



## AQUCAR™ RO-20 Water Treatment Microbiocide

CAS Reg. No. 10222-01-2

*Non-Oxidizing Biocide* to Eliminate Biological Fouling in Reverse Osmosis (RO) Systems for Municipal and Potable Water Production

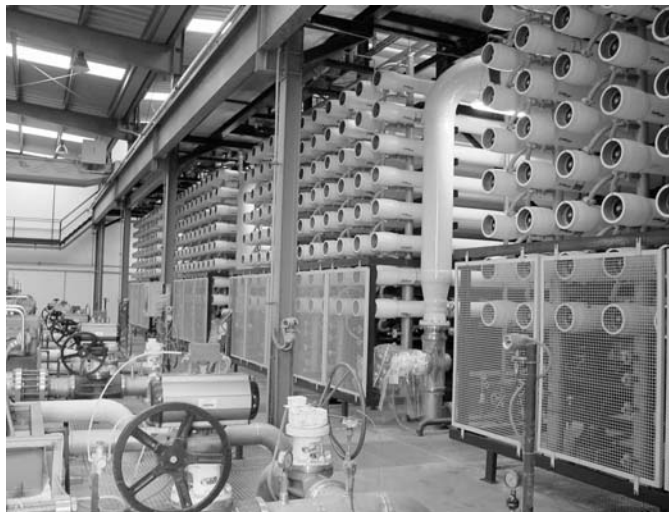


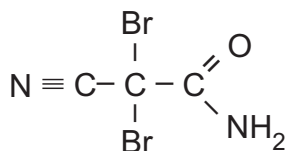
Photo courtesy of Inalsa

### General

Biofouling of RO membranes is a common problem for many filtration systems that source water from open ocean intakes, sea water wells, brackish river water and other surface waters that contain naturally occurring organic matter. The limiting factor to biofouling control is the incompatibility of the polyimide thin-film composite RO membrane to chlorine exposure, as well as exposure to other oxidizing chemicals commonly used for process water disinfection.

In May 2005, NSF International granted certification to Dow Biocides under NSF/ANSI Standard 60, for AQUCAR™ RO-20 to be used for the online biocidal treatment of RO systems used for municipal water production. Municipal water production includes the supply of drinking, household, and irrigation water. The NSF certification does not constitute registration approval, and Dow Biocides is currently working with national authorities to comply with individual country registration requirements. Check with your Dow Biocides representative before using AQUCAR RO-20.

### Structure



MW = 242

**Physical Properties** The following are typical properties of AQUCAR™ RO-20; they are not to be considered product specifications.

Active Ingredient (%)	20% by weight
Inert Ingredients	Polyethylene glycol and water
Color	Clear to amber
Appearance	Liquid
Odor	Low, mildly antiseptic
Freezing Point	About -50°C (per ASTM D-97)
Boiling Point	> 120°C for solution, but active ingredient decomposes prior to boiling
Freeze-Thaw Stability	Passed 7 cycles at -15° to 20°C
Specific Gravity	1.24-1.27 g/ml @ 23°C
Vapor Pressure (DBNPA)	2 x 10 <sup>-5</sup> mmHg @ 25°C



Photo courtesy of SUT Seraya

**Features and Benefits**

AQUCAR RO-20 water treatment microbiocide is an aqueous formulation containing a 20% w/w concentration of DBNPA (2,2-dibromo-3-nitropropionamide). When properly applied to the RO feed water systems, AQUCAR RO-20 is:

- Fast-acting, non-oxidizing biocide
- Effective against a broad spectrum of microorganisms
- Completely miscible with water upon dispersion at end-use levels

DBNPA, the active ingredient in AQUCAR RO-20, has proven efficacy at low concentrations against bacteria, fungi, yeast, cyanobacteria (blue-green algae) and the true algae. The DBNPA molecule will function immediately upon introduction into the feed water; the rate of this activity is not affected by pH, and antimicrobial control is rapidly achieved if properly dosed.

Because of its extremely rapid kill, proliferating microbes and their biofilm formation on the RO membranes and in the feed channel spacers are either eliminated or significantly reduced. The low persistency of DBNPA minimizes safety and environmental concerns with water discharge and atmospheric emissions.

