International Journal of Advance Research in Science and Engineering
Volume No 06, Special Issue No. (02), September 2017, ICITTESE-17
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Corrosion Detection

Neha Singh, Divya Singh

Asst. prof. Dept. of ET&T,

Asst. Mtech Schlor Dept of ET&T

ABSTRACT

A Blast furnace is an investment in the future. It is necessary that there is the proper dimensioning of all the equipment, systems and components as well as incorporation of technologies which assure the desired production and quality so that improved performance of the blast furnace can be achieved.

Gas is one of the major resources of nature. Gas distribution across any part is processed by the method of pipeline. Pipeline transporting gas is vulnerable to internal corrosion when water form a part of transport fluid. Internal corrosion of flow line and pipe line is inevitable when gas contain corrosive species. The consequences of corrosion such as material failure, loss of production, leakage in pipeline. Early detection on any abnormality on the pipeline such as corrosion is essential for efficient management. The corrosion rate prediction is normally carried on using a selected model for corrosion prediction. One of these models is NORSOK model, an empirical model development by NORSOK for CO_2 corrosion prediction in straight pipes.

The main objective of this research is to develop a method for early detection of corrosion in pipeline of Bhilai Steel plant. This will ensure than no leakage will take place due to effect of corrosion in pipeline. The corrosion rate is detected by using NORSOK CO_2 corrosion model. The commonly used sensors are temperature, pressure, flow sensor etc is used to measure temperature, pressure, flow rate and pH value which detect rate of corrosion. If rate of corrosion is max from ref. value then pipeline is corroded and by using ladder logic programming of PLC we can close the value of input pipeline and can be protected from harmful gas leakage.

In the industrial field and monitoring their changes using PLC and HMI interface mounted in the control room. Based on the communication between transmitter and programmed PLC module certain alarm signals can be raised and safety and security of the Industry can be maintained. Since one end being a visual Monitoring and Control (PLC) it becomes uncomplicated for one to understand what phenomenon is taking place in the field. The ultimate goal of the project is detecting corrosion and continuously monitor and if corrosion is detected it can be control by using PLC.

Keywords: Programmable Logic Controller (PLC)

I. INTRODUCTION

In industrial practice, corrosion is recognized in many components and facilities such as steel structures, chemical plants, energy production and distribution systems, oil and gas production and transportation systems, and many others (Omotosho et al., 2012). In gas production and transportation systems, internal corrosion of pipelines transporting of gas takes place due to presence of corrosive components such as carbon dioxide and hydrogen sulphate in the transported fluids.

International Journal of Advance Research in Science and Engineering
Volume No 06, Special Issue No. (02), September 2017, ICITTESE-17
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

As an alternative to applying the costly techniques of corrosion prevention and inhibition, process parameters can be monitored and controlled within safe operating limits. To do so, accurate corrosion models are used to estimate the corrosion rate and determine the critical values of the process parameters. The process should then be operated below these critical values. Efforts have been made to predict and control corrosion in many fields worldwide. As a result, many models and measurement techniques have been proposed.

In this paper, NORSOK model in straight pipes has been used to detect rate of corrosion in steel industries. This modified model can be combined with any erosion prediction model to predict the overall wear rate in pipelines. NORSOK (2005) standard CO2 corrosion model was developed by the Norwegian petroleum industry for calculation of corrosion rate due to the presence of CO2 in hydrocarbon production and process systems.

II. RELATED WORK

Our aim is to detect rate of corrosion in the pipeline. In blast furnace, numerous gases are present which contain several impure particles in it. As a result of these impure particles and exposure of pipelines to hazardous environment causes corrosion. For calculating rate of corrosion we need to know values of basic parameter of gas in the pipeline such as temperature, shear stress, and pressure of CO2 and pH value.

