NURT-2006
V INTERNATIONAL SYMPOSIUM
ON NUCLEAR & RELATED TECHNIQUES
Havana, Cuba, April 3-7

EVALUATING OF SOIL CORROSIVENESS ON API STEEL BY TOTAL REFLECTION X-RAY FLUORESCENCE

S. L. Jesus[1], V. F. Nascimento[2], I. Costa[3], E. Almeida[2],
R. E. Romero[4], J. L. Rossi[3]

[1,3] Instituto de Pesquisas Energéticas e Nucleares – IPEN/USP, São Paulo, Brazil
[2] Centro de Energia Nuclear na Agricultura - CENA/USP, Piracicaba, SP, Brazil
[5] Universidade Federal do Ceará – UFC, Fortaleza, CE, Brazil

Introduction

Soils can cause metal corrosion and their corrosivity depends on the type of soil. In order to avoid or decrease the corrosion, some protection methods have been developed without taking into account the nature and the corrosion mechanism due to metal-soil interaction. Investigation on soil corrosiveness has been carried out based on their physical and chemical properties, such as pH and electrical conductivity, among others. However, there are other factors affecting the corrosion process that could be used for corrosion evaluation such as chemical analysis of species or elements presents in soil profile. Soil is a natural and dynamic body composed of three phases: solid, liquid and gaseous, where the liquid component of soil, soil solution (SS), is the corrosive electrolyte of the corrosion process. The chemical and electrical properties of this solution, such as electrical conductivity and pH are prime factors in the soil corrosiveness. In this study, the soil solution characterisation of three types of soil – Arenic Hapludalf (AH), Typic Quartzipsamment (TQ) and Typic Haplaquox (TH) – have been carried out. The SS of these types of soil was obtained by centrifugation method. After extraction, the SS was used as a test medium (electrolyte) to evaluate the corrosion resistance of API 5L X70 steel which main application is in pipelines. With total reflection X-ray fluorescence (TXRF) were possible to evaluate the quality and to quantify the soil solution as an electrolyte showing adequate analytical results and simplicity of preparation (1,2). Despite pH values, the results showed that a variables can be considered in such way that the term potential of soil corrosivity (PSC) can reflect better the behaviour and the sequence in this case the corrosiveness process in API steel coupons would be TQ > AH > TH. However, because of limit of detection of this technique it is fundamental that the samples were carefully prepared in clean places. Finally, the experimental TXRF arrangement involved synchrotron facility and nuclear instrumentation laboratory as sources of radiation (X-ray tubes and radioisotopes sources).

Materials and methods

Soil solution was obtained by centrifugation method of 50 mg of the soils. In order to prepare test specimen for TXRF analyses a single drop (10 μL) of each soil solution was dried in a quartz support and after this, irradiated using synchrotron facility with time of exposure of 200 s and flux of 178 to 227 mA, figures 1 and 2. After, three metallic coupons as triplicates to each soil totalling nine (09) samples were immersed in sealed beakers with 40 mL of soil solution during thirty days.

RESULTS AND DISCUSSION

The main point in these analyses consisted in correlate the concentration of each one element in soil solution with the degree of soil corrosivity, that is, a way that the losses of material when plotted against elements present allowed a correlation establishment. Results shown in figure 3 note that the most representative elements are Fe, Ca, K, Cl, S and P. The content of Cl suggests its presence as an anion and frequently is very important in corrosion processes. According to this, TH shows more content of Cl when compared to TQ and AH but corrosion process was not similar. Furthermore, soil solution in AH exhibits a large amount of Fe and an intermediate pH. So, concentration of Fe in AH solution seems to act as a buffer protecting the integrity of metallic surface. It is supposed if Fe is added to the soil solution, it could decrease the potential of soil corrosivity (PSC). Therefore the same discussion and more studies could be carried out with the same approach for other elements.