When added to an RO system, DBNPA is easily rejected by the thin-film composite membrane layer and, at use dilution, shows excellent compatibility with all materials of construction of the RO membrane module. In addition, DBNPA has been used with great success for the past five years in industrial water applications such as boiler make-up water and offshore oil well flooding operations.

## Dosage Requirements

Due to the variety of different source waters for municipal water production, controlled laboratory experiments were undertaken to measure the passage of DBNPA through high-rejection sea water (SW) membranes, standard brackish water (BW) membranes, and nanofiltration (NF) membranes<sup>1</sup>. As with other dissolved species, DBNPA passage into the permeate-side depends on the thin-film membrane type. This dependence is illustrated by the recommended dosage guidelines provided in Table 1. For additional information please refer to the AQUICAR™ RO-20 water treatment microbiocide *Use Instructions for Various RO Membrane Systems* section (pg. 5).

As shown in Table 1, the on-line addition of AQUICAR RO-20 water treatment microbiocide is limited to a product concentration dosage of 50 ppm (10 ppm active) in the RO feed water stream of SW membrane systems. Correspondingly, for BW membrane systems, the on-line addition of AQUICAR RO-20 is limited to a product concentration dosage of 15 ppm (3 ppm active) in the RO feed stream. NF-membrane systems do not provide adequate rejection to support the on-line addition of DBNPA to the RO feed water stream for municipal water production. These guidelines are based on the NSF recommendation that DBNPA not exceed 90 ppb in the permeate stream. A reliable process control system is critical for the on-line addition of AQUICAR RO-20 for maintaining acceptable levels of DBNPA in the permeate product water.

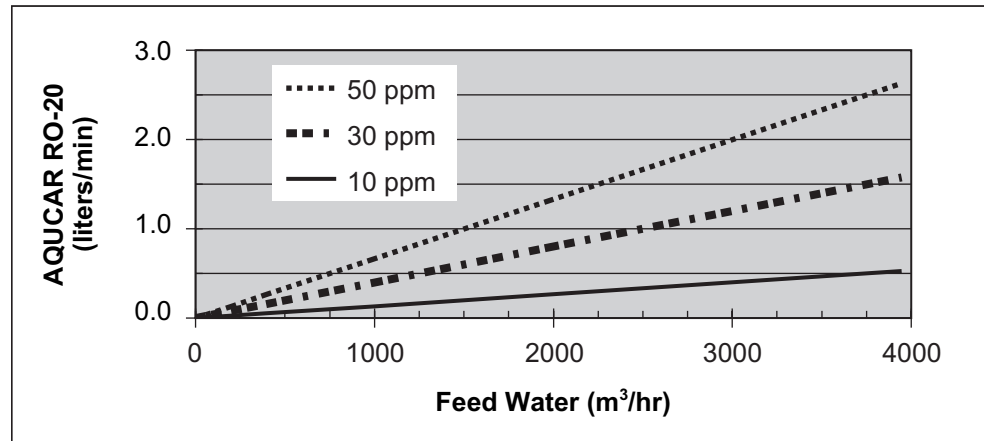
**Table 1  
DBNPA Dosage  
Guidelines for  
Various RO/NF  
Membrane Types**

Membrane	Min (ppm)	Max (ppm)
SW	10	50
BW	5	15
NF	Do not add on-line. Only applicable for off-line cleaning.	

Another vital element to successfully implement AQUICAR RO-20 is the AQUICAR RO test kit for concentration monitoring of DBNPA in the permeate stream. This kit has the capability to provide real time analysis of DBNPA to concentrations as low as 40 ppb. **At no time should the DBNPA concentration exceed 90 ppb in the permeate stream as measured by the AQUICAR RO test kit or other validated test methods.**

To establish an effective treatment program with AQUCAR™ RO-20, the proper selection and installation of a metering pump assembly for timed, intermittent delivery is essential. Figure 1 illustrates the required volumetric flow of AQUCAR RO-20 to achieve a desired set point dosage based on a particular feed water flow rate. This chart will help the system operator to determine the optimal dose concentration for their specific plant situation.

**Figure 1**  
**Addition Rate of**  
**AQUCAR RO-20 as**  
**a Function of Feed**  
**Water Flow and Set**  
**Point Dose**  
**Conditions**



Equally important to ensuring a reliable, accurate delivery of AQUCAR RO-20 is a successful tie-in to the process logic controller to suspend the addition of sodium bisulfite and/or any other reducing agents used for feed water pre-treatment. It is imperative to initiate this step at least 15 minutes prior to the addition of AQUCAR RO-20. Failure to coordinate the timed addition of DBNPA with the stoppage of sodium bisulfite will result in the deactivation of the DBNPA molecule to cyanoacetamide according to the following reaction.



