Preventive Maintenance of Underground Pipeline with the help of Cathodic Protection

Faheem Haider Haidry
Mechanical Department, Jhulelal Institute of Technology, Nagpur, Maharashtra, India

***Abstract*— Ever increasing problems in oil or gas pipelines can have serve environmental and economic consequent. Therefore, large investments have been made in studies on corrosion prevention for buried pipes. Important research is being conduct to determine and predict the corrosiveness of the oil, corrosion mechanism in the ground and to develop effective protection techniques such as coatings for buried metallic structures. Moreover, because of the hidden character of pipelines and their low accessibility, installation, survey, maintenance and repairs is intricate, elaborate and expensive.**

Numerical modeling can provide some relief by simplifying and optimize installation, maintenance and repair. When used in the planning phase, conceptual mistakes can already be traced before any actual installation, by calculating different set-ups in cheap, harmless and fast simulations. Also, a model can provide reference values for measurements on operational sites that can help in the tracing and solving of any possible anomaly.

Last but not least, the model technique creates a safe and cost effective on screen 'virtual' test environment where new corrosion engineers can gain experience without long and expensive 'trial and error' experiments on site.

Index Terms: **12VBattery, Electric Wire, Half Cell Device, G.I. Pipe, Multimeter**

I.INTRODUCTION

Research is being conducted to determine and predict the corrosiveness of soil, corrosion mechanism in the ground, and effective protection techniques such as coating and painting of menaced metallic structure. Moreover, because of the hidden character of pipelines and their low accessibility, installation, survey, maintenance, and repair are intricate, elaborate, and expensive.

In the present work, the OKAPPI model used to calculate situations where stray current disturb the system buried in the Soil and where the sources of safety current are completely underground. In a second phase, the model was adjusted and extended.

Numerical modeling can provide some relief by simplifying and optimize installation, maintenance and repair. When used in the planning phase, conceptual mistakes can already be traced before any actual installation, by calculating different set-ups in cheap, harmless and fast simulations. Also, a model can provide reference values for measurements on operational sites that can help in the tracing and solving of any possible anomaly.

Fig. No. 01

Last but not least, the model technique creates a safe and cost effective on screen 'virtual' test environment where new corrosion engineers can gain experience without long and expensive 'trial and error' experiments on site.

As demonstration by the four pipelines investigated, the synergistic use of polyethylene encasement and cathodic protection for ductile iron pipe is not new. The authors are aware of over 300 miles of DIP being constructed with this corrosion control strategy over the last 30+ years.

II.HISTORY OF CATHODIC PROTECTION

Cathodic protection was first described by Sir Humphrey Davy in a series of papers presented to the Royal Society in London in 1824. After a series of test, the first application was to the HMS Semarang in 1824.

Sacrificial anodes made from iron were attached to the copper sheath of the below the waterline and dramatically reduced the corrosion rate of the copper. However, a said effect of the CP was to increase marine growth. Copper, when corroding, releases copper ions which have an anti-fouling effect. Since excess marine growth affected the performance of the ship, the Royal Navy decided that it was better to allow the copper to corrode and have the benefit of reduced marine growth, so CP was not used further.

Davy was assisted in his experiments by his pupil Michael Faraday, who continued his research after Davy's death. In 1834, Faraday discovered the quantitative connection between corrosion weight loss and electric current and thus laid the foundation for the future application of cathodic protection.

Thomas Edison experimented with impressed current cathodic protection on ships in 1890, but was unsuccessful due to the lack of a suitable current sources and anode materials. It would be 100 years after Davy's experiment before cathodic protection was used widely on oil pipelines in the United States.

Case histories are presented where polyethylene encasement and cathodic protection have been used together to effectively control external corrosion of ductile iron pipelines in very corrosive soils. This practical and cost effective strategy capitalizes on the synergistic effects of these tow established corrosion.

Pipeline designs dating to at least the 1970s for over 300 miles of construction have included this corrosion control methodology. The case histories include both impressed current and galvanic anode protection. Non-invasive surface electrical potential measurements and record reviews were used to determine location for excavations to inspect the condition of the pipe and polyethylene encasement.

