TRYING NOT TO INTERFERE

Charlie Poore, SAE Inc., USA,
recalls how a team of experts applied innovative technology to solve an AC interference and mitigation issue in a harsh environment.

Alternating current (AC) interference is one of the major issues facing the pipeline industry today, and this issue has become more prevalent and widely recognised in the past 10 - 15 years. The increasing congestion of pipeline right-of-ways (ROWs) with collocated high voltage power lines has brought this issue to the forefront. Induced AC current from crossing or parallel power lines can result in AC corrosion on the pipelines when the induced AC current is discharged to the soil through coating imperfections on the pipe, known as holidays. New pipeline coatings and application techniques have improved significantly over the past decades. This, in turn, results in accelerated corrosion due to higher current discharge at these less frequent and typically smaller holidays, causing significant metal loss on pipe walls. AC interference can also result in dangerously

high levels of AC voltages on the pipeline; a health and safety issue for personnel who might come in contact with the pipeline, this voltage must also be mitigated.

Mitigation systems

AC mitigation techniques prevent induced AC current corrosion and high AC voltage levels on pipelines by providing an alternate current discharge path. By draining the induced AC current to the ground through electrical connections, AC current is prevented from flowing through the coating holidays. This also reduces the level of AC voltage to a safe level, protecting both personnel and assets.

Studies using modelling software are carried out to determine the level of AC interference and for the design of the required mitigation. Modelling software can also take projected future growth into account to provide flexibility should the level of AC interference increase based on these new parameters. Modelling software allows the owner to examine several different scenarios based on projected changes, and allows best practice techniques to be utilised in solving these complex problems.

AC mitigation systems require the pipeline to be connected to grounding electrodes, which allow the induced AC current to be discharged to the ground. Horizontal grounding electrodes are a preferred method of AC mitigation as they provide a consistent, large surface area path for the induced AC to be discharged into the ground. Additionally, solid state decouplers (SSDs) are included in the current discharge circuit, to ensure that the direct current from cathodic protection (CP) systems remains on the pipeline, while allowing the AC current to be discharged without harm to the pipeline.

Case study

In September 2014, El Paso Electric – the local utility company servicing El Paso, Texas (USA) and surrounding areas – approached independent liquids terminal and pipeline operators company, NuStar Energy, about installing three 115 kV power lines parallel to the company's pipeline along the ROW. The AC corrosion and safety risk of the existing NuStar 03P pipeline running east from El Paso in collocation with future El Paso Electric power lines, was investigated. After the initial investigation was completed, an additional study was required. The aim of this second study was to determine whether the original recommendation of continuous counterpoise electrode between power poles was required. The pipeline in question was a 10 in. coal tar coated pipeline that was installed in the mid 1990s, with approximately 14 000 ft paralleling the projected new electric transmission line. Several crossings of existing electric power lines and the pipeline were also a major concern.

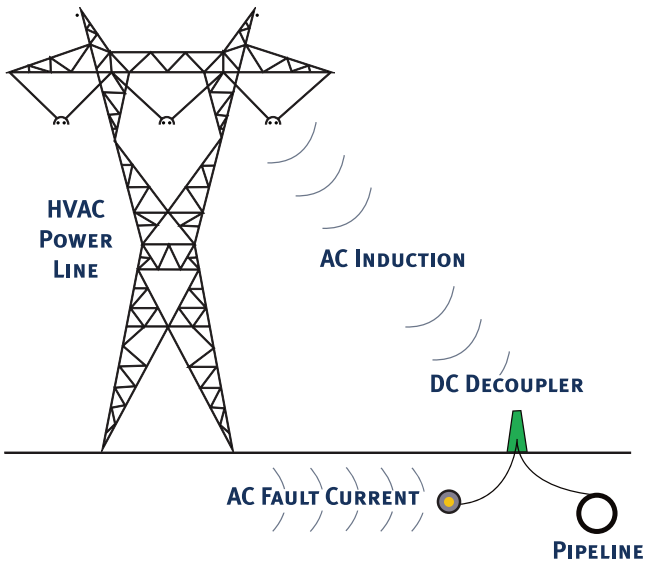

Figure 1. Typical AC mitigation solution for AC interference.

Testing

The initial testing indicated high soil resistivity and low moisture content in the soil strata. In addition, the ROW also paralleled a remote rural area with residential housing and commercial businesses along the pipeline, requiring consideration and preparation for health and safety concerns. In response, NuStar Energy assembled a team of experts consisting of the following strategic partners: Accurate Corrosion Control Inc., a full service corrosion control company located in Glendale, Arizona (USA); Elsyca, one of the premier AC interference modelling companies based out of the Netherlands; and SAE Inc., a conductive concrete manufacturer, specialising in grounding and CP protection systems headquartered in Barrie, Ontario (Canada). Accurate Corrosion Control Inc. was hired to perform the AC interference and mitigation study, and subcontracted Elsyca to do the modelling. The strategic partners were then tasked with providing a reasonable and cost-effective solution that would solve all these onsite issues.

