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Effect of Potassium Thiocyanate on Corrosion Inhibition of Steel in Simulated Concrete Pore Solutions

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Abstract

Reinforced concrete is classified among the most used building materials that have revolutionized the world; and this to its advantages offered compared to other materials. Although this material undergoes degradation in time and is affected by the conditions of temperature and relative humidity. Because of its relatively low tensile strength, steel is incorporated into the concrete mass in order to enhance its performance and improve its ductility. Corrosion of reinforcement in concrete is a current issue that has aroused the interest of researchers to find an effective, economical and rapid remedy against this phenomenon. A new alternative has emerged in recent decades and has proven remarkable results in reducing the rate of corrosion of reinforcements or even stopping this process [1]. It involves the use of corrosion inhibitors as a preventive measure, added to the concrete mixing water or impregnated on the cured concrete facings in order to waterproof the concrete against aggressive agents such as sulphates and chlorides [2]. The objective of this work is to present the advantage of the addition of potassium thiocyanate "KSCN" which presents a non-toxic chemical product, in powder form added at an optimum concentration which provides high inhibitory efficiency against corrosion of steel in solutions simulating pores of concrete contaminated with chlorides (3% NaCl) [3]. The tests are carried out by mass loss measurements

Keywords: Corrosion; Inhibition; Mass Loss Measurements; Potassium Thiocyanate; Steel

Introduction

Gravimetric Measurements

The steel used in this study is carbon steel C38, previously machined, its diameter Ø = 27 ± 1mm and thickness e = 2 ± 0.5 mm, these samples are used for gravimetric measurements tests [4]. This method allows us to evaluate the corrosion rates Cr and inhibitory efficiencies IE, given by the following formulas [5]:

$$C_r = \frac{\Delta m}{S.t}(mg.cm^{-2}.h^{-1}) \qquad IE\% = \frac{Cr_0 - Cr_{inh}}{Cr_o} * 100$$

Δm= M1-M2 : repesents the difference between initial and final sample mass (mg)

S: surface exposed to the electrolytic medium (cm^2)

t: immersion time (hours)

Cro and Crinh are the corrosion rates after immersion in the electrolyte solution in the absence and in the presence of the inhibitor respectively. The results relating to the influence of concentration on the inhibition efficiency after 24 hours of immersion at a temperature T = 25 °C are summarized in (Table 1).

Table 1: Evolution of corrosion rates and function of KSCN concentrations at 24h.

C(mol/litre)	Vcorr (mg/h.cm²).10^{-3}	EI%
Blank	3.924	/
7.5.10^{-4}	1.314	66.51
10^{-3}	1.825	53.48
2.5.10^{-3}	2.212	43.62
5.10^{-3}	3.053	22.2
10^{-2}	3.416	12.94
5.10^{-2}	3.598	8.31

Result and Discussion

The results obtained relating to the use of potassium thiocyanate as a corrosion inhibitor shows that the corrosion rate decreased as function of the addition of potassium thiocyanate by comparing with the sample without inhibitor. The best inhibition efficiency 66.5% was obtained at a very low concentration 7.5. 10-4 mol/l (Figure 1). This indicates that potassium thiocyanate inhibits the corrosion of steel in alkaline medium in the presence of chlorides and its effect becomes reversed when its concentration increases. The evolution of corrosion rates and inhibitory efficiencies was also evaluated as a function of immersion time, (Figure 2) illustrates a comparison between inhibitory efficiencies at 24h and 72h. It can be seen that corrosion rates at 24 hours of immersion in electrolytic solutions are greater than those recorded at 72 hours, since a time of 24 hours is not sufficient for the formation of the passive film on the metal surface due to the presence of alkali ions N+ and K+ in the synthetic solution. However, inhibition efficiencies at 24 h were improved by considering the neutralized medium undergoing a chloride attack, which confirms the inhibitory effect of KSCN. Further tests were carried out on high concentrations of potassium thiocyanate, it is found that at a concentration of 10-1 for 3 days of immersion in the electrolytic solution, the corrosion rate increased by more than 12% and at 7 days the corrosion rate increased more than 40%. The results are summarized in (Table 2). The high concentrations of inhibitor promote corrosion, so we must look for the optimal concentration while going through several concentrations.

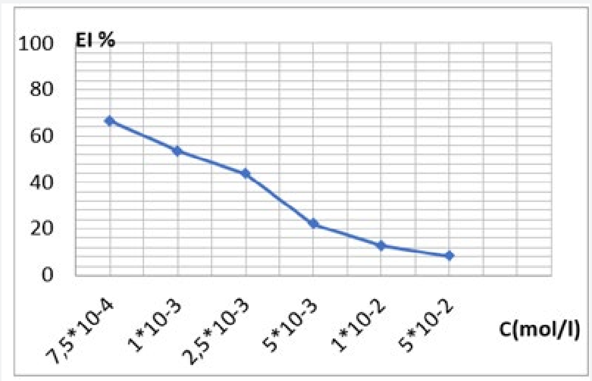

Figure 1: Evolution of inhibition efficiencies as function of KSCN concentrations at 24h.

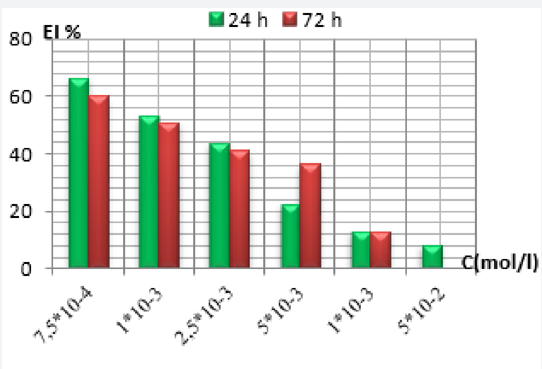

Figure 2: Comparison between inhibition efficiencies at 24h and 72h.

Table 2: Evolution of corrosion rates and inhibition efficiencies of KSCN at 7days.

C (mol/litre)	Vcorr 10 (mg/h.cm^2)	EI%
Blank	1.703	/
10^{-3}	1.053	38.19
10^{-2}	1.108	35.36
10^{-1}	2.4	-40.89

Conclusion

The study of the influence of potassium thiocyanate on the corrosion inhibition of steel placed in an electrolytic solution which simulates concrete pores contaminated by chloride at 3%, has shown that the optimum concentration is 7.5%. 4 mol / l, which offers a maximum inhibition efficiency of 66.5% by gravimetric measurements while scanning a very wide range of concentrations until the required concentration is reached at 25 °C. In addition, it has been found that a duration of 3 days makes it possible to acquire high efficiency following the formation of the protective film which allows the passivation of the steel. Also, high concentrations promote corrosion at 7 days.

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