CONTEMPORARY METALLIC MATERIALS

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Chapter 035

Cathodic Protection of Underground Pipes

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Keywords: Cathodic Protection, Underground Pipe, Corrosion Protection

Abstract: Corrosion in aqueous solutions is an electrochemical process where anodic and cathodic reactions occur simultaneously. No net overall charge builds up on the metal as a result of corrosion since the rate of the anodic and cathodic reactions are equal. If reactions anodic and cathodic occur simultaneously in a piece of metal, the rate of these two reactions can be altered by withdrawing electrons or supplying additional electrons to the piece of metal. It is an established principle that if a change occurs in one of the factors under which a system is in equilibrium, the system will tend to adjust itself so as to eliminate, as far as possible, the effect of that change. Thus, if we withdraw electrons from the piece of metal the rate of anodic reaction will increase and the dissolution of metal will increase, whereas reduction reaction will decrease. Conversely, if we supply additional electrons from an external source to the piece of metal, anodic reaction will decrease to give reduced corrosion and cathodic reaction will increase. The latter case will apply to cathodic protection. Thus, to prevent corrosion, continue supplying electrons to the metal from an external source is needed to satisfy the requirements of the cathodic reaction. Cathodic protection may be achieved in either by the use of an impressed current from an electrical source, or by the use of sacrificial anodes. Generally, sacrificial anode schemes have found favour for small well-coated low-current demand structures or for localised protection, while impressed-current schemes being utilized for large complex structures which may be bare or poorly coated.

Introduction

Development of cathodic protection systems was made in to meet the requirements of oil and natural gas industry which wanted to benefit from the advantages of using thin-walled steel pipes for underground transmission. Cathodic protection can, in principle, be applied to any metallic structure in contact with a bulk electrolyte. In practice, its main use is to protect steel structures buried in soil or immersed in water. It cannot be used to prevent atmospheric corrosion.

Structures commonly protected are the exterior surfaces of pipelines, ships' hulls, jetties, foundation piling, and offshore platforms. Cathodic protection is also used on the interior surfaces of water-storage tanks and water-circulating systems. However, since an external anode will seldom spread the protection for a distance of more than two or three pipe-diameters, the method is not suitable for the protection of small-bore pipework.