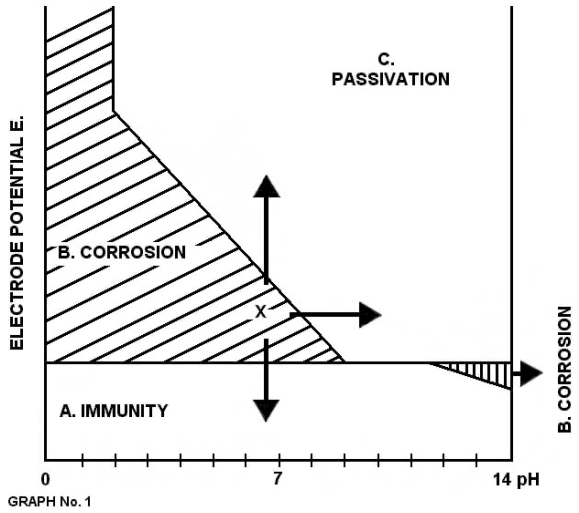
Corrosion of iron and passivation

Corrosion of iron. Generalities.

In most cases, the corrosion of iron is due to the action of water and atmospheric agents. The oxygen in the air increases the potential of the iron, and it is the driving force in the corrosion process.

Other atmospheric agents capable of influencing the corrosion process are acid fumes in industrial environments and sodium chloride in marine atmospheres. The result of these influences is an increase in the rate of corrosion.

The theoretical circumstances of corrosion, the immunity and passivation of the iron-water system, are given in Graph. N° 1 devised by Professor Pourbaix. The two variables are the electrode potential, E, and the pH.



GRAPH No. 1

CORROSION DIAGRAM OR IRON AT 25°C (77°F)

GRAPH N° 1

To review briefly, electrode potential measures the oxidizing or reducing property of an interface between a metal and a solution; the higher values correspond to the oxidizing, the lower values to the reducing properties.

Electrode potential is measured against the standard hydrogen electrode i.e. against the equilibrium potential of the reaction $H2 \leftrightarrows 2H^{+} + 2e^{-}$ in a solution of pH O, under pressure of 1 atmosphere.

In Graph N° 1, three separate areas have to be considered : A, B, C.

A. Area of Immunity : corresponds to the thermodynamic stability state of the metal which is absolutely incorrodable in this state.

B. Area of Corrosion : increases in acid environment.

C. Area of Passivation : corresponds to stability of the dissolved iron corrosion products which protects the surface against subsequent corrosion.

In normal conditions of aeration acid humidity, the steel which is thus exposed outdoors is in the condition indicated by point X in Graph N° 1. It means that the steel is vulnerable to corrosion.
Three electrochemical methods are used for preventing corrosion :

- Anodic passivation : potential is increased up to the passivation area.
- Cathodic protection : potential is reduced to the immunity area.
- Increasing of the pH of the environment.

Passivating action of KELATE®

KELATE® stabilizes the rust formed on metallic surfaces and in this way, protects the surfaces from subsequent corrosion.

The action of **KELATE®** on the rust corresponds to the first method described above for preventing corrosion : anodic passivation.

The research of Professor Pourbaix and Talbot demonstrates that the anodic passivation obtained by **KELATE®** treatment is positive and thorough in its action.

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Paris, le 26 février 1970.

A la demande de la s.a. PRB, nous avons examiné les propriétés inhibitrices du stabilisateur de rouille "KELATE" mis au point par les services de recherche de cette société.

Pour mettre en évidence ces propriétés inhibitrices dues notamment à la présence d'acide tannique dans le produit, nous avons utilisé la méthode des courbes intensité-potentiel. En effet, le tracé des courbes intensité-potentiel d'un métal permet de déterminer l'aptitude de ce métal à la corrosion dans le milieu considéré.

Il faut tout d'abord remarquer que le stabilisateur de rouille KELATE possède la propriété de former à la surface du fer rouillé un chélate ferri-tannique insoluble.

