



BACTIREP

Biocides



Additives
for oil production



The metallic materials (usually carbon steel) used in the field of oil production suffer a great deal of damage due to one of the most aggressive environments.

The bacteria in this environment play an important role in the phenomena of corrosion deterioration.

These alteration mechanisms may be direct or indirect, where they relate to the same activity of the bacteria in contact with the metal, but also to the bacterial activity that induces the production of corrosive chemicals, such as hydrogen sulfide.

BACTERIA IN THE OIL INDUSTRY

The oil and gas industry, where water is used as a vehicle and material of extraction, is an extremely favorable environment for bacterial growth that can cause considerable damage when it is not carefully monitored.

In the environment, two main types of physiological development occur in bacteria: a planktonic phase (the bacteria is suspended in the aqueous phase) and the fixed bacteria, called sessile, that attach to the surface and produce anchoring exopolymers and are the cause of the formation of biofilm.



Cratering due to the presence of SRB/TRB

The microbial attack is characterized by the rapid creation of craters located on the metal surfaces and eventually the drilling of production wells, injection lines of products etc.

The consequences can be very great for the production and result in financial losses and personnel safety issues.

The bacteria encountered, the sources of problems in oil production, are:

- **Acidogenic bacteria**

These bacteria produce acids via their metabolism that cause corrosion by attacking the passivation film of metal.

- **SRB (sulfate reducing bacteria) and TRB (thiosulfate-reducing bacteria)**

They are responsible for bacterial corrosion and the formation of localized corrosion. Via their metabolism, they produce H₂S and deposits of FeS. These are to be seen most often in injection or production water when it is mixed with seawater.

- **Ferrobacteria**

These bacteria convert the soluble ferrous iron to insoluble ferric iron.

CONTROL METHODS

Biocides are usually applied in closed systems to control bacterial proliferation in order to avoid the corrosion influenced by bacterial flora (MIC: microbially influenced corrosion), the production of organic acids and hydrogen sulfide (H₂S). Similarly, biocides also prevent the formation of biofilms and iron sulfide, which stabilize oil/water emulsions.

The control of bacterial populations in oil and gas recovery processes is critical to the functioning of operations.

Antimicrobial effectiveness, compatibility with equipment and chemical additives, the potential impact on the environment and safety of operators are major factors to consider when choosing a bactericide.

THE BACTIREP RANGE

In order to better select these products for oil and gas applications, REP has carried out comparative studies of antimicrobial effectiveness of the most commonly used active substances and formulations working in synergy. With increased efficiency, these formulations allow the use of biocides at lower doses than for said products of commodities.

The active ingredients constituting the BACTIREP range are selected to ensure optimum performance and to generate:

- lower cost for the operator,
- gain in storage volume,
- reduced impact on the environment,
- reduced risk to personnel.

The intrinsic efficiency of biocides is usually measured by the concentration required to achieve the complete elimination or blocking of metabolic functions.

The BACTIREP range protects the water surrounding the oil and gas extraction processes.

A microbial attack is characterized by the rapid creation of craters located on the metal surfaces and eventually the drilling of production wells, injection lines of products etc.

