Health and safety issues in the oil industry related to sudden or unexpected generation of H_2S by micro-organisms

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HEALTH AND SAFETY ISSUES IN THE OIL INDUSTRY RELATED TO SUDDEN OR UNEXPECTED GENERATION OF H_2S BY MICRO-ORGANISMS

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FOREWORD

Hydrogen sulfide (H_2S) is a toxic gas that can cause major health and corrosion problems for the oil and gas industry. Generation and release of H_2S by bacteria is unavoidable because sulfide-producing bacteria thrive when seawater and water comes into contact with oil sludge. H_2S gas can be released suddenly and unexpectedly as a result of cleaning procedures or pumping operations, but the reasons behind such releases are often misunderstood on-site. Releases of low levels of H_2S may be identified by its strong odour. However, at higher concentrations H_2S is undetectable by smell, due to the sensory paralysis caused by the gas itself – this may also occur from extended exposure to low levels of H_2S.

This guidance sets out to provide a single source of information on factors influencing the growth and development of H_2S-generating bacteria, the areas and circumstances in which this may create problems, how to monitor and control its release and how to assess and manage risk. It is aimed at on-site personnel (e.g. health and safety/site managers) and covers:

- The science behind generation of H_2S associated with microbiological activity (section 1).
- Industry-specific areas of work where microbially generated H_2S may be encountered (section 2).
- Risk assessment and management, including identifying risk situations and managing workers' exposure (section 3).
- Methods for monitoring of microbiological activity and microbially generated H_2S (section 4).
- Control of microbial sulfide generation including use of biocides and physical or chemical management of the environment (section 5).

Further, more detailed, information may be obtained from the references cited in this guidance and from the Energy Institute (EI) via their web site at http://www.energyinst.org/home

Workplace health and safety information for the UK is available from the HSE web site at http://www.hse.gov.uk/offshore/index.htm. This publication is based primarily on GB (and European) legislation and policy framework, publications and good practice. However, it is universally applicable provided it is read, interpreted and applied in conjunction with relevant national and local statutory legislation and publications. Where the requirements differ, the more stringent should be adopted.

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1 INTRODUCTION

1.1 OVERVIEW

Hydrogen sulfide (H_2S) is a very toxic, flammable gas. At low concentrations it is pungent with a 'rotten egg' odour and exposure to it can irritate the eyes, nose and throat. At higher concentrations it can rapidly cause asphyxiation, unconsciousness and death. Therefore it is important to be aware of its potential presence, to manage workplace activities that can lead to H_2S generation and to control occupational exposure.

H_2S can be a by-product of some microbiological processes, such as those involving sulfate-reducing bacteria (SRB) and other sulfide-generating micro-organisms. Sulfate-reducing microbes are defined in two ways: sulfate-reducing bacteria (SRB): any member of the phylogenetic kingdom *Monera*, division *Bacteria*, with the capability of reducing sulfate to sulfide, and sulfate-reducing *prokaryotes* (SRP): any member of the phylogenetic kingdom *Monera* (members of the divisions *Bacteria* and *Archaea*) with the capability of reducing sulfate to sulfide. These micro-organisms may be present in process systems in the oil industry; for example, when reservoirs begin to mature and take in water, or in well fluids, drilling muds, etc. Consequently, H_2S may be generated and released in any of these systems.

In the UK offshore oil and gas industry, 393 dangerous occurrences were reported to the UK Health and Safety Executive (HSE) under the Reporting of Incidents, Diseases and Dangerous Occurrences (RIDDOR) scheme in 2014 (source Health and Safety Laboratory analysis of HSE RIDDOR data). In the last five years, there was a total of three fatalities and 37 major/specified injuries. H_2S may be a significant component of SRB release. There were 115 hydrocarbon releases, a 20 % increase compared to 2013; the increase was in reported minor releases. In the first year of unanticipated H_2S release data being collected in 2009/10 three cases were reported, none were reported in 2014 (http://www.hse.gov.uk/offshore/statistics.htm).

Therefore, there is the potential for workers in the oil and gas industry to be exposed to a toxic and potentially fatal substance. The aim of this guidance is to provide a single source of information on the circumstances in which H_2S may be generated and released, how to monitor and control its release and how to assess and manage risk.

1.2 SRB AND OTHER H_2S-GENERATING MICRO-ORGANISMS

Although H_2S is often regarded in negative terms from the human standpoint, it should be recognised that it occupies a pivotal position in the global sulfur cycle (see Figure 1), and hence, is essential in maintaining the functioning of the biosphere. Consequently, there are many types of micro-organisms that are capable of producing or utilising H_2S.