**AQUCAR™ GA 18 NF Water Treatment Microbiocide**

A non-flammable and Low Freeze Biocide for Cold Weather Climates and for all year round

CAS: 111-30-8

**General**

Cold weather climates present a unique set of challenges for oilfield operators. Despite extreme temperatures, production efficiency must be maintained, which means microbial contamination of drilling fluids and produced waters must remain in check. Unfortunately, many biocides are water-based and simply cannot sustain their integrity under such conditions. Cold temperatures can cause a water-based biocide to become too viscous, and a frozen biocide presents safety, storage and handling challenges. Further, a biocide’s physical and performance properties often dissipate significantly after undergoing a freeze/thaw cycle, rendering them ineffective.

AQUCAR™ GA 18 NF is an effective biocide that can meet all of the requirements for an oilfield application. AQUCAR GA 18 NF is a non-flammable biocide with a freezing point below -50°C. This product is based on the active ingredient glutaraldehyde and a special blend of glycol ethers. AQUCAR GA 18 NF enables oilfield operators to address the microbial challenges even during the severe conditions encountered in the cold weather months.

Glutaraldehyde is a well known and highly effective microbiocide and provides protection against a wide variety of microorganisms including sulfate-reducing bacteria and slime-forming bacteria. A special blend of glycol ethers was chosen as the freeze-proofing agent due to its water solubility, which allows uniform dilution during mixing, low freeze point, low viscosity down to -40°C for pumping and handling and excellent compatibility with glutaraldehyde. The result is a stable, high performance, non-flammable and virtually freeze-proof biocide that can be handled at temperatures as low as -40°C.

**Structure**

![Glutaraldehyde structure](image)

**Physical Properties**

The following are typical properties of AQUCAR GA 18 NF microbiocide; they are not to be considered product specifications.

- **Appearance** ................................................................. Colorless, clear liquid
- **Viscosity @ 20°C** ............................................................. 12 mPa.s
  - @ -35°C ........................................................................... 1407 cps
  - @ -40°C ........................................................................... 1460 cps
- **Density @ 20°C** ............................................................... 1.0180 g/cm³
- **pH (as it is)** ................................................................. 5.7
- **Glutaraldehyde** ............................................................... 18%
- **Flash point (ISO 1523/closed cup)** ................................. 62 °C
AQUCAR™ GA 18 NF microbiocide is a solution of glutaraldehyde containing 18% active ingredient. This broad-spectrum biocide is effective over a wide range of pH and temperature conditions and is well suited for use in the following applications.

**Water Flood Injection Water**
Glutaraldehyde exhibits excellent stability in oilfield injection waters, which ensures that its antimicrobial activity will not be diminished in long pipelines. Hard waters or brines do not adversely affect its biocidal efficacy, and glutaraldehyde is non-ionic so it won’t interfere with the action of demulsifiers, corrosion inhibitors, or surfactants. AQUCAR GA 18 NF microbiocide is typically slug dosed into the injection water on a daily or weekly basis at 50 to 2500 ppm active for up to 4 hours, although the exact treatment regimen will depend on the condition of the system, the amount of water being treated, etc.

**Drilling, Completion, Workover, and Fracturing Fluids**
Glutaraldehyde functions as a biocide over a broad pH range and its efficacy is much faster at neutral to alkaline pH’s than at acidic pH’s. Therefore, the AQUCAR GA 18 NF microbiocide is an excellent choice for use in preserving drilling muds and other oilfield fluids that are typically alkaline in pH. The combination of rapid alkaline efficacy at the typical use rates of 25 to 500 ppm as active and proven stability and effectiveness in high salinity matrices ensures microbial protection of these important fluids.

**Produced Waters**
Most oilfield systems contain sulfate reducing bacteria (SRB’s) and acid producing bacteria (APB’s). The presence of SRB’s and APB’s presents a serious challenge for effective control of microbial contamination in a production system. For a biocide to be effective against these problematic organisms, it must be stable in the presence of sulfides or organic acids that are produced by these organisms. Glutaraldehyde, unlike some other biocides (formaldehyde, acrolein, and isothiazolone) does not react with, and is not deactivated by, H₂S or organic acids. This ensures that all of the glutaraldehyde added is available to act as a biocide. Like its use in waterflood injection systems, glutaraldehyde is typically added in slug doses on a daily to weekly basis at concentrations of 50 to 2500 ppm as active.