BACTIREP RANGE

Products	Chemical nature	Usual characteristics						Applications						Comments
		Density 20°C	pH pure 20°C	Viscosity at 4°C (cPs)	Viscosity at 20°C (cPs)	Solubility at 20°C	Flash-point in a closed cup (°C)	Oil production	Hydrate gas production	Injection water	Desulfation membranes	Fuel storage	Deep offshore injection	
BACTIREP 1418	Quaternary ammonium	0.88 – 0.92	6.0 – 8.0	-	20 – 30 (Anton Paar)	Water	29							Water cooling Algaecide
BACTIREP 1418N	Quaternary ammonium base	0.93 – 0.96	4.5 – 6.0	-	-	Water	> 65							Cooling water, Algaecide, low foaming
BACTIREP 2007	DBNPA	1.25 – 1.29	2.5 – 3.0	-	-	Water, limited to 7.5g/100g	74.5							DBNPA = 2,2, dibromo-3-nitrilo-propionamide
BACTIREP 3902	Glutaraldehyde base	1.06 – 1.09	3.5 – 5.0	-	15-40 (Brook field, M2V60)	Water	> 62							Excellent against sulfidogenic bacteria (SRB) Penetrating biofilm
BACTIREP 3918S	Glutaraldehyde base	1.10 – 1.13	3.5 – 5.0	60 – 80 (Anton Paar)	20 – 30 (Brook field, M2V60)	Water	> 62							Excellent against sulfidogenic bacteria (SRB) Penetrating biofilm
BACTIREP 3918SM	Glutaraldehyde base	1.08 – 1.11	3.5 – 5.0	55 – 85 (Anton Paar)	15 – 35 (Brook field, M2V60)	Water	> 62							Excellent against sulfidogenic bacteria (SRB) Penetrating biofilm
BACTIREP 4018	THPS Base	1.24 – 1.28	5.5 – 7.0	5 – 15 (Anton Paar)	5 – 15 (Brook field, M2V60)	Water	> 62							Excellent against sulfidogenic bacteria (BTR)
BACTIREP 4018M	THPS Base	1.17 – 1.20	4.5 – 5.5	25 – 30 (Brook field, M2V60)	5 – 20 (Brook field, M2V60)	Water	> 110							Excellent against sulfidogenic bacteria (BTR)
BACTIREP 4020	THPS Base/ glutaraldehyde	1.10 – 1.12	4.5 – 6.0	-	-	Water	53							Excellent against the sulfidogenic bacteria (SRB/TRB) Penetrating biofilm
BACTIREP 4024S	THPS Base	1.28 – 1.32	3.5 – 4.5	-	-	Water	> 65							Excellent against sulfidogenic bacteria (SRB/TRB) Penetrating biofilm
BACTIREP 4028S	THPS Base	1.22 – 1.26	3.0 – 6.0	-	-	Water	> 110							Excellent against sulfidogenic bacteria (SRB/TRB) Penetrating biofilm
BACTIREP 4029S	THPS Base	1.28 – 1.36	3.0 – 6.0	-	-	Water	> 110							Excellent against sulfidogenic bacteria (SRB/TRB) Penetrating biofilm
BACTIREP 5146	THPS Base	1.29 – 1.32	2.5 – 3.5	30 – 40 (Anton Paar)	-	Water	> 85							Excellent against sulfidogenic bacteria (BTR)
BACTIREP 5147	Glutaraldehyde base	0.99 – 1.02	4.0 – 5.5	50 – 60 (Anton Paar)	-	Water	> 85							Excellent against sulfidogenic bacteria (SRB) Penetrating biofilm Low foaming
BACTIREP 6100	Halogenated derivative	1.02 – 1.06	3.5 – 5.0	-	80 – 120 (Anton Paar)	Water	138							In situ treatment of fuels and propellants
BACTIREP 9406	Halogenated derivative	1.07 – 1.11	2.5 – 6.5	-	5 – 15 (Brook field, M2V60)	Water	> 100							Compatible anionic polymers for assisted recovery of oil

BACTIREP 3000 RANGE, BASED ON THE ACTIVE SUBSTANCE GLUTARALDEHYDE (GA)

Glutaraldehyde Case number: 111-30-8



Operates on a wide pH range

Very fast-acting at high temperature
(thermophilic bacteria)

Broad-spectrum bactericide:

- Very effective against BSR
- Effective against aerobic and anaerobic bacteria

Readily biodegradable:

- Passed the OECD 301A standard
Readily biodegradable
- Passed the OECD 306 standard
Biodegradable in seawater

Compatible with most chemical additives, except:

- The glutaraldehyde reacts with primary amines and ammonia
- The glutaraldehyde is deactivated by bisulfites of NaHSO_3 (sequestrants of O_2)

- The secondary amines do not pose any particular problem

- It is compatible with tertiary amines and quaternary ammoniums

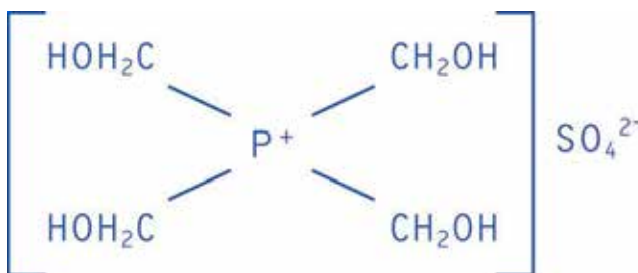
Do not reject formaldehyde

Non-corrosive to metals at recommended doses

There are simple dosage methods for use on the production site.

