Signals acquisition and processing for corrosion control in carbon steel pipelines used for potable water supply

Technical Area: Signals Processing.

H. Lara-Ordaz[1], E. Bolaños-Rodríguez[2], J.M. Ramírez-Hernández[3], J. Bautista-López[4], G.Y. Vega-Cano[5], E. Flores-García[6]
[1, 2, 3, 4, 5, 6]Escuela Superior de Tizayuca, Universidad Autónoma del Estado de Hidalgo, Km 2.5 Carretera Federal Tizayuca-Pachuca, C.P. 43800, Tizayuca, Hidalgo, México.
Correo-e: [1]herbertlara@hotmail.com, [2]bola7112@yahoo.com.mx,
[3]jose_manuel1704@hotmail.com, [4]jobaulo@yahoo.com.mx, [5]*gaby@uaeh.edu.mx,*
[6]etizayuca@gmail.com

Abstract

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

Key Words: Carbon steel SAE 1018; Signals digital processing; Potable water.

1. Introduction

Corrosion phenomenon is a deterioration process suffered by metallic materials and their alloys in presence of an aggressive medium through chemical or electrochemical reactions [4], which generates considerable economic, material, environmental and human losses if the system is not controlled [2],[8].

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. Among the main factors influencing the corrosion phenomena, whose presence causes whole or partial loss of material, are the pH and oxidizer mediums that frequently are powerful accelerators of the process or sometimes could retard the deterioration due to rust formation on surface or oxygen layers absorption that turn it resistant against chemical attacks and temperature [1].

In this way, it is necessary to take into account techniques that facilitate the obtaining of real time information about the physical variables behavior, such as water's ionic conductivity, pH, chloride concentration, and temperature. The necessity of signals digital processing has great importance in our days, so that, it is very important to acquire data of signals coming from outside, generally from transducers located in different systems of production and/or manufacturing, through cards connected to the computer. Nowadays, processing via computer and visualization of data acquisition via software are essential in the monitoring and operation of control systems, which due to their complexity level and necessity could be required, providing of an interaction between the user and the system.

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: conductivity, pH, chloride concentration, and temperature; supported by a graphical user interface developed (GUI) through Lab VIEW,

in order to detect and predict faults in the system.

2. Development

2.1 Background Research

In the world of the electronic and the scope of monitorized of variables including in the control system.

Today in common observe a computer show the data acquisition by specific purpose software. In this way the monitorized of system includes multiple variables in accordance with study case, between some common like pressure, conductivity, pH, concentration, temperature, level, spending, humidity, among other.

Measurement Engineering should be highlighted signals captured by sensors that help control certain process. So the signals acquired are based on electrical measurements without differentiating are continuous or discrete, are all considered analog signals, for example to acquire a temperature through a thermocouple should measure a voltage drop or a current flowing through the bimetallic joint. If this electrical signal is referred to a distant site, the voltage or current measured is probably not exactly the value, because the electrical conductor offers some resistance and that affect the measured value, to compensate this difference should be in waypoints or elements that maintain the value of the signal, this type of analog signal is easily affected by external means to induce noise.

Today is imposed conversion of the analog signal into digital analog converters that must be located close to the sensor or primary element measuring, then this digital signal can be sent without suffering many alterations. [3]

When increase the rate of data acquisition and the advantages of silicon technologies, large amounts of data must be transferred to the PC for processing. These transfers are handled by the data bus connecting the device to the PC memory. However, the rate at which data transfer occurs is often the bottleneck in measurements, and is the main reason that many instruments have incorporated expensive memory on the card. [6]

The type of data acquisition system, analog or digital depends on the use of recorded data. In general, analog data systems are used when required bandwidth or inaccuracy can be tolerated. Digital systems are applied when the physical process under study has a little variation (narrow bandwidth) and when this needs a high accuracy and low cost per channel. Digital systems vary in complexity from single-channel systems for measuring and recording voltage automatic systems to multiple channels, which measure a large number of input parameters, compare them with respect to predetermined conditions or established limits, are to perform calculations and make decisions about the input signal. Digital systems are generally more complex than analog, both in terms of volume and complexity of the input data can be handle [9]

The variables involved in the control systems are manifested as analog signals, preserving this nature, is difficult to process them by today's digital devices, to solve this problem made use of digital processing, using current electronic systems, thus it is possible make a monitorized of different variables that denote the behavior of systems and provide elements for decision making process. This point is the importance of the work presented, the aim is to provide a base system that is capable of acquiring data from external signals from various sensors, which in the productive sector can be found in different sections of a system manufacturing, digital processing through a DAQ and provide a friendly environment for the submission of information by software through the computer, as shown in Figure 1.