Modelling

Initial modelling with the simulated additional induced voltage from these proposed power lines showed the project with maximum coating stress before mitigation of 8066 V and maximum touch voltage before mitigation of 3110 V. Once the modelling was completed, it was determined that the continuous counterpoise electrode originally proposed between power poles was not required. The recommendation came back calling for 16 690 ft of #4/0 copper cable encased in a 6 x 6 in. horizontal conductive concrete, Conducrete® electrode, which was installed at a depth of 5 ft, approximately 5 ft from the pipeline. The electrode was to be connected to the pipeline at five locations. The connections were made through solid state decoupler devices with a current rating of 20 A (steady state) and 5000 A (fault, three cycles clearance time). Due to the remote location, geography and logistic constraints, the engineered design called for the Conducrete to be applied in powder form. As Conducrete is hygroscopic in nature, it would absorb up to 32% of its mass in moisture from the surrounding soil. In its solidified state, it would also improve contact with earth, extend up to 20 times the life of bare

copper and significantly reduce the risk of theft of copper cable or electrode damage due to future excavations.

Installation

Accurate Corrosion Control Inc. was then faced with the task of installing this system. Two options were looked at for installing the Conducrete: it could be placed manually, which was a daunting task, as it would require approximately 5000 bags of 55 lb to be opened and poured dry over the copper cable; or a delivery system would have to be engineered to allow the super sacks (2200 lb each) to be utilised.

The decision was made to develop an automated Conducrete delivery system that could be used in a rural two track road setting. The delivery device needed to be very reliable, requiring minimal maintenance and limited personnel and equipment in order to support it in this harsh desert environment. The ROW consisted of a two track path in sandy dry desert soil so the unit needed to be compact enough to be towed behind a 1 t, 4 x 4 pickup truck. Due to this rural environment and limited resources in the field, the unit needed to be completely self-contained, including power to run the delivery system. Furthermore, fast daily setup of the machine was required as all materials and equipment had to be stored overnight in a secure environment some distance from the ROW. A minimum production capability of 500 ft/d was also requested to fit the timetable of installation and allow completion within the scope of the project.

SAE Inc.'s engineering staff designed, built and tested a Conducrete delivery system at its plant in Midhurst (Ontario). The system, mounted on a three axle trailer and powered by a 20 kW generator, was then disassembled and sent via transport truck to NuStar Energy's terminal facility in El Paso. SAE Inc.'s engineering staff then flew down to oversee the assembly, and be on hand to train and troubleshoot any issues with the Conducrete delivery system. A large 60 hp Ditch Witch trencher, extended reach forklift, a backhoe and 1 t, 4 x 4 truck completed the construction equipment list. An additional pickup truck and trailer were utilised to haul super sacks of Conducrete, copper cable and the installation crew to the jobsite. Once the delivery system was up and running, the crews trained in its operation, placement rates of 800 - 1000 ft/d were achieved. Extended travel time to and from the jobsite, trenching the ditch, laying the cable, installing the Conducrete electrode and backfilling the trench were also included in this daily production rate. These production rates were achieved with a construction crew of four to six people, plus personnel on hand from NuStar Energy to oversee and monitor the project.

The job also required that communication be closely monitored between Accurate Corrosion Control Inc. and SAE Inc., as there was limited inside storage on site. Each super sack contained enough material to cover approximately 130 ft of horizontal Conducrete electrode. With the product being shipped from SAE Inc.'s Midhurst factory at 18 super sacks per semi-truck, logistics became a critical component.

Figure 2. Compact design allows for use of 2200 lb super sacks of Conducrete for a fast and efficient placement.

Figure 3. Production rates of 800 - 1000 ft/d were realised by the SAE automated delivery system.

With a minimum lead time of one week, scheduling issues required that Accurate Corrosion Control Inc.'s purchasing department and jobsite receiving team, along with SAE Inc.'s factory and shipping personnel, work closely together to prevent a costly downtime and keep the time sensitive project on schedule.

Conclusion

The project was completed in December 2016 and commissioned shortly thereafter. The initial readings showed a significant decrease in AC voltages. It was readily apparent that the team assembled by NuStar Energy had come together with a successful design and implementation strategy. A long-term mitigation solution was achieved for this challenging project, utilising new construction methods and installation procedures in this harsh desert environment. Even with the addition of the new high voltage power lines in this shared ROW, NuStar Energy's pipeline will be adequately protected from AC interference by this AC mitigation system for years to come.