By using these parameters and putting this values to norsok corrosion calculation programme using ladder logic we will finally calculate corrosion rate in gas pipes . Once the corrosion rate is detected and if the value is much larger than the actual range then the supply will be stopped as all the valves will get closed

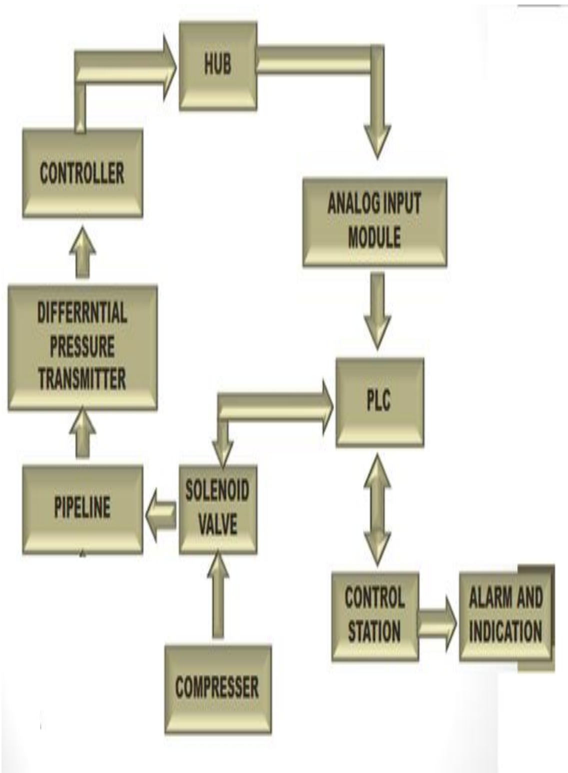


Figure 1.1 Basic block diagram of proposed work

- Gases which is to be transported are transported using different pipelines.
- Different sensors are fixed inside the pipeline so that a particular pressure of the gases and flow can be observed

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

- Once the pressure is detected it is send to controller where the necessary operation and monitoring function is to be done and after that it is send to hub.
- From hub all parametric values are transmitted to analog input module so that it can be converted to analog form which is easily understandable for plc.
- Once all the required calculation for detection of corrosion rate is done using ladder logic programme the value is transmitted to control station and if there is any variation i.e higher than the range then the alarm station will indicate the situation.

Norsok M-506 Model

This model (hereafter denoted Model NO) is an empirical model developed by the Norwegian oil companies Statoil, Norsk Hydro and Saga Petroleum. The model is fitted to much of the same lab data**8** as Model DW, but includes in addition more recent experiments at 100 to 150 °C. The model takes larger account for the effect of protective corrosion films at high temperature and high pH than DW and several of the other models. The model is considerably more sensitive to variation in pH than DW. In the second revision of the model the lower temperature limit for the model was extended from 20 to 5 °C and a lower limit of 0.1 bar CO_2 partial pressure was introduced. The model has been issued as a standard for the Norwegian oil industry and is openly available.

The model contains modules for calculating pH and wall shear stress. Three options for calculating pH are available. For condensed water without corrosion products the pH is given by the temperature and CO_2 partial pressure. The pH in condensed water saturated with iron carbonate produced by corrosion can also be calculated. For formation water the pH calculation is based on the bicarbonate content and the ionic strength. Wall shear stress can be calculated from production rates and pipe diameter. The model does not account for any effect of oil wetting. The model is not intended for corrosion prediction in systems where pH stabilization is used for corrosion control.

Basic function of this paper is to design the project which is used to detect corrosion in the steel pipeline by using NORSOK model of corrosion detection and if corrosion is detected then particular valve of pipe line is closed and can be protected for hazardous effect of gas leakage.

1) Define the process to be controlled
2) Make a sketch of the process operation
3) Create a written sequence listing of the process step by step
4) Different sensor are used to get the field data
5) That field data is applied to the NORSOK model and with the help of NORSOK mathematical calculation corrosion is detected.
6) If corrosion is detected in the particular pipeline than that particular valve is closed with the help of PLC programming.

III. RESULT

The developed model has been implemented to visual basic programming to develop a computational package with friendly graphical user interface with an input data form Extension of NORSOK CO2 corrosion prediction model for elbow geometry 105 shown in Figure 5.1.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

The input data are those related to shear stress calculations and corrosion rate calculations. To analyse the code output, the input data in Table 5.1 has been used.. That is to say, the corrosion rate variation with temperature, partial CO2, pH, shear stress and CO2 partial pressure can be obtained as output in tables or graphical forms.

