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Experiment design for copper corrosion inhibition using an expired drug

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INTRODUCTION & AIM

Corrosion is a significant issue in various industries, often leading to material degradation, economic losses, and safety concerns. The use of environmentally benign and cost-effective inhibitors has gained considerable attention in recent years, with organic compounds demonstrating promising results due to their ability to adsorb onto metal surfaces and form protective layers. Expired pharmaceutical drugs, rich in organic functional groups containing nitrogen, sulfur, oxygen, and phosphorus atoms, present an innovative and sustainable approach to corrosion inhibition.

The primary aim of this work is to evaluate the efficiency of the expired drug in mitigating copper corrosion using weight loss measurements as the primary method. To gain deeper insight into the factors influencing inhibition performance, this study employs Response Surface Methodology (RSM). RSM enables the systematic exploration of interactive effects between key variables, including inhibitor concentration, temperature, and immersion time. By applying this statistical approach, the study not only identifies the optimal conditions for maximum inhibition efficiency but also highlights the practicality of using pharmaceutical compounds in green corrosion protection strategies.

The findings aim to provide a sustainable alternative for corrosion mitigation while promoting the use of environmentally friendly inhibitors in industrial applications.

METHOD

In this study, the experimental design and statistical analysis were conducted using MODDE Software Version 9.1. The individual and interactive effects of the corrosion process on independent variables were analyzed through the standard Response Surface Methodology (RSM), utilizing the Multiple Linear Regression method. The process variables examined in perchloric acid included inhibitor concentration (Con), temperature (Temp), and immersion time (Te). Each of these variables was studied at three distinct levels. The specific settings and levels for each parameter are detailed in Table 1.

Table 1. Levels of variables and factors considered for experiment design

Factors	Levels		
	-1	0	+1
Concentration(Con,% V/V)	0.1	0.3	0.5
Temperature (Temp,°C)	20	40	60
Time of immersion (Te,h)	0.5	1	1.5

The experimental design involved measuring the weight loss of samples before and after immersion in an acidic solution, with and without the inhibitor, using an analytical balance. The immersion time varied between 0.5 and 1.5 hours, while the temperature range was set between 293 and 333 K.

RESULTS & DISCUSSION

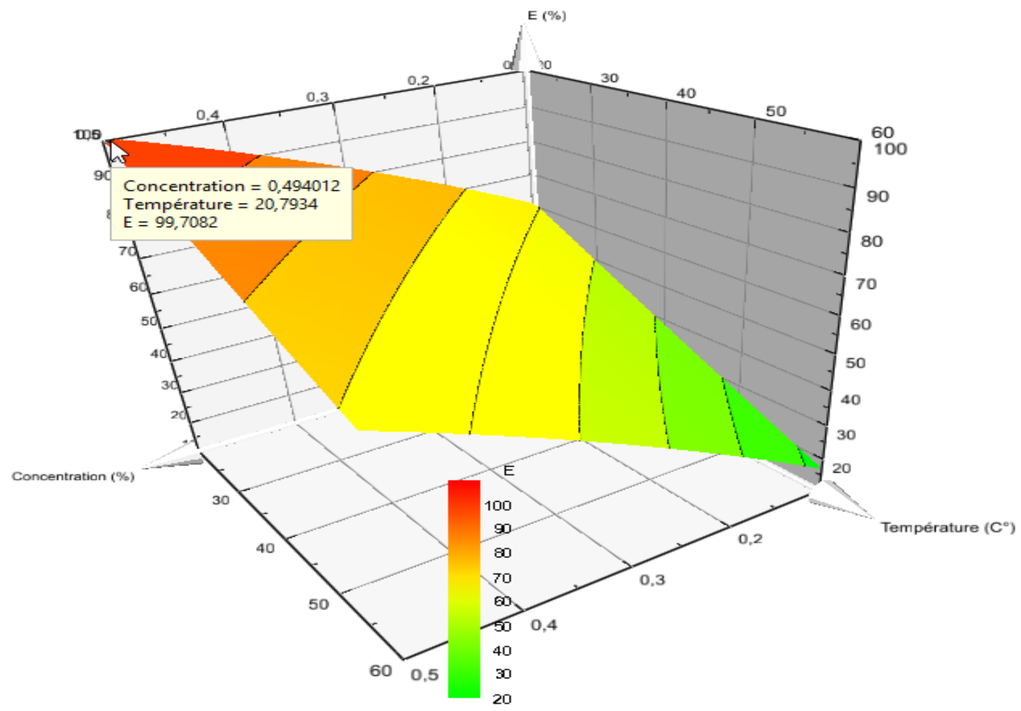

Figure1. Plots of the effects of temperature and inhibitor concentration on inhibition efficiency