BACTIREP 4000 RANGE, BASED ON THE ACTIVE SUBSTANCE THPS

Tetrakis Hydroxymethyl Phosphonium Sulfate
Case number: 55566-30-8



Active at pH <7 (oil production)

Broad-spectrum biocides,
very effective against SBR/BTR

Aerobic biodegradability:

70% biodegradation after 21 days (U.S. EPA FIFRA)

Anaerobic biodegradability:

60% biodegradation after 30 days (U.S. EPA FIFRA)

THPS degrades in THPO by hydrolysis and oxidation

Reacts with FeS to form a non-bactericidal product:
Improved water quality (FeS stabilizes emulsions)

Is not deactivated by H₂S unlike glutaraldehyde

Compatible with most chemical additives, except:

- THPS is deactivated by bisulfites of NaHSO_3 (sequestrants of O_2)

Compatible with amines and quaternary ammoniums

Non-corrosive to metals at recommended doses

Simple dosage methods exist for usage on production sites.

BACTIREP 4000 S SERIES

- Not adsorbed on rock reservoirs
- Not deactivated by H₂S like glutaraldehyde
- Dissolve FeS
- Have proven their ability to maintain or increase productivity
- Can assist in oil/water separation in an acidic environment
- Are non-foaming
- Are biodegradable, non-bioaccumulative and have low toxicity towards aquatic organisms



Specially developed
to achieve excellent
penetration of biofilms



COMPATIBILITY

Hydrocarbon production requires the use of many additives that can interfere with the activity of certain biocides. It is therefore imperative to know the potential unmatchings and physicochemical properties of biocides that could adversely affect operations.

Applications	THPS only	Glutaraldehyde only	3000 Range	4000 Range	4000 S/4028S 4029S... Ranges
Improved performance against planktonic bacteria	No	Yes	Yes	Yes	Yes
Enhanced biofilm penetration	No	No	Yes	Yes/No*	Yes +
Effectiveness in control of MIC (bacterial corrosion)	No	No	Yes	Yes	Yes +
Compatible primary amines	No	No	No	No	No
Compatible with bisulfites	No	No	No	No	No
Compatible with H ₂ S	Yes	No	No	Yes	Yes
No emulsifier	Yes	Yes	Yes/No**	Yes	Yes
Non-foaming	Yes	Yes	Yes/No**	Yes	Yes

(*): According to formulations

(**): According to applications

IMPORTANT POINTS TO CONSIDER DURING THE TREATMENT OF BACTERICIDE APPLICATION

Reaction with sequestrants of O_2 scavengers ($NaHSO_3$ or NH_4HSO_3)

It is important not to inject products containing THPS/Glut. with bisulfites at the same time, or inject them at distant injection points.

Reaction with H_2S presents

Treatment modality

The habituation phenomenon

The penetration aspect, scraping and dispersal of biofilm

Environmental aspects

The short and long-term biocidal performance of the treatment after several batches.



FOAM

A foam bactericide can cause problems during application.
Minimal foaming is a desirable parameter in the selection of a bactericide.

THERMAL STABILITY

Biocides with a higher temperature stability can better resist “deep offshore” applications, providing protection not only against microorganisms in the injection water, but also against acidifying microorganisms naturally existing in the formation.

CORROSIVE EFFECTS ACCORDING TO UTILIZATION DOSAGE

Certain biocides in concentrated form (commercial form) are corrosive to metals, including stainless steel.
However, when properly diluted and formulated to their utilization concentration (200 ppm or less), most meet the corrosiveness criteria required by our industry.

Oxidant biocides remain highly corrosive even at utilization concentrations (1 ppm or less).

TOXICITY

Consider the potential ecotoxicity of a bactericide in its concentrated form, which can lead to a misinterpretation of the potential risk of its utilization at the recommended treatment doses. Prediction models based on risk that take into account all factors (such as toxicity, treatment concentrations, biodegradation, etc.) are more relevant and therefore used by the regulatory authorities.

CHEMICAL DEGRADATION AND BIODEGRADATION

Biodegradation and chemical degradation are important properties to consider for the sustainable use of a bactericide in oilfields.