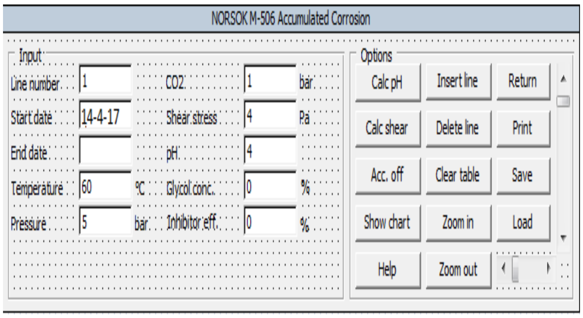


Figure 1: The input data form for corrosion prediction

Temperature(°C)	60
Pco2(bar)	2
pH	5
Shear stress(Pa)	19

Table 1: Input data for corrosion prediction

The effects of CO2 partial pressure on CO2 corrosion

The CO2 partial pressure highly affects corrosion rate. The relationship is directly proportional. From NORSOK model, CO2 partial pressure contributes to corrosion rate as CO2 fugacity which is to be calculated using. CO2 fugacity affects corrosion rate directly (raised to the power 0.62) and implicitly as a part of wall shear stress exponent. Figure 5.2 and Table 5.2 show how the corrosion rate varies with the CO2 partial pressure.

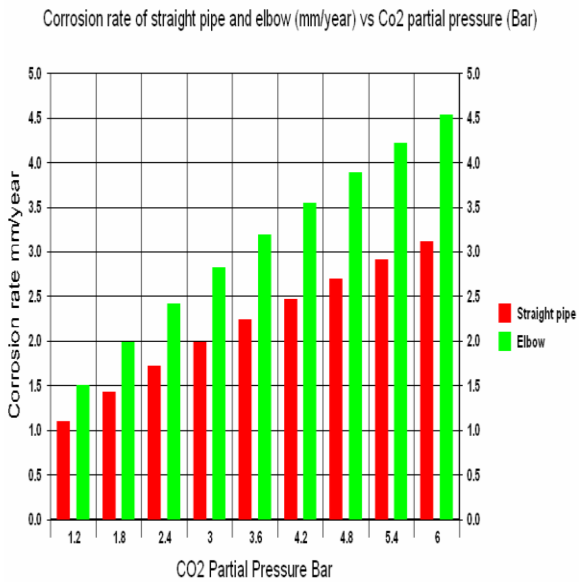


Figure 2 The effect of CO2 partial pressure (Bar) on corrosion rate (mm/year) for straight pipes and elbows

International Journal of Advance Research in Science and Engineering
Volume No 06, Special Issue No. (02), September 2017, ICITTESE-17
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

S.No.	CO2 partial pressure (bar)	CO2 partial pressure bar Corrosion rate (St pipe)mm/year	Corrosion rate (elbow) mm/year
1	1.2	1.031	1.422
2	1.8	1.339	1.872
3	2.4	1.612	2.274
4	3.1	0.862	2.645
5	3.6	2.094	2.993
6	4.2	2.313	3.323
7	4.8	2.521	3.637
8	5.25	2.671	3.865

Corrosion rate measurements

Corrosion rate was measured by connecting the electrodes to their corresponding wires in GillAC potentiostat, which was connected to a computer. The potentiostat signals were displayed in the form of simultaneous fluctuations of current and potential with time. A software package called sequencer was used to display the signals and to analyse the results to obtain the corrosion rate in mm/year.

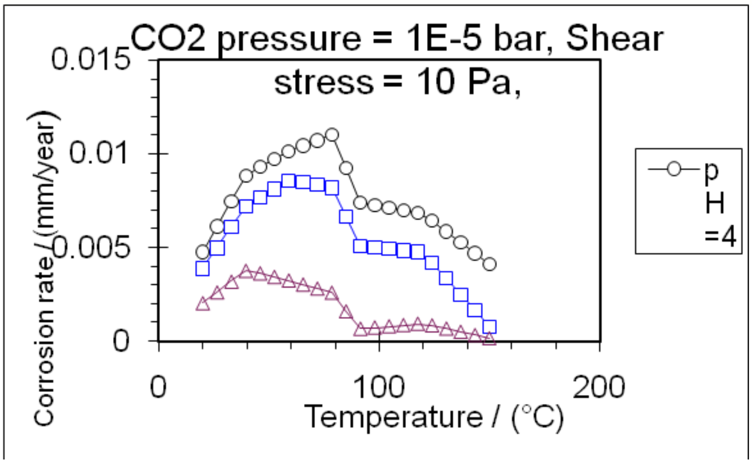
Figure.3 show the value of rate of corrosion for 3 different value of each parameter. On the basis of the input data output is calculate by NORSOK model of corrosion rate prediction

