Aegis Tech Line

Aegis Chemical Solutions

Technical Newsletter
Volume 04, December 2017

MITIGATION AND PREVENTION OF BACTERIA IN OIL & GAS PRODUCTION

The last issue of AEGIS TECH LINE, the ACS Technical Newsletter, focused on Bacteria in Oil & Gas Production. That volume profiled the type of bacteria common in oil & gas production and the problems associated with the presence of bacteria in O&G production systems. This Volume 04 of the Technical Newsletter is the follow-on piece that will discuss mitigation and prevention of bacteria in O&G production systems.

BIOCIDES (Review)

The strict definition of 'biocide' is: it will kill living cells. Whether it can successfully “kill” bacteria depend upon several variables not least of which is the dose (i.e. the concentration of biocide) and the time the biocide is in contact with microorganisms.

Most biocides can also be regarded as biostatic. At concentrations lower than that required to kill, the biocide inhibits cell growth, while it is present. Once the chemical is removed, the bacteria will continue to grow again. At doses lower than biostatic, the biocide can even become a source of nutrition and therefore encourage bacterial growth.

It is often necessary to run a “time-kill” test to evaluate the effectiveness of a given biocide. A time-kill test is usually run on location with fresh, field brine. A properly run test will yield information on type of biocide, dosage and contact time necessary to effectively treat the system.

NON-OXIDIZING BIOCIDES

Non-oxidizing biocides function primarily by altering the permeability of the cell walls of the microorganisms and interfering with their biological processes. Bacteria may build immunity to biocides particularly if routinely “under dosed”. Some chemical programs alternate between treatment with different biocides to minimize the chances of bacteria building immunity to a specific biocide.

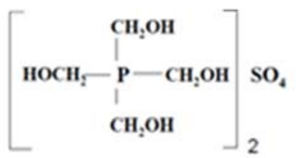
The use of blended chemistries may also offer a way to prevent bacteria from building immunity. Biocides may interfere with other treating chemicals; or conversely, may enhance performance of other chemicals such as corrosion inhibitors or surfactants. (Suggest running tests to determine effects).

Common non-oxidizing biocides include the following:

- Glutaraldehyde
- THPS (Tetrakis hydroxy methyl phosphonium sulfate)
- Quaternary ammonium salts
- Coco diamine salts
- DBNPA (Dibromonitrilopropionamide)
- Acrolein
- Combinations – particularly of glutaraldehyde and quaternary ammonium salts, commonly called “glut-quats”
- Formaldehyde
- Isothiazoline

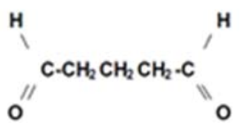
Many common corrosion inhibitors and some surfactants have similar effects on bacteria as biocides. However, these products cannot be applied as “biocides”, since they are not registered products. To be applied as a BIOCIDE, a product must be registered.

Common Non-Oxidizing Biocides



THPS

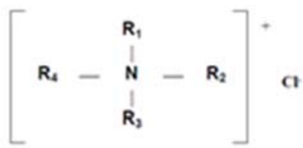
TetrakisHydroxymethyl Phosphonium Sulfate



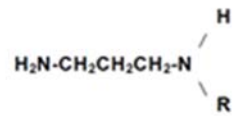
GLUTARALDEHYDE

- water-soluble
- non-foaming
- good system throughput
- reservoir compatible

- excellent cleaner
- penetrate biofilms
- can cause foaming
- filming can limit system throughput



QUATERNARY AMINE



COCODIAMINE

R = coconut oil

OXIDIZING BIOCIDES

Oxidizing biocides function by reacting with biological organisms. Some oxidizers are generated on location to minimize the costs and dangers associated with transportation to location and storage of the oxidizing biocide on location. These include:

- Chlorine dioxide (ClO_2) – the safest and most effective
- Ozone (O_3)
- Chlorine (Cl)

Bacteria will not build immunity to oxidizing biocides. In addition, oxidizing biocides often provide additional benefits such as deoiling solids and converting iron sulfide to iron oxide (rust). Deoiled solids and iron oxide will settle out of the water much more quickly and completely.

Oxidizer Classification

Oxidizers are a separate hazard class and require a special label since they can react violently with many different chemicals. These include crude oil, other production chemicals, and reducing agents (such as bisulfite oxygen scavengers). Since oxidizers will react with almost all organic materials and are consumed in the process, higher quantities of oxidizer must be used to kill bacteria.

Common oxidizing biocides include the following:

- Chlorine (Cl)
- Chlorine dioxide (ClO_2)
- Sodium Hypochlorite (bleach - NaClO)
- Bromine (Br)
- Peroxyacetic acid (PAA - $C_2H_4O_3$)
- Hydrogen Peroxide (H_2O_2)
- Ozone (O_3)

MECHANICAL / OPERATIONAL CONTROLS

A key to controlling the damage that can be caused by bacteria in oil and gas productions systems are some mechanical and operational controls. These include the following:

- Avoid build-up of solids
- Remove solids from bottom of tanks and vessels
- Eliminate stagnant areas
- Pig flowlines

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CHEMICAL TREATMENT REQUIREMENTS

For chemical treatments to be effective there are some requirements that should be considered. Effective treatment for controlling bacteria in oil and gas production systems requires an adequate time for the chemicals to be in contact with the bacteria. It also requires an appropriate concentration of the chemical(s) to kill the bacteria. Regular periodic treatment is required since the surviving cells re-establish and continue to flourish between treatments.