**Oil and Gas Transmission lines**
Biofilms are a major problem in oil and gas production systems and pipelines are often afflicted with biofilm related problems. Microbiologically influenced corrosion (MIC) is often associated with the presence of a biofilm. The control of biofilms is therefore crucial to ensuring that corrosion events, due to microorganisms, are minimized. Glutaraldehyde has been shown to penetrate a biofilm and kill the microorganisms that are contained within it. The penetrating ability of glutaraldehyde, along with its long-term stability in oilfield waters, makes it an effective product to control established biofilms in pipelines and prevents the formation of new ones.

**Gas Storage Wells and Hydrocarbon Storage Facilities**
The water bottoms in hydrocarbon storage tanks and gas storage wells can often be contaminated with SRB’s and serves as hosts to biofilms. This, in turn, can lead to the formation of H₂S in the gas storage facility and the corrosion of hydrocarbon storage tanks. Glutaraldehyde preferentially partitions into the water phase in a mixed hydrocarbon/water system and so would attack any microorganisms that are present in these water bottoms.

**Production Wells**
The injection of scale and corrosion inhibitors into production wells can introduce microorganisms into the production equipment and the formation. The addition of
glutaraldehyde during these injections (squeeze treatments) can help to control these microorganisms and may help reduce the occurrence of MIC in production equipment.

The efficacy of glutaraldehyde (GA) is demonstrated by the following experiments. Field isolates of seawater and produced water SRB’s (sulfate reducing bacteria) were grown to high levels in the laboratory and then challenged with glutaraldehyde. The following results were obtained.

### Efficacy of Glutaraldehyde vs. Seawater SRB’s

<table>
<thead>
<tr>
<th>Biocide (ppm a.i.)</th>
<th>Log Reduction (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA, 25</td>
<td>4 4 7</td>
</tr>
<tr>
<td>GA, 50</td>
<td>6 7 8</td>
</tr>
<tr>
<td>GA, 100</td>
<td>8 8 8</td>
</tr>
<tr>
<td>Control</td>
<td>$10^8$ $10^8$ $10^8$</td>
</tr>
</tbody>
</table>

### Efficacy of Produced Water SRB’s

<table>
<thead>
<tr>
<th>Biocide (ppm a.i.)</th>
<th>Log Reduction (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA, 25</td>
<td>4 6 5</td>
</tr>
<tr>
<td>GA, 50</td>
<td>5 6 5</td>
</tr>
<tr>
<td>GA, 100</td>
<td>5 8 8</td>
</tr>
<tr>
<td>Control</td>
<td>$10^8$ $10^8$ $10^8$</td>
</tr>
</tbody>
</table>

The experimental protocol allowed for the growth of both high populations of SRB’s as well as the accumulation of bacterial metabolites such as sulfide. As these results show, glutaraldehyde was effective against these field isolates.

### Field Test Methods for Glutaraldehyde

Increasing regulation of the discharge of chemicals into the environment requires that there be careful monitoring and control over the use of biocides. The active concentration of glutaraldehyde in AQUCAR™ GA 18 NF microbiocide can easily be determined by a glutaraldehyde field test kit. There are several different kits that are commercially available and all allow for the rapid on-site determination of glutaraldehyde concentrations, discharge levels, half-life, and biocide/system compatibility. By regularly monitoring the active concentration of biocide in the system, the cost effectiveness of the treatment program can be maximized by accurately regulating biocide additions.

### Compatibility

While glutaraldehyde is compatible with most commonly used system additives (scale and corrosion inhibitors), there are some incompatibilities that should be noted. Glutaraldehyde is incompatible with primary amines and ammonia. Secondary amines are not as problematic as primary amines, but if a secondary amine is present at high concentrations (>1000 ppm), then care should be taken to add the glutaraldehyde at a distance from the addition point of the secondary amine. Information is available which predicts the loss of glutaraldehyde from systems that contain ammonia. This information is helpful in anticipating the expected decrease in active glutaraldehyde concentration in systems that contain ammonia. Please contact your Dow Microbial Control representative for copies of this data.

Glutaraldehyde is also incompatible with bisulfite-based oxygen scavengers. This interaction can most easily be managed by temporarily shutting off the bisulfite feed during the addition of glutaraldehyde. If shutting off the bisulfite feed is not an option, then it is
important to realize that the ratio of reaction of glutaraldehyde with the oxygen scavenger is approximately 1:2. That is, 1 ppm of glutaraldehyde will react with and consume 2 ppm of oxygen scavenger.

