Evaluation of the Corrosion Behavior in the SAE 1018 Carbon Steel Pipelines that Carry Potable Water Applying Acquisition and Data Processing

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This work deals with the monitoring of physical variables influencing the corrosion process suffered by SAE 1018 carbon steel pipelines used potable water supply in a region of Hidalgo State, Mexico, by data acquisition card (DAQ) from four sensors: conductivity, pH, chloride concentration, and temperature supported by a graphical user interface through LabView 9.0. The obtained mains results show the potable water is not the cause of the possible faults or cracking in the carbon steel pipelines.

Introduction

Digital Signals Processing technique is major application in monitoring and control systems in Today, through the physical quantities are transformed it allow electrical signals, which are conditioned and are discretized to be treated by systems digital, all with for the purpose of get useful and necessary information in agreement to the application for decision making.

The constant and accelerating progress of technology through the years has led to the creation of diverse equipment and electronic devices that make life easier for the human being and are oriented to seek the comfort self. In this context of the universe of technology and oriented to the acquisition and signal processing, one of the most valuable and effective contributions in the development of experimental equipment are the testing and evaluating systems of controlled by computer. (1)

The digital processing of a signal requires of the implementing a major number of calculations, making it impractical if not have a high-speed calculating machine or computer. This problem difficult to development in the area of Digital Signal Processing, DSP, to 60's and 70's, the time at which progressed quickly thanks to the availability of large computers in the institutions. In the early 80's was reduced the size of transistors enough to make a DSP processor able to multiplying 2 numbers in 1 machine cycle (800 nanoseconds). With the progress of the technologies integration, this time has now decreased to a few nanoseconds.

One test system operated by computer requires at least three elements: first, it must available test equipment compatible with it, and second, to use a PC, the software should be available so that desired tests and presentation of data to be properly, and thirdly, it

requires a system which allows effective communication between the computer and test equipment. (2)

DSP applications are large; among these are the verification of the quality of electricity supply, medicine, analysis from vibration of machines, oceanography, imaging, telephony, audio, voice, inter alia. (3)

The results obtained from this paper are feasible to apply in Monitoring of systems in which several variables are involved (physical quantities that can be monitored) which denote the behavior of their operating conditions.

The device that converts the physical signal to electric is the sensor, it provides the necessary voltage levels for data acquisition card (DAQ) and this with the right software provides a graphical and numerical report of the behavior of the physical sign, as shown in Figure 1.

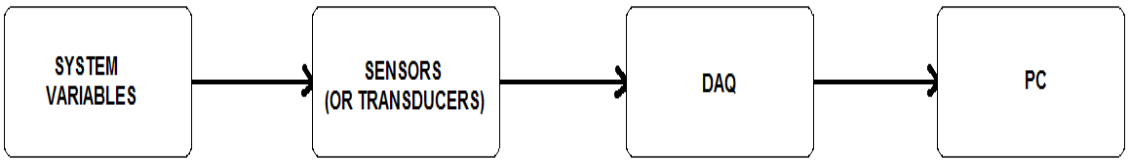

Figure 1. Esquematic diagram for data acquisition.

The system under consideration in this research consists of SAE 1018 carbon steel pipes that transport potable water and factors reported in the literature as possible causes of the phenomenon of corrosion, among which are: conductivity of the medium, pH, chloride concentration and temperature. (4)

Metallic material at contact with watery solutions (potable water) constitutes an environment that fundamentally is associated with corrosion problems due to the medium's ionic conductivity, reason why generally occurs an electrochemical-type corrosive attack. The main objective in this work is to monitor the corrosion suffered by SAE 1018 carbon steel pipelines used for potable water supply, by using DAQ the four sensors studied; supported by a graphical user interface (GUI) developed through LabVIEW, in order to detect and predict faults in the system.

Method and Material

The SAE 1018 carbon steel pipelines, have the next composition, expressed in percent of weight; iron (93.6%), carbon (0.15) zinc (5%), silicon (0.35) manganese (0.70) inter alia. (5) and (6). This work was develop using a NI USB-6229 M Series card, this card has 32 input channels, resolution of 16 bits and velocity of 250 KS/s. The software used was LabVIEW 2009 from National Instruments.

The method employs in the acquisition of data of the physical variables involve in this work consist in measurement values through of adequate sensors for each specific case; the sensors provides an electrical signal output measure that provides information that denoted the behavior of the variables monitorized.

The electrical signals provides from sensors are connected to input channels in the DAQ with already communication through of a GUI developed in LabVIEW; it shows the values taked of the input variables.

The obtained record lets the visualization in numerical form or behavior graphical of the variables in measure. These were obtained 672 samples; each one is taked by hour in a period by four weeks for each variable. The data history is generated in the computer connected at DAQ through VI (Virtual Instruments) configure to save values by hour.

Results and Comments

The results obtained referring to conductivity variable is displayed in the Figure 2. The behavior average from data for this variable takes a value of 76.1 mS/cm and a standard deviation close to 0.3 mS/cm, what evidence low dispersion and the concentration of dissolved calcium salts, carbonates, sulfates and phosphates are high, this favors the presence a passive layer on the carbon steel pipelines in the system what inhibits the corrosion process.

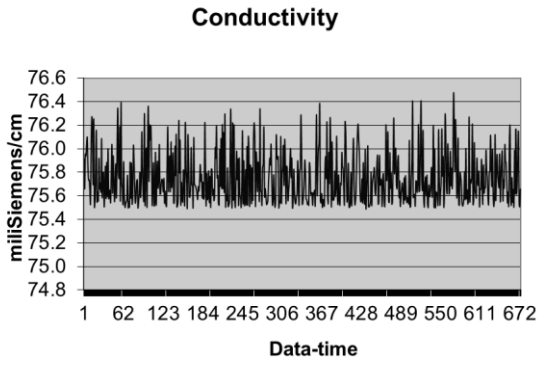

Figure 2. Behavior of Conductivity.

