ISSN No.: 2454- 2024 (online)

International Journal of Technical Research & Science

# UPCOMING AND EXISTING SYSTEM IN CATHODIC PROTECTION OF PIPELINES

**Yash Kumar Singh[1], Dr. Pushpendra Singh[2], Yash Mathur[3]**
**yashkumarsingh2@outlook.com[1], pushpendrasingh@jklu.edu.in[2], mathuryash93@gmail.com[3]**
**Electrical[1,2], Mechanical[3] Department, JK Lakshmipat University, Jaipur, India**

**Abstract:** This review paper mainly focuses on the corrosion in pipelines and to provide cathodic protection by using RTU, Data Logger and GPS time module of MDPL, HPCL Jaipur. The overall purpose was to make existing system smart and interacting which can help in every manner i.e. safety, efficiency and productivity. Some of its applications are providing suitable alarm system, mobile notification and operation and three level security of existing system. As compared to the already existing system the new smart system turns out more efficient and reliable, economically easy, safe and occupies less space. The use of PLC and SCADA helped to monitor the smooth working of the pipelines and rectify any fault if noticed.

## 1. INTRODUCTION

Cathodic protection (CP) is a technique used to control the corrosion of a metal surface by making it the cathode of an electrochemical cell. A simple method of protection connects the metal to be protected to a more easily corroded "sacrificial metal" to act as the anode. The sacrificial metal then corrodes instead of the protected metal. For structures such as long pipelines, where passive galvanic cathodic protection is not adequate, an external DC electrical power source is used to provide sufficient current. Impressed Current Cathodic protection is used in pipelines in this method an impressed current is applied in the opposite direction to nullify the corrosion current and convert the corroding metal from anode to cathode. ICCP systems use anodes connected to a DC source the negative terminal of DC source is connected to pipeline to be protected. The anode is kept in the backfill to increase the electrical contact with the surrounding soil.

## 2. CORROSION

The process by which metal convert into its lower energy metal oxide is called corrosion. Thermodynamically metal always seeks to its lower energy state. A significant amount of energy is put while it's extracted from its ore. It's like in order to make iron from iron from iron oxide. Internationally one tonne of steel turns into rust every 90 seconds Energy required to make 1 tonne of steel is equal to the energy consumed by 1 family over 3 months 50% of steel produced world over is used to replace rusted steel One rupee invested in corrosion control saves seven rupees worth of corrosion loss Corrosion loss is approx. 3 - 4% of GNP in each country.

### 2.1 Due to Corrosion

- Loss of mechanical strength
- Loss of efficiency
- Loss of lifetime
- Wear
- Expensive control system
- Routine system

**Table-2.1 Things Lead to Degradation**

| AQUEOUS | SOIL | SURFACE |
|---|---|---|
| PH level | Temperature | Area |
| Partial pressure of oxygen | Acidity | Gas |
| Flow velocity | Partial pressure of oxygen | Temperature |
| Conductivity | Presence of chlorine | Humidity |
| | Bacteria | Salt content |

## 3. CORROSION IN PIPELINE

- Corrosion is a natural process that occurs when materials made from metal return to their original state through a chemical reaction known as oxidation

- Corrosion of all types is one of the leading causes of pipeline leaks and raptures.
- Improved technology has led to better prevention, monitoring, detecting and mitigation of external pipeline corrosion.

### 3.1 External Corrosion

External corrosion can result in the gradual reduction of the wall thickness due to environmental condition outside the pipeline.

- Resulting the loss of pipe- strength.
- External corrosion occurs due to environmental condition outside the pipe.
- External pipeline corrosion creates weakness at points in the pipe, which in turn makes the pipe more susceptible to the third-party damage, overpressure events etc.

