# Hydrogen damage in brief

We could never have imagined just how challenging the past year has been to all business across the North West. Axiom Engineering Associates Ltd is no exception. Despite obstacles, Axiom has adapted quickly to the needs of their clients and provided first class engineering and Inspection/NDT services. Looking ahead to 2021, the Company is forging ahead with plans for growth and development of accounts within the NW region.

Axiom's regional base in Runcorn opened in Spring 2020 and following this, they have steadily sought to use this localization to broaden the scope of our services to a growing portfolio of regional clients. This approach has spearheaded Axiom's drive to deliver an increased volume of value-adding support to the North West during these times of uncertainty.

The guidance and support on offer from technical experts in Axiom's business has really come to the fore in the past year, as clients seek to best understand how they can continue operating their plant safely and economically in the present climate. To do so, a detailed understanding of the risk factors present within their assets is key, and Axiom's 'joined up' offering of Inspection and Non-Destructive Testing, supported by Mechanical and Materials Engineering consultancy, sees Axiom uniquely placed to devise strategies aimed at both preventing and managing life-limiting plant degradation.

One of the most pertinent, and often misunderstood, damage mechanisms present within operational facilities in the Chemicals sector, is hydrogen damage. Here, Axiom's Principal Materials Engineer, Steve Woodward, imparts his thoughts in brief on the subject of understanding the risks associated with this phenomenon.

"Hydrogen atoms are minutely small and able to diffuse (tunnel) through iron, however a proportion remain trapped, causing reduced ductility in high strength steel by restricting internal 'slippage' along crystal planes. Low strength steels may blister due to the pressure of gas molecules, which are orders of magnitude larger than individual atoms. Austenitic stainless steels are immune to embrittlement because their FCC structure has 4 more slip planes than BCC iron.

"Hydrogen may be present in steel from manufacture, or it may enter due to corrosion or from process gas. Sour (H2S) corrosion is more virulent because the sulphur inhibits the formation of gas molecules, making available substantially more atomic hydrogen. Molecules dissociate to atomic hydrogen above 205°C resulting in hydrogen 'charging' which doesn't reduce ductility whilst hot but can when cold or if welding is undertaken. Above ~240°C hydrogen combines with the carbon in steel, forming methane, surface fissuring and decarburisation (HTHA). Hydrogen can be driven out of steel by heating to above ~300°C, but HTHA is irreversible.

"The mysteries of hydrogen damage remain because, really, we don't know the first thing about how atoms work, hence we ended up believing quantum entanglement is actually a thing!"

Steve Woodward is a Chartered award-winning Materials Engineer and fellow of IoM$^3$ who has worked at Axiom for over 12 years, although his roots working within the Process sector stretch back further into the 1980's, where he worked as a Research Scientist for ICI's Advanced Materials Group.

Steve is a member of the EEMUA Materials Technology committee and the IoM$^3$ Materials Failure Investigation Group. He also sits on the 'events panel' of the Cleveland Institution of Engineers. Away from work, Steve's passion for Materials extends to rocks and minerals where, for the past ten years he has been secretary to Northumbria's Open University Geological Society.

***For more details please visit http://www.ax-ea.co.uk/ contact: + 44 (0)1642 732745 or email: info@ax-ea.co.uk***

*Steve Woodward*