III.CONSTRUCTION

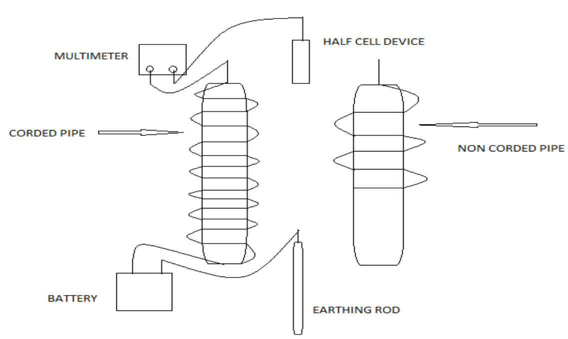

Fig.No. 02

IV.WORKING

Two cast iron pipes are taken them one pipe is fully coated with rubber coating. Another pipe is not completely coated which is assumed to be corroded pipe i.e. damage pipe. Now both the pipes are buried under the ground. Between two pipes half-cell device is placed which is used to measure the soil potential. The earthing rod is also buried underground in soil. Both the pipes buried under soil are connected with the two wires which are taken above. One connection of the 12V battery is connected with the non-corroded pipe i.e. with cathode and anode terminal of battery is connected with earthing rod.

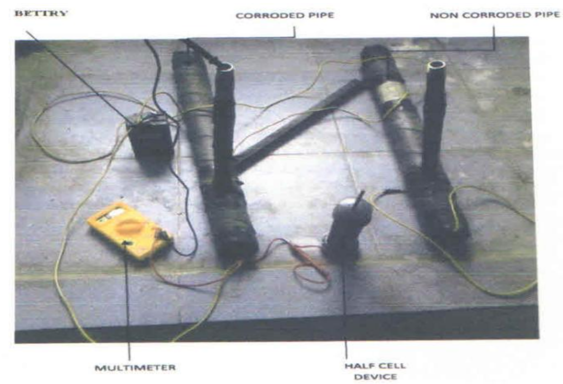

Fig.No. 03

Now the readings are taken with the help of using multimeter. One terminal of multimeter is connected with the half-cell device and another to the rod connected to the pipe. Readings are noted. The table below shows the sample readings with both corroded and non-corroded pipe with 6V and 12V battery.

PIPES	6V BATTERY	12V BATTERY
NON-CORRODED PIPE	5.67	11.65
CORRODED PIPE	3.48	6.87
M.S. STEEL PIPE	6	12

Table No. 01

V.ENGINEERING UNDERGROUND PIPELINE SAFETY

Each day in the United Sates we use millions of gallons of crude oil to maintain our living and lifestyles. A 2004 study Economic Energy Report on oil Production and consumption, has listed the amount of world's daily production of oil at about 76 million barrels per day. According to the report, the United Sates use 20 million barrels of oil daily. This is an enormous quantity of energy use in this country.

Natural Gas Pipelines:

Underground pipelines are also used to distribute natural gas to consumer including homes and apartment buildings. The aging steel, gas, plastic pipes. (Since plastic pipes are buried underground they never corrode). One major problem with plastic pipes, however, is that unfortunately, they are vulnerable to ruptures caused by construction equipment.

VI.ADVANTAGES AND LIMITATIONS

Advantages:

1. Pipelines are generally the most economical way to transport large quantities of oil, refined oil products or natural gas over land. Compared to shipping by railroad, they have lower cost per unit and higher capacity.
2. The main advantage is the detection of the corrosion before pipe bursting.
3. The pipeline corrosion detection helps in continuous supply of fuels.
4. The risk transportation of highly inflammable fuels through tankers is overcome.
5. The set-up cost is low.

Limitations:

1. The construction of underground pipelines is difficult.
2. The construction of underground pipeline is high.

VII.CONCLUSION

As petroleum pipelines age, the public is increasingly concerned about the safety condition. Although the oil and gas utilities companies continue to install new and better pipelines, the major damage to underground oil and gas lines often is caused by contractors who repeatedly violate the state’s damage prevention laws.

We know that the safety of underground pipelines has substantially improved over the last 30 to 35 years. However, there is some concern that the oil companies’ preventive maintenance and corrosion-control practices have not worked completely in all cases, but nevertheless, pipelines are still the safest and most economical means of transporting oil and gas products compared to transportation by trucks, trains etc.

Although the oil and gas utilities companies continue to install new and better pipelines, the major damage to underground oil and gas lines often is caused by contractors who repeatedly violate the state damage prevention laws.

REFERENCES

[1] A.W. Peabody, Peabody's Control of Pipeline Corrosion, 2nd Ed., 2001, *NACE International*. ISBN 1-57590-092-0.
[2] EN 12473:2000 - General principles of cathodic protection in sea water.
[3] Transportation Safety Board of Canada, Report Number P99H0021, 1999.
[4] *NACE International* Paper 09043 Coatings Used in Conjunction with Cathodic Protection.
[5] R.C. Morrison, Metallurgical Corrosion (1969)
[6] Davy, H., Phil. Trans. Roy. Soc., 114,151,242 and 328 (1824).
[7] Cathodic Protection Installation Systems.
[8] Cathodic Protection Surveys (CIPL).
[9] Propane Tanks Installation.
[10] Corrosion in Indian Petroleum industry-HajraChoduhari.