CAPROCO
INTERNAL CORROSION MONITORING SPECIALISTS

Hydrogen Monitoring General Information

INTRODUCTION

Hydrogen damage is an environmental-mechanical failure process which results from the presence of, or interaction of metal with excessive amounts of hydrogen, usually in combination with residual stresses in high strength steels and certain other high strength alloys. Cracking caused by hydrogen damage may be referred to as hydrogen stress cracking or hydrogen induced cracking.

Hydrogen damage in any one of its forms, causes problems with many types of alloys and in some applications may severely restrict the use of certain materials. Hydrogen damage can develop in a wide variety of systems due to the ready supply of hydrogen from water, moist air, hydrocarbons, acids and hydrogen sulfide. Hydrogen may also be available from chemicals during processing, pumping and storage.

The hydrogen present in the system reacts with a metal (generally steel) and produces a hydrogen ion which is capable of permeating that metal, resulting in hydrogen damage.

TYPES OF DAMAGE

The basic forms of damage which could be occurring are:

Blistering
Damage caused by the build up of hydrogen gas pressure in voids or cracks of a metal. This pressure can cause accelerated crack propagation or rupture.

Embrittlement
Damage caused by the interaction between accumulations of hydrogen and advancing cracks in a material during plastic deformation.

Decarburization
Selective removal of carbon from a metal which occurs by chemical reaction with an environment containing hydrogen. It is most commonly found in steels subject to elevated temperatures in a petrochemical plant environment.

Carburization
The reverse of decarburization, this form of attack can occur in hydrogen hydrocarbon gas mixtures commonly encountered in petroleum refining operations. Carburization may lead to a decrease in ductility and the removal of certain solid solution elements through carbide precipitation.

All of these types of damage can result in metal failure. A hydrogen probe is designed to collect hydrogen gas and measure the rate at which it permeates the metal. This measurement gives a relative correlation to the rate of corrosion and acts as an indication of the extent and types of damage which may be occurring.

RESULTS

Theoretically it is possible to calculate a correlation between the hydrogen permeation (transmission) rate and the extent of damage which is occurring. This correlation is an approximation of the corrosion activity.

The best approach is to use the hydrogen transmission rates as calculated. If a substantial hydrogen transmission rate exists in a known corrosive system and the rate can be significantly reduced and/or eliminated by corrosion control procedures, then it can be assumed that significant reduction of the corrosion attack has been achieved.

As data is collected by the hydrogen probe, the transmission rate may be calculated for each period.