## 4. CATHODIC PROTECTION

Although coating by themselves may not be the one perfect answer to corrosion control, they are extremely effective when properly used. A properly selected and applied coating will provide all the protection necessary on most of the pipeline surface to which it is applied.
On a typical well-coated pipeline this should be better than 99% and along with the CP, should give total protection.
So basically, cathodic protection (CP) is a technique to reduce the corrosion rate of a metal surface by making it the cathode of the electrochemical cell. On a pipeline the anodic and cathodic area are present on the pipe surface. At anodic areas current flows from the pipeline steel to the electrolytic environment and pipeline corrodes. At cathodic areas current flows from the electrolyte to the pipeline surface and the rate of corrosion reduced. So, it become obvious that the rate of corrosion can be reduced if every bit of exposed metal on the pipeline could make to collect the current. This is exactly what CP does. Direct current forces on the all surfaces of pipeline. This direct current shifts the potential of the pipeline in the active region resulting in a reduction in the corrosion rate of the metal. When the amount of current is adjusted properly it will overpower the corrosion current discharging from the anodic areas of the pipeline, and there will be a net current flow onto the pipe surface at these points. The entire surface than will be anode and the corrosion rate will be reduced.
Two types of Cathodic Protection: Galvanic cell cathodic protection, Impressed current cathodic protection

## 5. TR UNITS

TR Units stands for transformer rectifier units. In CP rectifiers have the following major components:

- Transformer
- Rectifier
- Controlling element

TRUs impress DC currents in to the carbon-steel/steel structure to be protected in opposite direction to the galvanic corrosion currents and protects the structure from corrosion.

### 5.1 Features and Benefits

Types of units: Natural Air Cooled, Oil cooled, Indoor Outdoor Type, Self-standing.
Transformer: All the transformers in TRUs are designed to give high efficiency giving low loss. The insulation material is used of high standard class F.
Rectifier: Rectifiers circuits have different topology depending upon load requirement
Control Element: The DC output controlled by solid state silicon-controlled Rectifiers (SCRs) with plug in type control card of electronic circuits.
Mode of operation: Auto reference mode, Manual mode, CVCC mode

## 6. sTRU

sTRU stands for smart transformer rectifier unit. As the name suggest we are making the TRU unit automated. sTRU make TRU unit more reliable, as it provides:

- Accuracy in readings
- Data Logging
- Real Time Alarms
- Alarm Notifications via GSM
- Time Stamped Data record.
- Complete Remote Control on TRU Parameters.
- Safe Mode of Control.

### 6.1 Features

TRU is integrated with RTU (Communication with SCADA), Data Logger (Stand-alone Device) and GPS Timer Modules

Better maintainability as integrated solution.
Option to monitor and control up to 40 Reference Electrodes as against 5 in legacy design. Improved data monitoring & control through Hi-Tech LCD panel and keypad Wide operating temp range: $0^0$C to +$60^0$C.

**6.2 Issues in TRU**

- It consumes more space.
- Voltage variability is high
- Low efficiency.
- Error in indication because of analog meters
- Lack of security and safety

**6.3 Improvement in Performance due to sTRU**

- It consumes less space
- Higher efficiency
- Higher security and safety
- More reliable

## 7. ANALYSIS

In the upcoming sTRU system the objective is to make the existing TRU system smart. This is achieved by implementing Data logger, GPS Timer, RTU (Communication with SCADA). By which it can store the data, give warning using alarm system in case of any emergency and provide mobile notifications about various parameters of the system. As shown in the figure below:

