

Health and safety issues in the oil industry
related to sudden or unexpected generation
of H₂S by micro-organisms

HEALTH AND SAFETY ISSUES IN THE OIL INDUSTRY RELATED TO SUDDEN
OR UNEXPECTED GENERATION OF H₂S BY MICRO-ORGANISMS

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CONTENTS

	Page
Foreword	3
Acknowledgements	4
1 Introduction	5
1.1 Overview	5
1.2 SRB and other H ₂ S-generating micro-organisms	5
1.2.1 Sulfate reduction	6
1.2.2 Other electron acceptors	7
1.2.3 SRP nutrition	7
1.2.4 Sulfur-reducing bacteria	8
1.2.5 Protein biodegradation	8
1.2.6 SRP temperature and pressure constraints	9
1.2.7 Salinity and pH constraints on SRP growth	9
1.2.8 Locations at risk from SRP activity	9
1.3 Hydrogen sulfide toxicity and exposure	9
1.4 Factors influencing hydrogen sulfide concentrations	10
1.4.1 Factors influencing hydrogen sulfide production by SRP	11
1.4.2 Factors influencing the fate of hydrogen sulfide	12
1.5 Partitioning of hydrogen sulfide between oil, water and gas phases	14
1.5.1 Water pH effects	15
2 Microbially generated H₂S in specific areas	17
2.1 Pipelines	17
2.1.1 Iron sulfide accumulation	17
2.1.2 Pigging operations	17
2.1.3 Pyrophoric iron sulfide	18
2.2 Storage tanks in refineries and terminals	18
2.2.1 Water accumulation and microbial growth	18
2.2.2 Petroleum product storage tanks	18
2.2.3 Crude oil storage tanks	19
2.2.4 Exposure to hydrogen sulfide from storage tanks	20
2.2.5 Control	21
2.3 Drilling operations	21
2.4 Oil platform operations	22
2.5 Ships	24
2.5.1 Cargo tanks	25
2.5.2 Segregated ballast tanks	25
2.5.3 Grey water tanks, sewage tanks, slops tanks and sludge tanks	26
2.5.4 Bilges	26
2.5.5 Fuel tanks, oil tanks and other tanks	27
2.6 Multimedia water filters	27
2.7 In the laboratory	29
3 Risk assessment and management	32
3.1 Context	32
3.2 Identifying risk situations	32

Contents continued...**Page**

3.3	Predictive models for microbially generated hydrogen sulfide.	32
3.3.1	Background.	32
3.3.2	Souring models	33
3.4	Risk management	34
3.4.1	Control H ₂ S production	34
3.4.2	Manage equipment and provide safe systems of work.	34
3.4.3	Managing workers' exposure.	34
3.4.4	Provide detection and alarms.	34
3.4.5	Provide emergency procedures	35
3.4.6	Additional information about personal protective equipment (PPE)	35
3.4.7	Additional information about the area classification scheme	36
4	Monitoring of microbially generated H₂S.	37
4.1	Monitoring H ₂ S	37
4.2	Monitoring SRP and microbial activity	39
4.2.1	Sampling.	39
4.2.2	Serial dilution	40
4.2.3	RapidChek® II and Quickcheck® SRB detection system	41
4.2.4	Fluorescence <i>in situ</i> hybridisation (FISH).	41
4.2.5	Bacterial population profile and SRB identification using DGGE	42
4.2.6	Quantitative PCR (qPCR)	42
4.2.7	Activity measurements.	42
5	Control of microbial sulfide generation	44
5.1	Biocides and oxidising chemicals	44
5.1.1	Oxidising biocides	45
5.1.2	Metals.	46
5.1.3	Organic biocides	46
5.2	Nitrate as a competing electron acceptor.	48
5.2.1	Nitrate doses.	50
5.2.2	Enhanced corrosion.	50
5.3	Physico-chemical manipulation of environment	51
5.3.1	Overview of theoretical strategies	51
5.3.2	Increasing pH	51
5.3.3	Adjusting temperature.	52
5.3.4	Increasing oxygen concentration	52
5.3.5	Reducing or eliminating nutrient sources	53
5.3.6	Reducing or eliminating sulfate sources	53
5.3.7	Filtration and centrifugation	53
5.3.8	UV light.	54
Annexes		
Annex A	References.	55
Annex B	Abbreviations	59

FOREWORD

Hydrogen sulfide (H₂S) is a toxic gas that can cause major health and corrosion problems for the oil and gas industry. Generation and release of H₂S by bacteria is unavoidable because sulfide-producing bacteria thrive when seawater and water comes into contact with oil sludge. H₂S 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 H₂S may be identified by its strong odour. However, at higher concentrations H₂S 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 H₂S.

This guidance sets out to provide a single source of information on factors influencing the growth and development of H₂S-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 H₂S associated with microbiological activity (section 1).
- Industry-specific areas of work where microbially generated H₂S 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 H₂S (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 (H₂S) 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 H₂S generation and to control occupational exposure.

H₂S 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, H₂S 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. H₂S 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 H₂S 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 H₂S may be generated and released, how to monitor and control its release and how to assess and manage risk.

1.2 SRB AND OTHER H₂S-GENERATING MICRO-ORGANISMS

Although H₂S 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 H₂S.