Tank Battery Treatment

The equipment at tank batteries including heater treaters, fresh water knockouts (FWKO) and separators can be batch treated with biocides. This requires taking the units out of service for the time required to mitigate the bacteria. The system is treated with a "slug" of biocide at the battery inlet. The concentration is usually around 500ppm but can be significantly higher. The biocide is allowed to "soak" for a minimum of four (4) hours or as determined in the kill study. This is usually done on a weekly basis.

Pipeline Treatment

Pipeline treatment for control of bacteria includes routine pigging to accomplish the following:

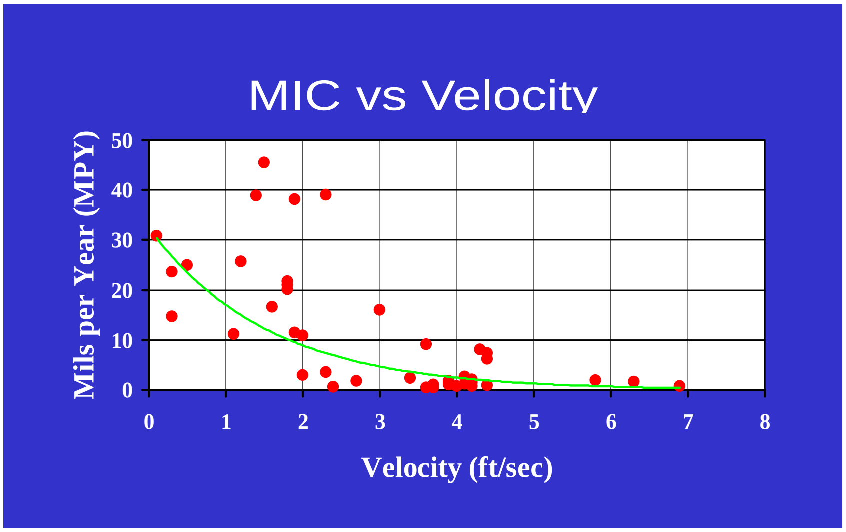
- Remove water from low spots
- Remove built-up solids
- Remove and disturb biofilm

In addition to a frequent and regular pigging program, it is often recommended that the pig runs include batch biocide treatments. Batch treating with a biocide is accomplished as follows:

- Pigging the line to remove liquids and solids (if possible)
- Batching the line with 5% biocide in water or methanol
- Total treatment volume based on length of the pipeline and estimated water content (liquid hold-up) of pipeline

CASE STUDY OF CORROSION RATE VS WATER VELOCITY (MICROBIAL INDUCED CORROSION)

The graph below was taken from corrosion coupons on various water injection wells in a water disposal system. Coupons from high velocity wells had low corrosion rates (>5-6 ft./sec) as seen in the graph. The same water going to low velocity wells showed heavy pitting and severe corrosion. NACE paper 184, 1989.



AEGIS FACILITIES LOCATIONS

Corporate Headquarters *Houston* 4560 Kendrick Plaza Dr., #190 Houston, TX 77032 Tel: (855) 532-2033	**Permian Basin** *Midland* 2200 Market St. Midland, TX 79703 Tel: (432) 695-6285	**Permian Basin** *Abilene* 4657 FM 707 Abilene, TX 79606
Permian Basin *Breckenridge* 566 FM 2231 Breckenridge, TX 76424	**Permian Basin** *Forsan* 300 1st St. Forsan, TX 79720	**Permian Basin** *Lubbock* 13622 Hwy 87 S. Slaton, TX 79423 Tel: (806) 329-4609
Permian Basin *Monahans* 1332 PR Thrasher Ln. Monahans, TX 79756	**East Texas** *Kilgore* 4524 State Hwy 42 N. Kilgore, TX 75662 Tel: (903) 218-0058	**East Texas** *Raywood* P.O. Box 219 Raywood, TX 77582 Tel: (409) 550-5211
East Texas *Teague* 931 W. Hwy 84 Teague, TX 75860 Tel: (903) 218-4795 x1058	**South Texas** *Freer* 5743 Hwy 44 Freer, TX 78357 Tel: (361) 226-3103	**South Texas** *Asherton* 664 Hwy 190 Asherton, TX 78827
South Texas *Cuero* 424 U.S. Hwy 87 S. Cuero, TX 77954	**South Texas** *Jourdanton* 8229 S. State Hwy 16 Jourdanton, TX 78026 Tel: (830) 265-5595	**South Texas** *San Antonio* 311 N. Frank Luke Dr., #103 San Antonio, TX 78226
North Louisiana *Haughton* 140 Sligo Industrial Dr. Haughton, LA 71037 Tel: (318) 261-8333 x1056	**South Louisiana** *Elizabeth* 3552 Highway 10 Elizabeth, LA 70638 Tel: (318) 634-5252	**Mid-Con** *Ratliff City* P.O. Box 98, 1500 Old Hwy 7 Ratliff City, OK 73481 Tel: (580) 856-2015
Mid-Con *El Reno* 801 N. Willie L. Minor, #B-1 El Reno, OK 73036	**Mid-Con** *Hennessey* 1117 S. Main St. Hennessey, OK 73742	