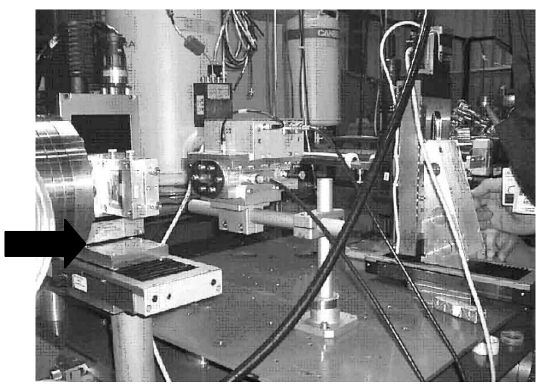

Figure 1 – Samples intake in the TXRF line.

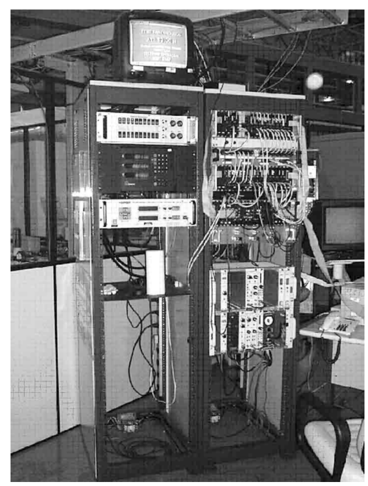

Figure 2 – Collection and treatment of data.

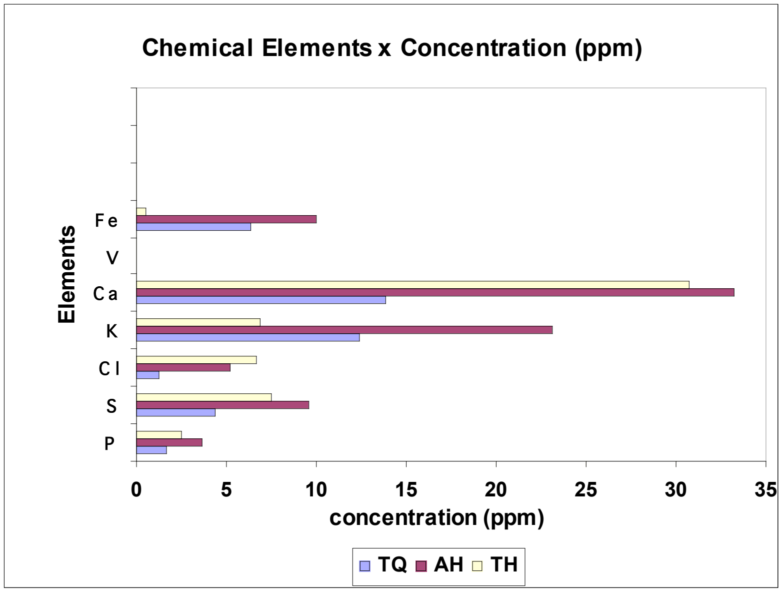

Figure 3 – Graphic showing elemental composition in SS after TXRF analyses.

CONCLUSION

With TXRF it was possible to evaluate the quality and to quantify the soil solution as an electrolyte showing adequate analytical results and simplicity of preparation. The comprehension and classification of soil corrosiveness can be admitted using soil solution aqueous extract. However, because of limit of detection of this technique it is fundamental that sample were carefully prepared in a clean place. Finally, the experimental TXRF arrangement involved synchrotron facilities and nuclear instrumentation laboratory as sources of radiation (X-ray tubes and radioisotopes sources).

Acknowledgements

The authors are thankful for the support of LNLS/CNPQ.

References

[1] PRANGE, A. Total reflection X-ray spectrometry: method and applications. Spectrochem. Acta, 44B: 437, 1989.

[2] SIMABUCO, SM., NASCIMENTO FILHO VF. Quantitative analysis by energy dispersive X-ray fluorescence by transmission method applied geological samples. Scientia Agricola, Piracicaba, 51(2): 197-206, 1994.