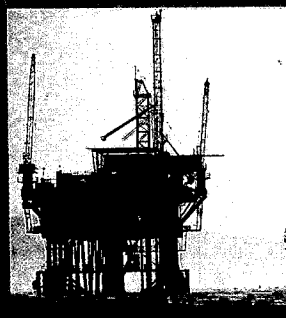

Controlling the Damaging Effects of Sulphate-Reducing Bacteria

MARINE RESEARCH REVIEW 10

MARINE RESEARCH REVIEWS

The aim of this series of short reviews, begun in 1993, is to disseminate the results of research programmes that were administered by the Marine Technology Directorate (MTD) beyond the immediate circle of the researchers and their sponsors to a wider readership in the offshore and marine industries.

The activities of MTD Ltd are now being carried out under the banner of a new company, CMPT, The Centre for Marine and Petroleum Technology Ltd. CMPT acknowledges the support of the Offshore Safety Division of the Health and Safety Executive in the production of these six reviews of research that has some implications for the safety and lifetime integrity of offshore structures. HSE was one of the contributors to each of the projects or programmes covered. Neither the Executive, the Division nor CMPT assume any liability for the reviews nor do they necessarily reflect the views or the policy of the Executive or the Division.

Six reviews have already been published, five of them with funding from the Oil and Gas Projects and Supplies Office (OSO) of the Department of Trade and Industry.

About the Offshore Safety Division

The responsibilities for regulating health and safety offshore were unified in a single body - the Health and Safety Executive - as a result of the recommendations of the Lord Cullen enquiry into the Piper Alpha disaster. A new Offshore Safety Division was set up as a result.

Research has played an important part in ensuring safety in the North Sea and will continue to do so. A major aim is to undertake an integrated programme of projects which address both the strategic or generic investigation of offshore hazards and the related short term needs, for example to support safety case assessment. A risk-based research strategy has been developed by HSE with input from the Division's Research Strategy Board to provide a means of prioritising research effort and helping to ensure that value for money is obtained.

About CMPT

CMPT is a new organisation set up to integrate research, innovation and technology for the upstream petroleum and marine industry. It will build on the capability and services of both the Marine Technology Directorate (MTD) and the Petroleum Science and Technology Institute (PSTI), each with its track record of meeting industry needs. CMPT's objective is to be the primary focal point and resource centre upon which its members rely for the provision of expertise and the facilitation of technology to enhance business performance.

Publications like Marine Research Reviews play their part in CMPT's technology transfer, delivering new technology from CMPT research programmes into use.

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Acknowledgements

This review is based on work at Cranfield University. It covers two research projects from the third and fourth phases of the Managed Programme on The Influence of Welding on the Performance of High Strength Steels (IWPHSS) (1990 - 1992; 1992 - 1994) and work that is on-going. The researchers are Dr M J Robinson and Dr P Kilgallon. The Managed Programme was funded by the Science and Engineering Research Council (now the Engineering and Physical Sciences Research Council - EPSRC) through MTD and a number of industrial sponsors (see page 14).

Members of MTD may consult the full research reports in the MTD library. Part of the work described here is also included in the MTD publication - *High strength steels in offshore engineering* (Ref. 95/100) which is priced at £55 to non-members (£40 to members). Anyone interested in taking up the described techniques should contact the researchers or the programme manager:

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Note

The Offshore Safety Division of the Health and Safety Executive has supported publication of this report to encourage dissemination of the results of research that has received public funding. This support does not imply automatic endorsement by the HSE of any of the technologies described.

Summary

Sulphate-reducing bacteria (SRB) are known to promote hydrogen absorption in steel, a process that can reduce the mechanical properties of the steel. Because of the obvious safety implications for offshore structures, two projects have investigated the combined influence of SRB and cathodic protection systems on the hydrogen embrittlement of high-strength steel. The projects have generated valuable information that will enable cathodic protection designers to select the best criteria to balance effective corrosion protection against an increased risk of embrittlement in the presence of SRB. Similar work is now being carried out on duplex stainless steels, which are being used increasingly offshore, and a further project will investigate the influence on embrittlement of biofilms which form on the surface of steel in the marine environment.

Introduction

The typical marine environment contains many kinds of micro-organisms, but the attention of the offshore industry has focused on sulphate-reducing bacteria (SRB). These organisms live in anaerobic conditions where oxygen is excluded, such as in mud deposits around platform legs and beneath marine fouling. The interest has arisen because SRB have been shown to promote hydrogen absorption in steel, a process that can have an adverse effect on the properties of high-strength steel, and therefore on the safety of offshore steel structures. Cathodic protection systems, which are widely used to control the corrosion of steel structures in seawater, are also known to increase the hydrogen content of high-strength steels. As more protection is applied to the steel, the increase in hydrogen can progressively lower the threshold stress intensity for hydrogen-assisted crack growth. It is important, therefore, to find a balance between a cathodic potential that will protect the steel from corrosion and one which will make it more susceptible to embrittlement. Two projects in the MTD Managed Programme, *Influence of Welding on the Performance of High-strength Steels*, therefore measured the combined effects of cathodic protection (CP) and SRB on the corrosion fatigue and hydrogen embrittlement of two welded high-strength low-alloy (HSLA) steels.

HSLA steels are relatively new and have two major advantages over conventional alloy steels that makes them valuable to the offshore industry. First, they offer much higher strength than a traditional carbon-manganese steel of the same weight. Second, this strength is gained by special processing so that they contain smaller amounts of expensive alloying elements, making them more cost-effective. The work on SRBs and HSLA steels began in the third phase of the Managed Programme (1990 - 1992), and was continued in the fourth phase (1992 - 1994).