Rawabi روابـي
لتقنية مكافحة الصدأ
Corrosion Technology

Rawabi Corrosion Technology

Refurbishment and upgrade of an existing Cathodic Protection system for buried pipe work within a Petrochemical complex utilising a closely distributed impressed current anode system

Prepared By Gary Lindsay - Operations Manager

Introduction

- **Motivation**

  This presentation shows how the installation of the close anode type Cathodic Protection system has successfully been installed and will protect the buried pipelines within a complex plant to the required criteria

  RCT are currently in the final commissioning and monitoring stages of a LSTK contract with Sharq (a SABIC company) to install commission and monitor a close anode protection system within the Sharq complex,

  This complex is now reaching approx 25 years in age and the existing Cathodic Protection system required upgrading or replacing, many of the existing plants in the Jubail area are of the same age and will require upgrades to the existing CP systems in the near future,

  This presentation is aimed as a guide for operators and maintenance departments involved in the overseeing of such a project.

Introduction (Cont'd)

- **Site location**

  Eastern Petrochemicals (Sharq) Jubail

- **Cathode type**

  Multiple Pipelines with various diameter and coating types considered to be a complex cathode.

  Separated into 11 non isolated sections within the complex.

- **Lack of isolation**

  Many of the pipelines have little or no isolation from grounding and above ground pipe-work.

Design Principles

- **Standards**
  SABIC standards.
  NACE standards.

- **Close anode system**
  Distributed anodes chosen to be located so that the structure to be protected is within the voltage gradient of the anode (non remote anodes) effective for protection of various cathodes in varying resistivity soil.

- **Current requirement**
  Current requirement calculations were carried out at the design stage of the project based on the relevant SABIC standards and separated into 11 sections on a plant by plant basis.

Design Principles

- **Anode placement**

  Anodes placed at 1.2m depth

  Minimum anode spacing of 1.5m from pipe

  Maximum anode spacing of 5 m from pipe

  Maximum anode to anode spacing of 30m

- **Congested areas**

  Due to large diameter pipes within the EG plants in close proximity to each other, anode-flex was selected was selected in these locations to supply Cathodic Protection current to areas that may have otherwise been shielded.

Material Selection

- **Transformer Rectifier Units**

  Oil cooled Transformer Rectifier units were selected that included the following features.

  Remote Monitoring and Control via a RS485 network (optional).

  Synchronised current interruption.

- **Junction Boxes**

  Stainless steel with individual shunts and resistors for measuring and adjusting individual anode current outputs.

- **Anodes**

  Cannistered Silicon Iron Tubular Anodes with various cable lengths to suit cable routing to nearest junction box.

Material Selection (Cont'd)

- **Anodeflex**

  Anodeflex 1500 to be installed in congested areas.

- **Reference electrodes**

  Permanent Copper/Copper sulphate or Silver/Silver chloride reference electrodes installed at all of the 296 new test points, depending upon ground conditions for potential monitoring purposes.

* **Coupons**

  Test coupons installed at all 296 new test points.

- **Area Classification**

  Due to the location of some pieces of equipment (TR units and Junctions boxes) within hazardous classified areas, some equipment was required to be Hazardous area type.

Installation

- **General**

  All installation work was carried out in accordance with the relevant SABIC standards and the installation monitored by both the affiliate and STC-J.

  Even thought the contract was primarily a CP upgrade the majority of the actual work was civil, i.e. excavation, cable laying, compaction and reinstatement works.

  It is essential to have an experienced civil contractor with knowledge of the relevant SABIC standards and preferably one who has worked in the plant previously and is therefore familiar with the operations and staff on a day to day basis.

  Due to the fact that the plant was operating 24 hours a day for the duration of the project all civil work was required to be carried out by hand, no mechanical excavation was allowed.

Installation (Cont'd)

- **Anode flex**

  The installation of anode-flex in the congested areas of the EG plants called for extensive excavations in congested and hazardous areas and involved cutting and removal of steel reinforced concrete slabs to allow access to install the anode-flex.

- **Paved Areas**

  Many of the anode locations were located in paved areas consisting of steel reinforced concrete slabs over the pipeline and anode locations within the complex, this called for extensive manpower requirements as all excavation had to be carried out by hand.

- **Bonding**

  To ensure a common cathode, additional bonding was required in many locations as the previous system had been sacrificial anodes at fink type test stations.

Installation problems / resolutions

Many excavations were carried out for installation of anodes at locations shown on design drawings only to find that another service was already in that location.

Approximately 30% of the 840 anodes installed had to be relocated due to existing pipelines, power cable, foundations etc. Close liaison with client technical department was required for multiple anode relocations.

Many additional services were found during the installation work and design modifications carried out and in some cases additional anodes were required to ensure all buried services were able to be protected at the completion of the project.

Many excavations were carried out and non metallic pipe located (RTR), trial holes were then required and the installation of additional bonding to ensure all metallic sections of pipe were bonded.

Pre-commissioning

Pre-commissioning was carried out in accordance with the approved procedure.

Before starting the commissioning phase of the project all sacrificial anodes were disconnected from the original Cathodic Protection system

A full potential survey was carried out at all 296 new test points, prior to energising.

It was noted that many of the permanent reference electrodes installed had failed, investigations were carried out and reference electrodes excavated and examined.

All reference electrodes that had failed were found to be in chloride contaminated water saturated soil when they were excavated.

Pre-commissioning (Cont'd))

Discussions with installation engineers / technicians confirmed that at the time of installation all reference electrodes had been installed in dry sand.

seasonal variations and the completion of expansion works which included turning off and removal of all dewatering equipment were believed to be a possible cause of the rise in the ground water level that had contaminated many of the new reference electrodes.

Discussions were held and a decision made to install silver / silver chloride reference electrodes at all the failed locations and any locations where test post installation had not yet been completed.

Commissioning

TR units were energized at 20% of the original design current and left for approximately 1 week, initially very little potential shift was noted on the structures, outputs were increased to between 50% and 80% of the TR unit capacities after numerous small increases were carried out.

It was at this time a safety issue was noted by the end user, a spark was visible between open ended drain pipes that were included in the CP system and the braided hoses that were periodically placed in them for draining certain vessels, investigations were carried out with the affiliate, STC and ourselves to find the root cause of the problem. It was noted that no sparks occurred when the CP system was not operating. Due to safety concerns especially in the hazardous areas the system was switched off until additional grounding was installed that solved the problem.

Commissioning

Due to the complex nature of the cathode (buried pipelines) some pipelines were still found to be discontinuous when the system was re-energised this was easily noticed when the 31 TR units were synchronously switched to enable instant off readings to be recorded.

During the initial commissioning phase additional bonding work was carried out to ensure all pipelines were electrically continuous.

Monitoring surveys will be carried out at quarterly intervals and minor adjustments made to ensure full protection is achieved at all test point locations.

Thankyou for your attention