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On The Role of Corrosion (Knowledge) Management for a better Materials Selection

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After 2008 economic meltdown, it was proved to be a solid fact that no country can count itself immune to economic crisis and also that corrosion management in strategic industries such as but not limited to energy and power, transportation and infrastructures is a vital requirement to let these industries keep their head above water. Budget cuts and downsizing could be temporary measures to address increasing costs for a while, but they are certainly far from offering a sustainable solution.

Corrosion is an issue that can be considered to be a multilateral issue, it has economic as well ecologic impacts and in addition to that it is one of the gateways into sometimes disastrous failures of engineering structures.

Economic cost of corrosion is classified as "direct cost of corrosion". Based on a background history of about 70 years cost of corrosion is estimated to be between 1 to 6% of GDP (Gross Domestic Cost) of a given country. Obviously, the more sophisticated and diverse the industries in the country, the higher the expected cost of corrosion. Currently, there are four accepted economic models that have been tried in several countries over decades to estimate the cost of corrosion. These models are : Uhlig Model, Hoar Model, Input/Output (I/O) model and Life Cycle Cost model. Some examples of cost of corrosion are:

- Insurance companies have paid out more than US$91 billion in losses from weather-related natural disasters in the 1990s (including Turkey's earthquake) whereas direct loss of corrosion in 1994 just in the US industry was US$300 billion .
- Of every ton of steel from the world production approximately 50% is required to replace rusted steel
- Internationally, one ton of steel turns into rust every 90 seconds, on the other hand, the energy required to make one ton of steel is approximately equal to the energy an average family consumes over three months.
- The outstanding impact of corrosion is so high that even in some countries, some politicians have appreciated it (https://www.defenseindustrydaily.com/Sen-Tom-Coburn-Americas-Fiscal-Defense-Crisis-06412/, visited 1 December 2019).

Ecologic cost of corrosion, however, is classified as "Corrosion indirect cost" and none of the four models used for considering economic cost of corrosion have expressed clearly their approach towards modelling ecologic cost of corrosion. At the moment, ecologic cost of corrosion is expressed as "environmental impact", meaning that the change that is caused in the elements of environment (Water, soil and air) as a result of interaction between corrosion and these elements. More specifically, cases of corrosion leading into environmental catastrophes are frequently reported without actually figuring out the wholesome cost that has been imposed on the elements of environment. It has been customary to just report that because of corrosion, the production had to be ceased for such and such days or such and such liters of a toxic material was released into the environment. However these are "orphan information" in the sense that further detailed costs are not reported. For instance, how did the release of oil from a subsea pipeline affected the marine food chain and how this in turn affected the economy of living for people whose income was dependent on that (Fishermen and the local fishing industry for example).Or ,how uncontrolled use of corrosion inhibitors and biocides in a given industry can find its way into the surrounding soil and water environment to affect the lifecycle of plants and animals in the neighbourhood. This author supervised an Master of Science research project during which we showed that release of these effluents into the surrounding environment has detrimental effects of mouse, starting from blindness and normal ovulation to eventually death.

On the other hand, engineering importance can be defined as a function of both risk and cost. Therefore, if something is of high, risk and cost, it follows that its importance is high too. It is in this context that management of corrosion will make sense as both its cost and its risk are high.

Management of corrosion can be approached from two angles: Corrosion Management (CM) and Corrosion Knowledge Management (CKM). CM and CKM are completing each other in the sense that CM deals with the risk of corrosion and CKM is to handle cost of corrosion, both direct and indirect costs. In other words, technical-engineering management of corrosion is what CM needs to consider and management-focused CKM is to seek for ways to investigate and control cost of corrosion.

There are five ways to manage the risk of corrosion, one of which being materials selection. What is simply meant by materials selection will be the art and science of finding a material that compared with existing material in use, will show a much better corrosion resistance. For instance, if due to practical constrains, a less suitable material is used for a given application by a feasible, right materials selection it may be possible to seek a much better corrosion protection.

CM is an approach that due to its very nature uses materials selection frequently. Therefore, it will not surprising if a CM model uses materials selection as an option to prevent and/or control corrosion. However, possibility of CKM in a better materials selection is a very novel idea and in this extended abstract, we will explain how CKM and better materials selection can be highly interrelated.

CKM can be simplified as Figure 1 below:

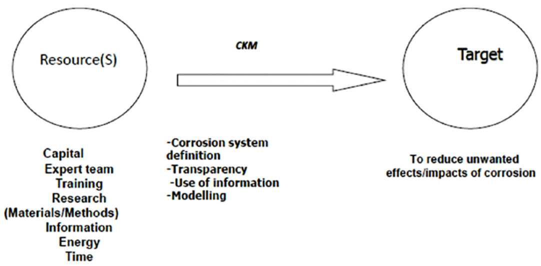

Figure 1: Simplified modelling of CKM

Through a CKM model, it is possible to justify material selection more efficiently. It must be noted that one of the most important drawbacks of materials selection is its additional cost that is imposed on the project. Through a corrosion-focused CKM cost analysis , the extra cost can be justified. This is an approach that if a CM model required material selection /upgrade, CKM may be applied to show that the initial high CAPEX can be levelled by low or very low OPEX down the service life of the equipment.