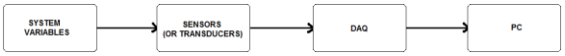

Figure 1. Esquematic diagram for data acquisition.

2.2 Materials and Methods

The carbon steel pipelines SAE 1018, 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.

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 dates of the physical variables involve in this work consist in measurement values through of adecuated 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 and an 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 question conductivity, pH, concentration of clorures and temperature.

Were obtained 672 samples, each one is taked by hour the 24 of day in a period by four weeks for each variable.

The data history is generated in the computer connected at DAQ through VI (virtuals instruments) configure to save values by hour.

3. Results and Discussion

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.

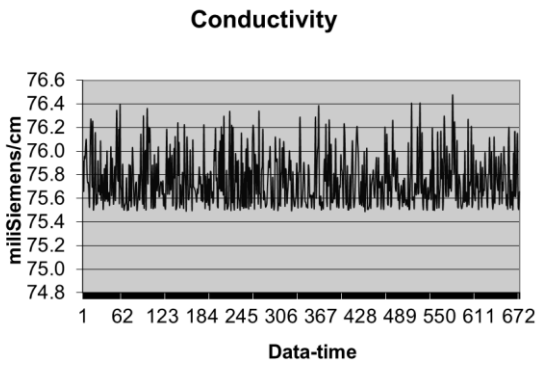

Figure 2. Behavior of Conductivity.

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] where indicated neutral pH or close neutral, the carbon steel is immune.

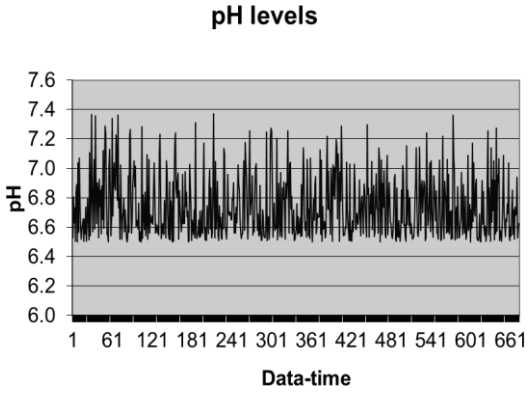

Figure 3. Behavior of pH.

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.

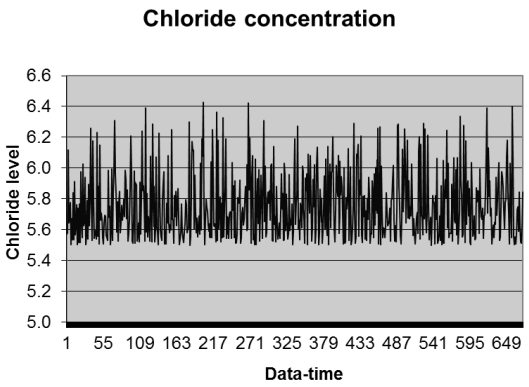

Figure 4. Behavior of Concentration chloride.

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 carbon steel SAE 1018.

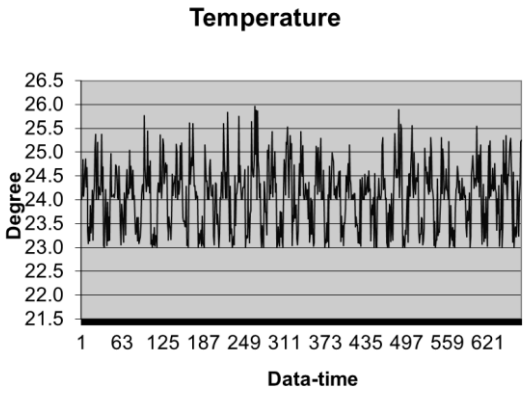

Figure 5. Behavior of Temperature.

4. Conclutions

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 carbon steel SAE 1018 used in supply potable water from Hidalgo region studied.

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