Equipment	Identifier	Temperature	Pressure	CO_2 partial pressure	mole% CO_2	CO_2 fugacity	Shear stress	pH	Inhibitor efficiency	Glycol concentration	Glycol reduction factor	Specific gravity	Water viscosity	Maximum relative liquid viscosity	Corrosion rate without inhibitor effect	Corrosion rate with inhibitor or glycol effect	Comment
		°C	bar	bar	%	bar	Pa		%	%			cp		mm/year	mm/year	
c		20	1	0.1	10	0.1	10	5	0	0	1	0.8	1.089	7.06	0.83	0.83	
c		20	1	0.1	10	0.1	10	5	0	10	0.84	0.8	1.089	7.06	0.83	0.7	
c		68	1	0.16	16	0.16	10	5	0	10	0.84	0.8	0.4373	7.06	1.1	0.93	

Calculated results from the NORSOK M-506 CO2 corrosion rate model

On the basis of three different value of each parameter corrosion rate is detected and graph is plotted for corrosion rate and temperature with constant value of CO2 pressure and shear stress

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346



Graph between corrosion rate and different value of temperature with CO2 pressure and shear stress as constant

IV. CONCLUSION

In This final project has designed to detect the rate of corrosion in the blast furnace gas pipeline and after the calculation of corrosion rate it is used as a set value. If the corrosion rate of any particular pipeline exceeds from their maximum limit then with the help of ladder logic programming that particular valve is closed to protect leakage of hazardous gas. Through the completion of the project, we were able to protect leakage of hazardous gas and prevent from accidents caused by leakage of gas.. A system was created to simulate a typical assembly line application. Designs were drawn, and programs were written using information and ideas expressed in the PLC course. In the end, this was a successful project and a great learning experience.

Programmable Logic Controllers (PLCs) are basic command/control units in an automation environment. PLC hardware, interfacing, programming and testing techniques should be mastered properly by engineering students, before they proceed to more advanced automation domains.

NORSOK standard CO2 corrosion prediction model has been modified to make it applicable to e to straight pipes. A visual basic program with friendly graphical user interface has been developed to implement the extended computational model. The results of the modification show significant detection of the corrosion in blast furnace pipe. The programme allows the investigation of the effect of different model parameters on corrosion rate. It was found that CO2 partial pressure has the largest effect on corrosion rates whereas viscosity has the smallest effect. The model results have been validated with measured data and accepted agreement has been attained.

This paper proposes the architecture of a PLC programming environment that enables a visual verification of a PLC program by synchronizing a PLC program with a corresponding virtual plant model. The model layer of the proposed architecture consists of three models: a plant model, a PLC program (control model) and an I/O mapping model. The plant model includes all manufacturing devices of the production system, and the PLC program contains the control logic for the plant model. The I/O mapping model functions as a communication link between these two models. As the plant model plays a key role in the proposed PLC programming environment, it is essential to develop a practical methodology in the construction of a virtual device model as well as a virtual plant model. We made a simple PLC system which act as a real world system to present a basic

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

concept of mapping a control system model to a controller for testing the control system. In addition, we have presented a specific implementation using Rockwell Software applications. We have focused on the configuration of I/O points, connecting it to tags defined in the control system for communication between the control system and programming monitor. The processor proposed can solve a ladder logic rung in a cycle. Hence, it can provide fast processing because the relay logics are being solved concurrently regardless of the number of steps in a rung. The proposed calibrator for training in Automation and Control Engineering was successfully tested. The proposed methodology for the construction of a plant model has two major benefits. The first is the reusability of a virtual device model, signifying that the structure of the virtual device model achieves independence from the configurations of a production system. The second benefit is that we can intuitively define the state transition diagram of a virtual device model. It is not necessary for users to have in-depth knowledge of discrete event system modeling, as they simply have to identify a set of tasks in order to define a virtual device model.