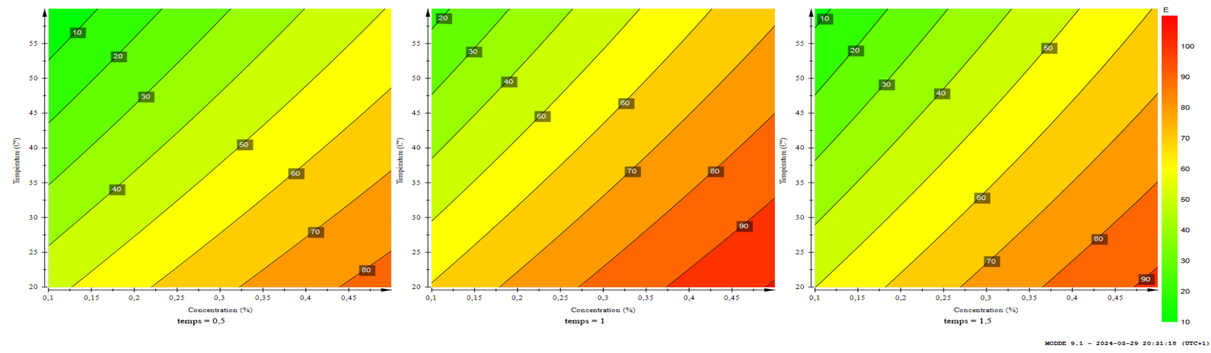

Figure 2. Contour plots at various times studying.

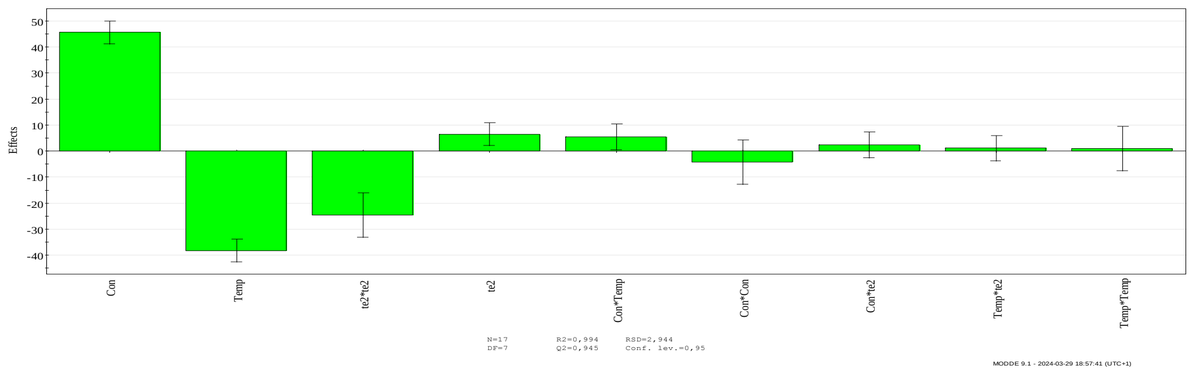

Figure 3. Main effect coefficients plot

CONCLUSION

The study achieved a reliable second-order polynomial model with high correlation coefficients and Q^2 values above 0.9, confirming strong agreement between observed and predicted data. Using RSM, the optimal inhibition efficiency of 99.71% was obtained under ideal conditions: 0.5% (v/v) inhibitor concentration and a temperature of 21°C.

FUTURE WORK / REFERENCES

Kok-Hui,G.; Teik, L.; Peng-Cheong, C. Evaluation of the effect of dosage, pH and contact time on high-dose phosphate inhibition for copper corrosion control using response surface methodology (RSM). Corrosion Science, **2008** , 50 ,918 - 927.

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