### Glutaraldehyde and the Environment

Many studies have been performed on glutaraldehyde to determine its potential to biodegrade in the environment. The details of two of the many biodegradation studies that have been performed on glutaraldehyde are given below.

The OECD 301 series of biodegradation protocols are designed to determine the biodegradation potential of substances under stringent conditions. In one such biodegradation test, glutaraldehyde met the OECD ready biodegradability classification criteria and thus was found to be readily biodegradable.

![% Biodegradation of Glutaraldehyde in OECD 301A Test](image)

The OECD 306 test determines the potential for a substance to biodegrade in seawater. This test is unique in that seawater is both test medium and the sole source of microorganisms. Although this test is not a test for ready biodegradability, substances that pass this test are considered to have the potential for biodegradation in the marine environment. When glutaraldehyde was evaluated in the OECD 306 test, a high rate of biodegradation was achieved, and thus it met the pass criteria of the OECD 306 test. It should be noted that glutaraldehyde is one of the few commonly used oilfield biocides that passes this test.

![% Biodegradation of Glutaraldehyde in OECD 306 Test](image)
A study of the aquatic metabolism of glutaraldehyde in river water sediment under aerobic and anaerobic conditions was performed. The results indicate that the metabolism of glutaraldehyde is rapid. Under aerobic conditions, the metabolism proceeds to complete mineralization with carbon dioxide as the principal metabolite. Under anaerobic conditions, only primary degradation is observed with the production of 1,5-pentanediol as the major metabolite. Both pathways of degradation are shown in the adjacent column.

**Aerobic Aquatic Metabolism**

$T_{1/2}$ in river water – 10.6 hr. Carbon dioxide was major metabolite, with glutaric acid as intermediate.

```
H   O   H   O   H
\( \rightarrow \) H   O   \( \rightarrow \) CO₂
Glutaraldehyde  Glutaric Acid  Carbon Dioxide
```

**Anaerobic Aquatic Metabolism**

$T_{1/2}$ in river water – 7.7 hr. 1,5-Pentanediol was major metabolite.

```
H   O   H   O   H
\( \rightarrow \) H   O   \( \rightarrow \) O   H   OH
Glutaraldehyde  5-Hydroxypentanal  Pentane 1, 5-Diol
```

The compiled ecotoxicology data indicate that glutaraldehyde is a readily biodegradable compound which has little environmental impact when handled properly. Due to its rapid metabolism and biodegradation under both aerobic and anaerobic conditions, it has a favourable ecotoxicology profile. Complete details on the biodegradation tests mentioned above, as well as many other environmental fate and ecotoxicology tests that have been performed on glutaraldehyde, are summarized in a Dow Chemical Company publication entitled “Ecotoxicology of Glutaraldehyde” (253-01418).

The following is a partial listing of toxicological data on glutaraldehyde, the active ingredient in AQUCAR™ GA 18 NF microbiocide. For product safety information, refer to the Product’s Safety Data Sheet. For a complete discussion of the toxicology of glutaraldehyde, please ask your Dow Microbial Control sales representative for a copy of the booklet entitled “Toxicology of Glutaraldehyde” (253-01419).

**Product Stewardship**

Dow Microbial Control encourages its customers to review their applications of Dow Microbial Control products from the standpoint of human health and environmental quality. To help ensure that Dow Microbial Control products are not used in ways for which they are not intended or tested, Dow Microbial Control personnel are willing to assist customers in dealing with ecological and product safety considerations. Contact your representative if you need any assistance or information. When considering the use of any Dow product in a particular application, review the latest Safety Data Sheet and country-specific product label to ensure the intended use is within the scope of approved uses and can be accomplished safely. Before handling any of the products mentioned in the text, obtain available product safety information and take necessary steps to ensure safety of use.
Notice: No freedom from any patent owned by Dow or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer’s use and for ensuring that Customer’s workplace and disposal practices are in compliance with applicable laws and other government enactments. The product shown in this literature may not be available for sale and/or available in all geographies where Dow is represented. The claims made may not have been approved for use in all countries. Dow assumes no obligation or liability for the information in this document. References to “Dow” or the “Company” mean the Dow legal entity selling the products to Customer unless otherwise expressly noted. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

USE BIOCIDES SAFELY. ALWAYS READ THE LABEL AND PRODUCT INFORMATION BEFORE USE.