxic, water based, as well as a permanent anticorrosive.

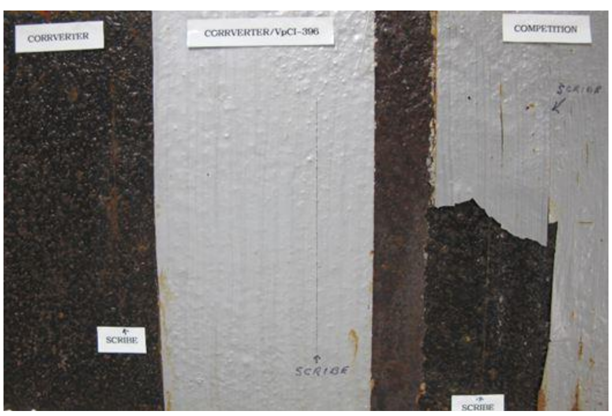

Figure 1 Salt fog test
Source: CORTEC Corporate

Figure 2 Corrverter inhibitor
Source: CORTEC Corporate

For example, image of a product type and with a sample applied is indicated, where it is CorrVerter, which is a fast-drying water-based one-coat primer system that converts rusted surfaces into a hydrophobic passive layer and prevents further rusting (Cortec vci, 2022).

Innovative environment

An industrial and substantial precept in the development of new alternatives to achieve increased customer satisfaction, where ISO 9001:2015 raises in its chapter 9.1.2 the aspects related to customer satisfaction, for this the standard cites that: The organization shall monitor the perception of customers on the degree of compliance with the requirements, and the organization shall monitor the perception of customers on the degree of compliance with the requirements. Therefore, the development of the experimental study generates an economical and viable alternative in domestic and industrial applications.

Also, because of the applications of the organization's own methodology with respect to the standards and requirements of the client, supported by its sustainable management indicators.

META Laboratory

The following three figures identify the basic equipment/instruments of the META laboratory for the development of its tests and control of the chemical production process. It is META, by the first four letters of the company's name, as part of any validation before starting the service of a corrosion protection system in the market.

Figure 3 Laboratory equipment
Source: Metalyzinc

Figure 4 Laboratory cleaning area
Source: Metalyzinc

Figure 5 Laboratory equipment
Source: Metalyzinc

Where, the application of the electrochemical technique was developed through chemical analysis and observation of the results of each parameter or type of sample with an experimental study in the company's laboratory.

Results

In the development of the research work, the following potential equipment was identified to ensure the reliability of future studies, which are:

Potentiostat / Galvanostat Biologic sp 150, which determines the corrosion rate and evaluate the electrochemical behavior of the oxide converter.

Compact porosity detector, for the surface of the protective film. Commonly known as Holiday jeepers detectors or spark testers. Conforms to the requirements of As3894.1-1991. CE Smart. Identifies the porosity in protective film on the metal surface and allows to determine the type of coating with reference to the consistency and concentration of the protective solution.

X-ray diffractometer, with the function of determining the elemental composition of the treated surface.

Optical Emission Spectrometer, for the analysis of the chemical composition of the coating.

FT-IR, which is a functional group identifier. Surface characterization of the treated metal substrate by possible techniques such as Raman Spectroscopy, Fourier Transform Infrared (FT-IR), Raman Spectroscopy, which is a functional group identifier.

Raman Spectroscopy, which identifies iron oxides, present in the conversion film.

Therefore, in the experimental study, the following figures are identified in sequence as part of the research work at the company's facilities, where the time is indicated in parentheses, whereby, the experiment has had a duration of its process of approximately 24 hrs, which has allowed to visually identify the reaction of the converter substance on the oxidized metal surface.

With a commercial solution developed by the company, as part of the copyright process, the formulation and physical and chemical characteristics are under validation for subsequent commercial publication and contribution to the research. However, the market has.

Figure 6 Presentation of the sheet-type sample with oxide present (8:00 AM)
Source: Metalyzinc Laboratory

Figure 7 Cleaning of sample sheet with presence of rust (10:00 AM)
Source: Metalyzinc Laboratory

Figure 8 Beginning of converter application by sections on sample sheet with oxide present (15:07 PM)
Source: Metalyzinc Laboratory

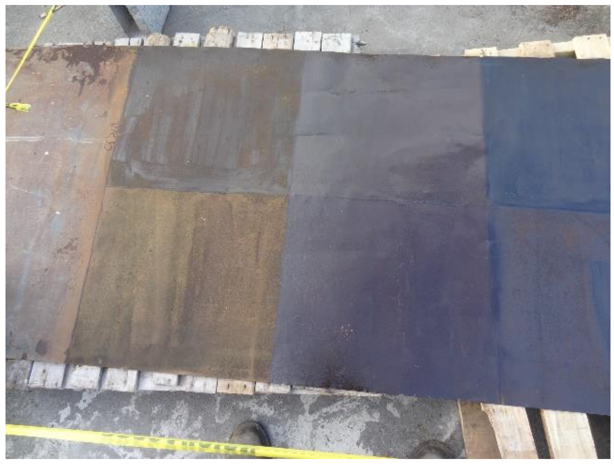

Figure 9 With sections of converter application on sample sheet with presence of oxide (16:49 PM)
Source: Metalyzinc Laboratory

Figure 10 Sample film with the converter after 15 hrs (07:50 AM)
Source: Metalyzinc Laboratory

Figure 11 Sample of coating substances
Source: Metalyzinc Laboratory

ISSN 2523-0344

Where, the developed product (oxide converter) will represent a benefit for the consumer (general public as well as for the industrial sector) likewise, the implementation of the developed product will represent a technological improvement for the company, placing it in a market of greater opportunity and competitiveness. And, a virtual corrosion laboratory allows the development of tests minimizing the costs of materials and operation time (Bethencourt M., et al., 2004).

Acknowledgement

The support of the company Metalyzinc through the use of its internal resources, as well as to the laboratory personnel for their support in the analysis of the results, and also to the members of the Academic Body UV-CA-470 Innovation in Management Systems for the compilation of the evidence of the study.

Conclusions

The study monitored the comparative of experimental parameters in the preparation of samples and performance of laboratory tests. The effectiveness of the application of the methodology and use of the equipment and inputs was ensured, generating reliable results for the development of the prototype, through the control of the parameters to validate the coating. Definition of the intellectual and industrial property protection strategy. Analysis of market needs and description of value proposition with reference to product cost and positive impact on the environment. Also, tracking of reactions to various environmental exposures in the field in the logbook and reports according to the parameters of the coating application. Verify compliance with the applicable regulations of the functional prototype, according to the inspection stages in accordance with the coating application parameters, compliance with the applicable regulations of the functional prototype.

Therefore, the possibility of improvement in the study, consolidates the application of tests in salt spray chamber according to ASTM B117-02, electrochemical analysis of the reaction mechanism of the anticorrosive system, surface characterization of the treated metal substrate by possible techniques such as Raman Spectroscopy, Fourier Transform Infrared (FT-IR) or X-Ray diffraction, and adhesion tests on the sheet type samples with the presence of oxide.

And the applicable standards for the cleaning of steel surfaces are considered the Swedish Standard SIS 055900, British Standard BS 4232, Surface Preparation Specification of the Steel, Surface Preparation of the National Association of Corrosion Engineers, (NACE), and the Colombian Institute of Technical Standards.

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Journal Industrial Engineering
December 2022, Vol.6 No.17 13-21

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ISSN 2523-0344