REFERENCES

[1]. R. Nyborg, "Overview of CO_2 Corrosion Models for Wells and Pipelines", CORROSION/ 2002, Paper No. 02233, (Houston, TX: NACE International, 2002).

[2] R.Jalilzadeh Hamidi, R.Jalilzadeh Hamidi, Seyed Hossein, Zhihua. 13 April 2015, "A Novel Approach to Utilize PLC to detect Corroded and Eroded Segment of power Transmission Lines", IEEE Transaction on power Delivery, Volume: 30, Issue: 2, . Page(s):746-754

[3] Ramanathan S. Lagudi, Barry L. McGraw, Robert J. Cain. 2014," Terahertz corrosio detection method", Battele Memorial Institute, Publication number, US8623653

[4] Nisar Ali Jafrey, Sujeewa Hatiwate., 2014, "Corrosion detection in steel reinforced aluminium conductor cables", Power Engineering Conference (AUPEC), Australasian **Universities**

[5] P. Huthwaite, Remo Ribichini, Peter Cawley,Michael J. S. Lowe. June 2013, "Mode **selection for corrosion detection in pipes and vessels via guided wave tomography." IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control (Volume:60) Page(s): 1165 - 1177**

[6] Zhu Liang, Liu Hong-yi, Yuan Pei-xin., 2010," Study on Image Identification Method of In-service Pipeline Corrosion Fault", Information Technology and computer Aided Technology, Second International Conference

[7] Richard K., J. Worsley. April 2008, "Digital Pipeline Leak Detection Using Fiberoptic Distributed Sensing (DTS)." Westwick-Farrow Publishing, What's New in Process Technology

[8] Y. Wen, P. Li, J. Yang, Z. Zhou,2004, " Adaptive Leak Detection and Location in Underground Buried Pipelines, International Journal Of Information Acquisition, vol. I, no.3, pp269-277

[9] De Ward, C.;Lotz, U.; and Dugstad,A., 1995. "Influence of liquid flow velocity on CO2 corrosion; a semi – empirical model",. NACE International corrosion/1995, paper#96019

[10] I. Y. Suleiman, O. B. Oloche,and S. A. Yaro, 1997, NACE International corrosion/1997, paper#601

[11] Fu-Chen Chen, Mohammad R. Jahanshahi, Rih-Teng Wu,Chris Joffe, 2017, A texture - Based Video Processing Methodology Using Bayesian Data Fusion for Autonomous crack Crack Detection on Metallic Surfaces", Computer-Aided Civil & Infrastructure engineering.

[12] Ms. Sindhu S Kale, Amairullah Khan.,2014, “Development on Gas Leak Detection and Location System Based on Wireless Sensor Networks”, International Journal of Engineering Trends and Technology (IJETT) – Volume 12 Number 6, Page 308

[13] Hongwei Wang, Ji Yong Cai, William Paul Jepson, 2002, “CO2 Corrosion Mechanistic Modeling and Prediction in Horizontal Slug Flow”, NACE International 2002

[14] S.Sivajothi Kavitha, S. Senthilkumar, April 2015, “A Wireless Gas Leakage & Level Detection with Auto Renewal System” International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 4, Issue 4,

[15] Kragujevac, Serbia and Montenegro.,2005, research regarding functional parameters, influence about corrosion rate at crude oil pipes’, balkantrib’o5 5th international conference on tribology, Vol. 18B, 1999, pp. 1821-1828

[16] Daniel J. Barnard and David K. Hsu.,1999, “data processing scheme with the Dripless Bubbler ultrasonic scanner in the ARINC trials” Review of Progress in Quantitative Nondestructive Evaluation, Vol. 18B

[17] Srdjan, N.,2007, “Key issues related to modeling of internal corrosion of oil and gas pipelines”—A review. Corros. Sci. 2007, 49, 4308–4338.

[18] NORSOK, "Condition Monitoring of Loadbearing Structures " vol. N-005, ed, 1997.

[19] NORSOK, "Assessment of Structrual Integrity for Existing Offshore Load-bearing Structures " vol. N-006, ed, 2015

[20] Rolf Nyborg, 1996, “Combining research and field data for corrosion rate prediction, CORROSION/96”, paper no. 27, Houston Texas: NACE International, 1996