### Environmental Advantages

#### Environmentally Friendly for Normal Disposal of Brine

DBNPA offers an advantageous combination of quick kill properties followed by fast chemical degradation, including hydrolysis. The dominant degradation pathway at use conditions involves reactions with nucleophilic substances or organic material invariably found in water. Nucleophilic degradation forms cyanoacetamide as shown in the above reaction.

When the disposal of concentrate involves the release to large open waterways, additional degradation will occur via exposure to UV-radiation. And upon sufficient dilution, DBNPA and its degradation products become biodegradable. The ultimate degradation products formed from both chemical and biodegradation processes of DBNPA include ammonia, carbon dioxide, and bromide ion.

Therefore, meeting the local environmental regulations for the permitted discharge of the reject stream should not be affected with DBNPA use. However, please note that compliance with local environmental regulations is the responsibility of the end-user.

Today's efforts to manage biofouling can involve a variety of added expenses that contribute to the total cost in producing water – increased energy to drive the high-pressure feed water pumps, chemicals and waste disposal for RO element cleaning, new RO element installation, penalties for lost production, contract laboratory assistance and technical consultation, and increased addition of pretreatment chemicals. AQUCAR™ RO-20 offers an opportunity to reduce and/or eliminate many of these added cost items.

**Table 2  
Projected Use of  
AQUCAR RO-20 for  
a Sea Water Plant  
with 14 Million  
Gallons per Day  
(MGD) Production**

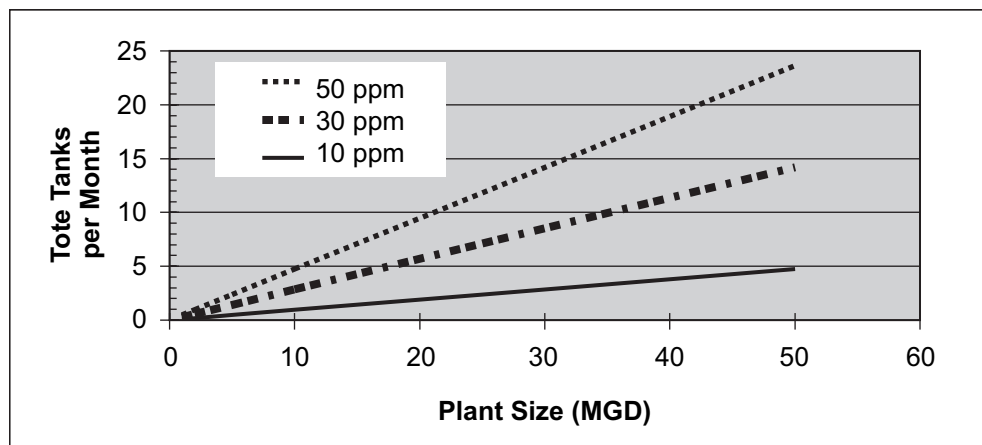
<b>BASIS:</b>	
Product water	= 10,000 gpm (2,270 m <sup>3</sup> /hr)
Set point dosage	= 30 ppm
<b>CALCULATE:</b>	
Feed water rate @40% recovery	= 25,000 gpm (5,680 m <sup>3</sup> /hr)
<b>AQUCAR RO-20</b>	
Flow required	~ 2.3 liters/min
Monthly Usage @1-hr per day	~ 4,090 liters (1,080 gallons)

To estimate potential cost savings, look at the total dollars spent today to combat biofouling, and compare to the expense of treating with AQUCAR RO-20. Table 2 provides an example calculation for the projected use of AQUCAR RO-20 at a sea water plant with 10,000 gpm (14 MGD) production. Assuming an on-line dosing program at 30 ppm intermittently at one-hour per day is typical for treatment programs now in use at industrial water facilities.

AQUCAR™ RO-20 is available in different size drums, pails and IBC totes. A product shipment schedule, in coordination with empty container pick-up, can be easily arranged for just-in-time delivery. For the example shown in Table 2 the AQUCAR RO-20 demand would require approximately four tote tanks each month.