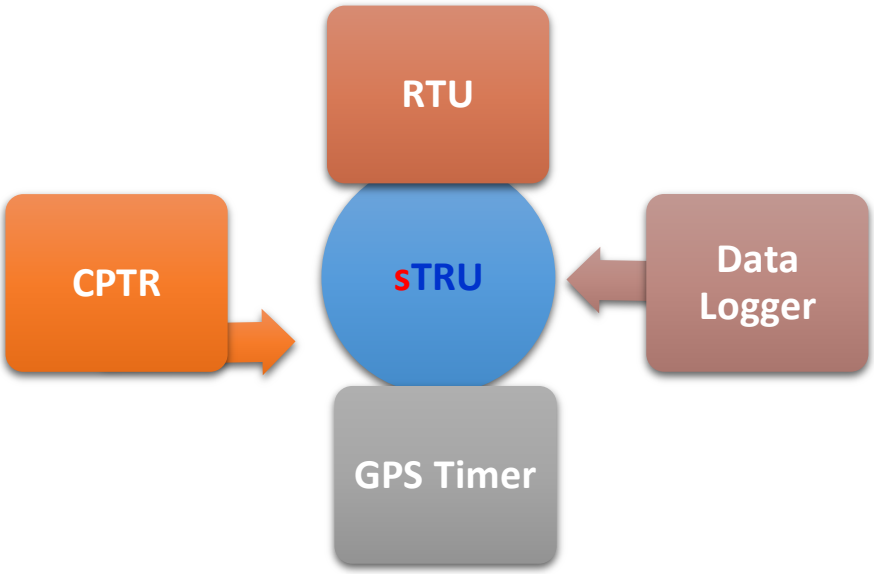


**Fig. 7.1 Features of sTRU**

**7.1 The Major Parameters of sTRU**

- Input: 1-ø, 240VAC ± 10%, 50Hz ±3Hz
- Output: 50V, 50A DC and can be extended for customer specific requirements.
- Full load power factor ≥0.8lagging @nominal input
- Operating Modes:
- Auto Ref. Mode or Auto Mode
- Constant Voltage/Constant Current Mode
- Manual Mode
- Voltage regulation in CVCC mode: 1%
- Current regulation in current limit mode: 1%
- Maintains P.S.P. within ±20mV (0.08% accuracy) of the set value under all conditions in Auto Ref. Mode
- Digital control using DSP processor to protect failures.

## 8. CONFIGURATION OF SMS SYSTEM

- sTRU will send SMS in case any of the below parameter goes out of step:
- AC Over Voltage
- AC Under Voltage
- Output Over current
- Heat Sink Temperature High

- Fuse Fail
- CAN Timeout (Communication failure between internal boards of sTRU)
- IO1 Timeout (Communication Failure between inbuilt RTU to inbuilt IO Boards)

## 9. MAJOR FINDINGS

**Table-9.1 Major Findings**

| CRITERIA | TRU | sTRU |
|---|---|---|
| **INPUT POWER SOURCE** | 1-phase 240VAC +-10%, 50 Hz<br>Derating below 216 V | 1-phase 230 VAC +-10%, 50Hz<br>No derating below 230 V |
| **EFFICIENCY** | About 70% | About 80% |
| **REFERENCE ELECTRODES** | 3 for controlling<br>6 for monitoring | 5 for controlling and upto 45 for monitoring |
| **OPERATING MODE** | Auto CVCC | Auto, CVCC, Manual |
| **VOLTAGE REGULATION IN CVCC MODE** | 0.25% | 1% |
| **PSP REGULATION** | +0.22V to -1.4V | +- 20 MV |
| **INDICATION** | Through analogue meters | Through Digital meters |
| **SIZE** | 1700X600X900MM | 1200X800X600mm |
| **DATA LOGGING** | NO | DL with inbuilt SD Card |
| **GSM NOTIFICATION** | NO | Yes via SMS |
| **TIME STAMPED ALARMS** | NO | Yes (SC Card) |
| **SECURITY PROTOCOLS** | NONE | 3 Layer (admin, standard, view) |

## CONCLUSION

In this paper we reviewed various ways to protect the pipeline from corrosion like impressed current cathodic protection also we compare the classical and upcoming smarter system and we find upcoming system more beneficial as sTRU is safe, secure, user friendly and economic. Data logger, GPS timer is a better and smarter solution for the challenges and the issues faced due to the classical transformer rectifier unit. New system has 3-layer security protocols.

## ACKNOWLEDGEMENT

Firstly, I would like to thank JK Lakshmipat University who provided me the opportunity of PS-1 so that I could be a part of one of the respective organisations of India HPCL-MDPL. I would like to thank Dr. Ing. Sanjay Goel Director IET- JK Lakshmipat University for allowing me and giving valuable advice and support.

I would like to thank Mr Amit Vinayak Nimdeo Manager-Operations MDPL Bagru, My Company supervisor Mr Kumar Mayur Sinha for the constant support and life lessons. I would also like to thank my faculty supervisor Dr. Pushpendra Singh for helping me during me during my entire research work.

## REFERENCES

[1] Peabody's Control Of Pipeline Corrosion By A.W. Peabody, Edited By Ronald L. Bianchetti.
[2] Presentation On Electrical System JRPS By Kumar Mayur Sinha Sir.
[3] Presentation On An Overview Of Pipeline Cathodic Protection By Ashish R. Abhimanyu Sir.
[4] Presentation On Stru By Anand Victor Sir.