FEASIBLE TESTS

- Tests on planktonic bacteria
- Tests on sessile bacteria in static conditions
- Tests on sessile bacteria in dynamic conditions

Values	Estimation in CFU/ml
0	< 50
1	5x10 ¹ - 5x10 ²
2	5x10 ² - 5x10 ³
3	5x10 ³ - 5x10 ⁴
4	5x10 ⁴ - 5x10 ⁵
5	5x10 ⁵ - 5x10 ⁶
6	5x10 ⁶ - 5x10 ⁷
7	5x10 ⁷ - 5x10 ⁸
8	> 5x10 ⁸

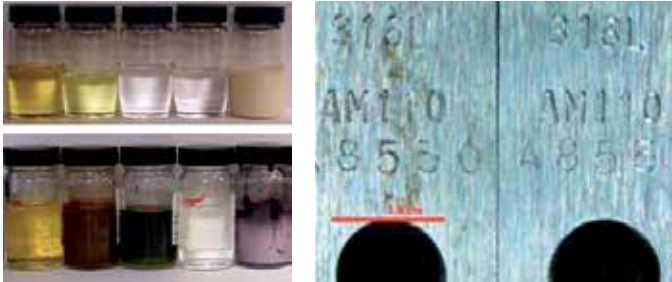
Biocide	ppm product	T0	T1j	T4j	T7j	Biocide	ppm product	T0	T1j	T4j	T7j
BACTIREP 4018	1000	0	0	0	0	BACTIREP 5150 bis	1000	0	0	0	0
	500	1	0	0	0		500	1	0	0	0
	250	1	0	0	0		250	1	0	0	2
	125	2	2	0	3		125	2	3	3	4
	63	2	3	6	5		63	2	5	6	7
	31	3	4	7	6		31	3	7	7	7
BACTIREP 3918S	1000	0	0	0	0	BACTIREP 5147	1000	0	0	0	0
	500	1	0	0	0		500	1	0	0	0
	250	1	0	0	0		250	1	0	0	1
	125	2	2	0	4		125	1	0	0	4
	63	2	4	7	8		63	2	6	6	5
	31	3	7	7	7		31	3	5	7	7
BACTIREP 3902	1000	0	0	0	0	BACTIREP 5149	1000	0	0	0	0
	500	1	0	0	0		500	1	0	0	0
	250	1	0	0	0		250	1	0	0	2
	125	1	2	0	4		125	1	4	6	5
	63	2	4	5	6		63	2	6	7	7
	31	3	6	7	6		31	3	6	8	7
BACTIREP 4024S	1000	0	0	0	0	BACTIREP 5150	1000	0	0	0	2
	500	1	0	0	0		500	1	1	0	3
	250	1	0	0	0		250	1	2	3	4
	125	2	0	0	3		125	1	4	6	5
	63	2	5	6	3		63	2	6	7	7
	31	3	7	7	6		31	3	5	8	7
BACTIREP 5145	1000	0	0	0	0	BACTIREP 5151	1000	0	2	0	0
	500	1	0	0	0		500	1	3	0	0
	250	1	0	0	1		250	1	5	0	2
	125	1	0	0	4		125	1	5	6	5
	63	2	5	7	7		63	2	6	7	6
	31	3	6	7	7		31	4	6	7	6
BACTIREP 5146	1000	0	0	0	0	Reference	0	2	6	6	6
	500	1	0	0	0		0	3	6	6	6
	250	1	0	0	1		0	4	7	6	6
	125	2	6	0	5		0	6	6	7	7
	63	2	5	7	5		0	7	8	8	7
	31	3	7	7	7		0	8	6	8	7

Example of results on planktonic bacteria:

Screening of biocides in anaerobic conditions (Tested doses: 1000 to 31 ppm in a commercial product), stems REP 11-219/SRB, Temp. 30°C, 2% NaCl salinity

FEASIBLE TESTS

- Corrosion on plates, weight loss, study of the surface with microscopy: corrosion with stinging (pitting), generalized corrosion



Standard: NACE Standard TRP0775-2005

Exposure of coupons in SS316L and in Duplex 22Cr to formulations of pure biocides and usage rates. Calculation of uniform corrosion by loss of mass and observation of localized corrosion.

- Compatibility with elastomers used on platforms
- Possible tests on water samples/bacteria from wells/networks to be treated

HELP and SUITABLE SUPPORT FOR YOUR NEEDS

The support of REP specialists will help you solve any microbial challenges regardless of your location. We have laboratories and partners specialized in industrial microbiology, and offer technical and sales assistance to help you find solutions to meet your future challenges.

Environment

In the field of oil production, REP products, developed in strict compliance with European standards, provide maximum safety, hygiene and prevention.

Packaging

REP products intended for use on site are available in a wide range of containers, notably including 215-liter drums and IBC totes of 1000 liters.

For further information about the BACTIREP Range
or to receive a sample, please contact us on
+33 (0) 1 30 98 80 00 or at info@rep.fr.



REP is available worldwide through its subsidiaries and distributors.
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