Figure 2 provides a chart showing the approximate tote tank usage of AQUCAR RO-20 each month at various dosing levels for sea water municipal RO plants sized as large as 50 MGD production. All calculations are based on an intermittent addition rate of one-hour per day and a feed water recovery of 40%.

**Figure 2  
AQUCAR RO-20  
Usage (1,000 liter  
tote tanks) at  
Various Dose  
Levels for 1-hour  
per Day as a  
Function of Sea  
Water Plant Size**



## **Use Instructions for Various RO Membrane Systems**

AQUCAR RO-20 water treatment microbiocide may be used to control bacteria and reduce biofouling in reverse osmosis systems used for municipal water production for the supply of drinking, household, and irrigation water.

- 1. AQUCAR RO-20 water treatment microbiocide may be used for on-line, service cycle addition in RO systems that contain either sea water (SW) or brackish water (BW) type membranes. For RO municipal water systems that only contain nanofiltration (NF) type membranes, AQUCAR RO-20 may not be used for on-line, service cycle addition. AQUCAR RO-20 may be used for off-line addition as part of a chemical clean-in-place (CIP) treatment in NF-type membrane systems as directed on page 7.**
- 2. AQUCAR RO-20 water treatment microbiocide may be used for on-line, service cycle addition of all membrane systems (microfiltration, ultrafiltration, and nanofiltration) that are used to pretreat the feed water to either a BW or SW membrane system.**

### **On-Line, Service Cycle Addition**

**Note: Do not add AQUCAR RO-20 in the presence of sodium bisulfite or other reducing agents which are being added to the feed water of the RO system. The addition of any reducing agents must be suspended at least 15 minutes prior to the addition of AQUCAR RO-20 in order to avoid neutralization and deactivation of the active ingredient.**

Sea Water Membrane Systems:

AQUCAR RO-20 may be added to the RO feed water at a rate of 10 to 50 ppm based on the feed water flow rate (1 to 5 fl.oz./min per 1000 gallons/min feed water, or 8 to 40 mls/min per cubic meter/min of feed water). Intermittent addition should be applied once per day for duration of at least one hour. For highly-fouled systems, a 50 ppm dosage should be applied each day for several hours until the system performance is recovered.

Brackish Water Membrane Systems:

AQUCAR™ RO-20 may be added to the RO feed water at a rate of 5 to 15 ppm based on the feed water flow rate (0.5 to 1.5 fl.oz./min per 1000 gallons/min feed water, or 4 to 12 mls/min per cubic meter/min of feed water). Intermittent addition should be applied once per day for duration of at least two hours. For highly-fouled systems, a 15 ppm dosage should be applied each day for several hours until the system performance is recovered.

### **Off-Line (Clean-in-Place) Addition**

AQUCAR RO-20 water treatment microbiocide may be added to the feed tank used for an off-line chemical cleaning procedure. Addition should be at a rate of 20 to 200 ppm based on the total amount of solution in the feed tank (2 to 20 fl. oz. per 1000 gallons, or 16 to 160 mls per cubic meter). Following the complete transfer of feed solution, re-circulate or soak for one to three hours to ensure sufficient contact of all RO membrane modules with the DBNPA solution. Following this cleaning cycle, begin a rinse cycle to allow for displacement of three system volumes. This ensures that all of the DBNPA solution has been flushed from the entire RO membrane module system. The time required to complete this rinse cycle will depend on the rinse rate and system volume size. It is critical to execute this rinse cycle before valving the permeate stream to the permeate water storage tank.

**Note: Add AQUCAR RO-20 separately to the feed tank system. Do not mix with other chemical additives as this may result in rapid decomposition of AQUCAR RO-20 due to the high pH of many additive formulations.**

## **Product Stewardship**

Dow Biocides encourages its customers to review their applications of Dow Biocides products from the standpoint of human health and environmental quality. To help ensure that Dow Biocides products are not used in ways for which they are not intended or tested, Dow Biocides 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.

## **References**

1. "The Application of DBNPA in Reverse Osmosis Systems Used for Municipal & Potable Water Production", Najmy, S., et.al, The Dow Chemical Company, Report filed with NSF, May 2005.

For further information visit our website:

[www.dowbiocides.com](http://www.dowbiocides.com)

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