The Figure 3 show the tendency of pH variable; can be seen the average is 7.1 and a standard deviation of 0.4, this value is considered minimum variation and it is match with reference (7) and (8) where indicated neutral pH or close neutral, the carbon steel is immune.

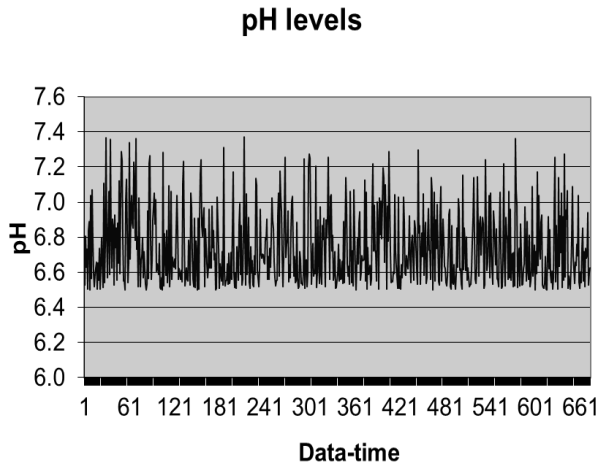

Figure 3. Behavior of pH.

The case of variable or chloride concentration factor, the average result in 6 mg/L, standard deviation 0.4 mg/L; the dispersion is not much and this means than in the presence of chloride ions in the environment, their effect in the corrosive process is obstructed by passive layer of salt forms, this result is evidence by visual inspection than there is not manifestation of bites on the surface in the pipelines. Show Figure 4.

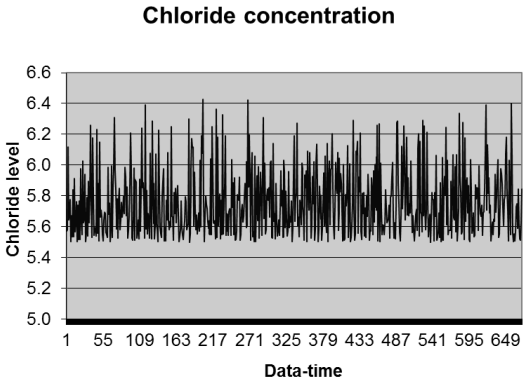

Figure 4. Behavior of Concentration chloride.

The Figure 5 show the behavior of temperature variable, the average is 24.5°C, the standard deviation about 1.5°C, the system functions in environment temperature and this operations conditions have not any influence in the corrosion velocity of SAE 1018 carbon steel.

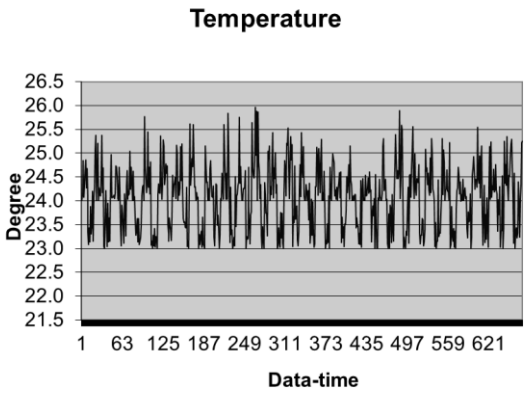

Figure 5. Behavior of Temperature.

If these conditions are maintained in the system operation will ensure the quality of water for human consumption and avoid health problems in population from the region. (9)

Conclusions

The results obtained by acquisition card about four parameters by four sensors: conductivity, pH, chloride concentration and temperature and GUI display from LabVIEW allow us to predict: The operation under existing conditions in the monitoring periodic, the environment or potable water does not cause of failure, steel cracking and other signs of corrosion than could happen in the SAE 1018 carbon steel used in supply potable water from Hidalgo region studied.

Acknowledgments

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References

1. National Instruments. 20 de abril de 2010, Introducción a PCI Express, 28 de mayo de 2010, http://zone.ni.com/devzone/cda/tut/p/id/5926#toc1.
2. W.D. Cooper, A. D. Helfrick, *Instrumentación Electrónica Moderna y Técnicas de Medición*, Editorial Pearson, Prentice Hall, 1ª Edición, New Jersey (1991).
3. M. Guzmán. 20 de abril de 2008. TEC ofrecerá nueva carrera de Ingeniería Mecatrónica. 25 de mayo de 2009, http:www.tec.ac.cr/sitios/Vicerretoria/vie/Documents/InvestigaTEC/InvestigaTEC%20NC2%BA6.pdf.
4. M. Morcillo, S. Feliú, J.M. Bastidas, *Rev. Iberoamericana de Corrosión y Protección*, **14**(2), 367 (1983).
5. P.L. Mangonon, *Ciencia de los Materiales. Selección y diseño*, p. 815, Pearson Educación, Vol. 1, México DF (2001).
6. R.S. Treseder, *NACE Corrosion Engineers Reference Book*, 2nd edition, NACE International, Houston (1991).
7. M. Pourbaix, *Lecciones de Corrosión Electroquímica*, p. 160, 1ra. Edición, Instituto Español de Corrosión y Protección, Madrid (1987).
8. E. Bolaños, L.D. López, M.A. Veloz, V.E. Reyes and G.Y. Vega, XXV, p. 593-599, The Mexican Section ECS Proceedings of 3rd Meeting of the Mexican Section ECS, Zacatecas, Zacatecas (2010).
9. F. Rico. 23 de marzo de 2008, La enorme importancia de la calidad del agua en la salud, 20 de mayo de 2008, http://www.dsalud.com/numero50_3.htm.