La comparaison entre les courbes intensité-potentiel du fer rouillé, d'une part, et du fer recouvert de rouille stabilisée, d'autre part, nous a permis de constater que la protection obtenue par l'action du KELATE est excellente. Ainsi, pour une potentiel imposé supérieur de 200 mV au potentiel de dissolution, l'intensité du courant est de :

0,45 mA/cm2 pour le fer rouillé

0,07 mA/cm2 pour le fer recouvert de rouille stabilisée.

Le stabilisateur de rouille KELATE constitue donc un moyen de protection très efficace contre la corrosion du fer.

Jean Talbot.

Potentiocinetic method used by Professor Talbot

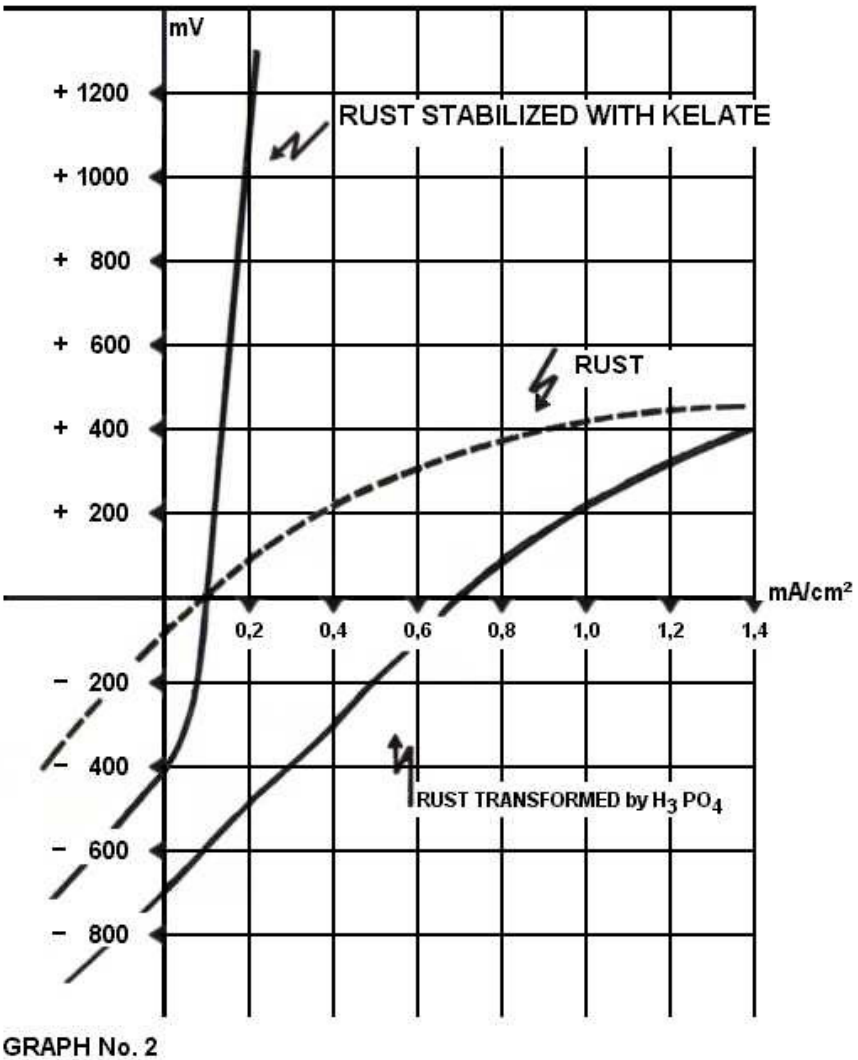
Professor Talbot is using the intensity potential curves method. The electrode potential is varied by a potentiostat from low to high or from high to low according to a pre-established pattern, in order to determine the influence of an oxidizing agent on corrosion.

In the area of corrosion B, an increase of the potential results in a progressive increase in the rate of corrosion which is given by the anodic current density. This is clearly demonstrated by the curves “Rust” and “Rust transformed by H3PO4”. (See Graph. N° 2)

In the area of passivation C (Graph. N° 1), a potential increase does not cause a corrosion current.

The vertical form of the curve “ Rust stabilized by **Kelate®** “ (Graph. N° 2) indicates that the passivating action of **Kelate®** is efficient.

POTENTIOCINETIC CURVES



GRAPH No. 2