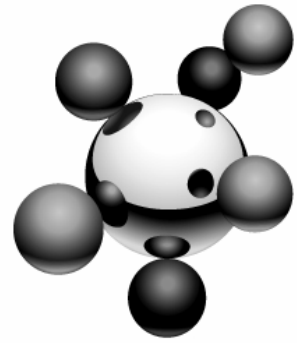


SASOL
reaching new frontiers



CATHODIC PROTECTION

Sasol Gas Limited

This Department is responsible for all the maintenance and installation of the cathodic protection system on the gas distribution network. There are three types of cathodic protection systems employed, these are the Transformer-Rectifier Units (TRU), the Forced Drainage Units (FDU) and the Natural Drainage Units (NDU).

1. Corrosion

Corrosion is an electrochemical reaction requiring the following conditions to be met:

1. There must be an anode and a cathode.
2. There must be an electrical potential between the anode and the cathode.

This potential can result from a variety of conditions on pipelines.

3. There must be a metallic path between the anode and the cathode.

Normally this will be the pipeline itself.

4. The anode and the cathode must be immersed in an electrically conductive electrolyte which is ionised - meaning that some of the water molecules (H_2O) are broken down into positively charged hydrogen ions (H^+) and negatively charged hydroxyl ions (OH^-). The usual soil moisture surrounding pipelines normally fulfils this condition.

Once these conditions are met, an electric current will flow and metal will be consumed at the anode. Figure 1 illustrates the conditions outlined above as applied to an iron anode. The pressure exerted by the potential difference between the anode and the cathode results in migration of electrons from the anode to the cathode along the metallic connection between the anode and the cathode. At the anode, with the loss of electrons, positively charged iron atoms remain which combine with the negatively charged (OH^-) ions in the environment to form a ferrous hydroxide ($Fe(OH)_2$) which may react further later to form ferric hydroxide ($Fe_2(OH)_3$) which is the familiar rust.

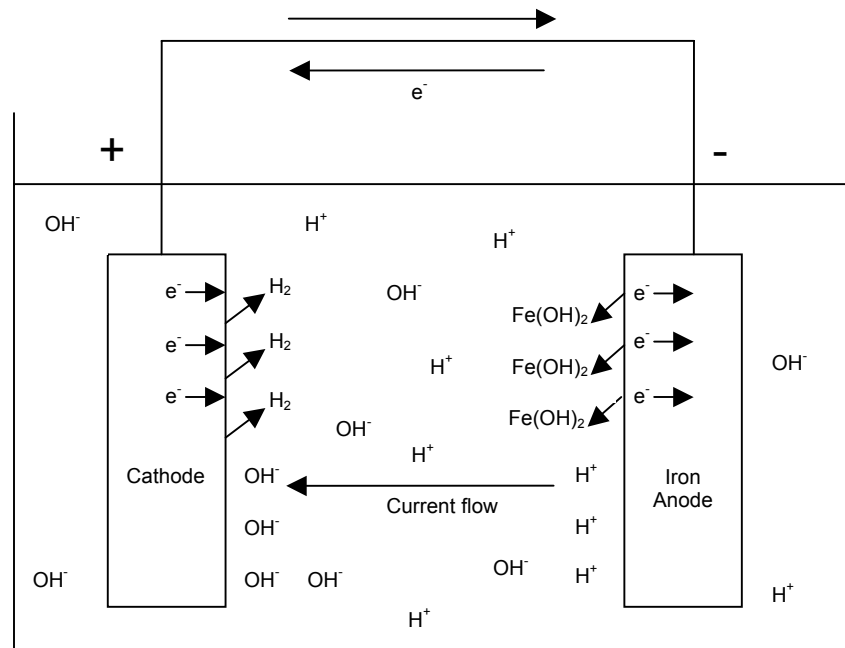


Figure 1: Diagrammatic representation of the corrosion of iron.

At the cathode, a surplus of electrons arrives from the anode. These surplus negatively charged electrons combine with positively charged hydrogen ions from the environment to form hydrogen (H_2).

2. The Principle of Cathodic Protection

In light of the corrosion mechanism described above, it becomes obvious that the pipeline corrodes at anodic areas, where current is flowing from the pipeline steel into the surrounding soil (electrolyte). Therefore, if every bit of exposed metal on the surface of a pipeline could be made to collect current, it would not corrode because the entire surface then would be cathodic. This is exactly what cathodic protection does. Direct current is forced to flow from a source external to the pipeline onto all surfaces of the pipeline. For cathodic protection to effectively protect a pipeline from corrosion wrapping of the pipe is required. The coating material used on Sasol Gas pipes is an effective electrical insulator. No coating is 100% defect free but applying it leaves only minute areas of exposed steel which need to be protected by cathodic protection. The current from the cathodic

protection flows to all the areas where the pipe is exposed. Much less current is applied to a pipe that has been wrapped, even with defects in the wrapping, than to an unwrapped pipe. When pipeline coatings are good, it is possible to cathodically protect very considerable lengths of pipeline from one location.

2.1 Transformer-Rectifier Units

Voltage from an outside source is impressed on the circuit between the protected pipeline and the ground bed. Presently the most common power source is a rectifier. The pipeline is connected to an anode (magnesium in gypsum benzonite) via the rectifier. The rectifier is a device that simply converts alternating current electric power (from Eskom) to low voltage direct current power. The usual cathodic protection rectifier has as its major components, a transformer to step down ac line voltage to low voltage ac on the secondary, a rectifying element (usually full wave rectification) and a housing for outdoor mounting.

2.2 Forced Drainage Units

Stray currents on pipelines arising from direct current transit systems such as trains can be very severe. Solving such problems is very complicated due to the continuously varying nature of the exposure as the load on the dc power sources varies. DC transit systems are operated normally with the overhead insulated feeder connected to a substation. The load current is supposed to return to the substation via the tracks which are also connected to the substation. Because tracks are laid at ground level and not insulated completely from the earth, some part of the load current will enter the ground where the tracks are most positive and take an earth path back to the substation. Pipelines in the area constitute a good return path for a portion of the earth current. Such a pipeline will carry the current to a location in the vicinity of the dc substation where it will flow from the pipeline to the earth and return to the substation. Where the pipeline is picking up

the current it is receiving cathodic protection but where the current leaves the pipeline severe corrosion will occur. The problem of stray currents is overcome by connecting the pipeline to the railway via a metallic bond. The current discharged by the tracks is picked up by all portions of the pipeline and drained off through the metallic bond. This setup ensures that the railway becomes the anode and corrosion does not occur on the pipeline.

2.3 Natural Drainage Units

The pipeline is connected directly to an anode. The anode is made from a very strongly anodic metal. This metal will corrode and in so doing will discharge current to the pipeline. This type of cathodic protection is normally only used where the current required for protection is small.
