DOW Antimicrobial 7287 and DOW Antimicrobial 8536: The fast-acting, broad-spectrum biocides with low environmental impact

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DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are formulations containing 20% and 5%, respectively, of the active ingredient 2,2-dibromo-3-nitrilopropionamide, commonly referred to as DBNPA. Both products provide broad-spectrum control of bacteria, fungi, yeast, cyanobacteria (blue-green algae) and the true algae.

DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are fast-acting biocides. Equally important, DOW Antimicrobial 7287 and DOW Antimicrobial 8536 decompose rapidly in aquatic environments, and are environmentally safe.

DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are effective at low concentrations and are completely compatible with standard chlorine treatment, providing synergistic control of microorganisms.

Because DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are characterized by extremely rapid kill, proliferating microbes and their attendant slime problems are quickly reduced. Systems run better, with a higher efficiency, and at a lower cost. In fact, when an effective non-oxidizing biocide is required, none can match the total performance package offered by DOW Antimicrobial 7287 and DOW Antimicrobial 8536. Its fast action gives results quickly. You also get control of slime and algae. Yet the low persistency of DBNPA minimizes safety and environmental concerns with water discharge and atmospheric emissions.

What happens when you treat systems with DOW Antimicrobials 7287 and 8536?

DOW Antimicrobials 7287 and 8536 are completely miscible with water and easily dispersed upon introduction into your system. Microorganisms that come into contact with these antimicrobials are rapidly killed by a mechanism that appears to involve reaction with the protein fraction of the cell membrane and inactivation of enzyme systems. The vast majority of microorganisms are killed within five to ten minutes.

At the time of introduction, DOW Antimicrobials 7287 and 3536 begin to degrade. Ultimately, only carbon dioxide, ammonia, and bromide ion remain as end products. The entire process could take place with a half-life of less than one-half hour, depending on system conditions. But since effective microbial control is achieved *before* degradation, the ultimate effect is virtually ideal. Almost instantaneous antimicrobial activity combines with rapid chemical breakdown to present one of the most cost-effective ways of eliminating microbiological contamination with a minimum of environmental concern.

DOW Antimicrobials 7287 and 8536 make short work of bacteria, fungi, yeast, and algae

DOW DBNPA formulations are broad-spectrum antimicrobials that quickly control fungi, yeast, bacteria, and algae. They are also effective against deleterious bacteria, including the etiological agent of Legionnaire's Disease *(Legionella pneumophila)*.

Mortality rates against specific bacteria are given in Table 1, algistatic and algicidal properties are listed in Table 2, and effects on sulfate-reducing and heterotrophic bacteria are given in Table 3.

Table 1 – Rate of Kill Caused by DOW 2.2-dibromo-3-nitrilopropionamide (DBNPA) (% Reduction After 1, 3, 24 Hrs. Exposure)

E. aerogenes

PPM	1-Hour pH				3-Hour pH				1-Day pH			
	5	6	7	9	5	6	7	9	5	6	7	9
5	99.85	99.99	100	100	100	100	100	100	100	100	100	100
10	100	100	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
25	↓	↓										
50	↓	↓										
100	↓	↓										
Control Bacterial Counts per ml x 10^6												
	3.7	4.7	3.9	2.2	3.1	5.1	5.0	2.9	17.9	21.7	18.3	10.5

	Pseudomonas aeruginosa pH = 8			*Bacillus subtilis* pH = 8		
PPM	1-Hour	3-Hour	1-Day	1-Hour	3-Hour	1-Day
5	100	99.99	100	99.94	99.93	99.99
10	↓	100	↓	99.89	99.86	↓
25	↓	↓	↓	99.99	99.94	
50	↓	↓	↓	99.94	99.86	
100	↓	↓	↓	99.95	99.97	
Control Bacterial Counts per ml x 10^6						
	8.0	13.0	23.0	1.1	72	2.2

Table 2 – Algistatic and Algicidal Properties of DOW DBNPA Against *Chlorella pyrenoidosa* (Wis. 2004) and *Phormidium retzii* (Wis. 1094)

		300,000 Cells/ml 7-8 Days Incubation				Gorham's Medium (minus EDTA) Subcultured After 4 Hours			
		Percentage Inhibition of Cultures				Growth in Subcultures[1]			
	Conc.	*Chlorella*		*Phormidium*		*Chlorella*		*Phormidium*	
Chemical DBNPA	PPM	1	2	1	2	1	2	1	2
	1/16	-	0	-	0	-	100	-	100
	1/8	0	0	0	0	100	100	100	100
	1/4	0	0	0	0	100	100	100	100
	1/2	0	0	0	0	100	100	100	100
	1	50	90	0	0	100	100	100	50
	2	100	100	50	0	100	100	50	50
	4	100	100	100	100	50	50	0	0
	6	100	100	100	100	0	10	0	0
	8	100	100	100	100	0	0	0	0

[1] *Growth in subcultures as percentage of controls: 0 indicates conc. which was algicidal with 4 hours treatment.*

Table 3 – Bacteriostatic Activity of DOW DBNPA Against Sulfate-Reducing and Heterotrophic Bacteria[1]

Organism		Growth (+) or No Growth (-) at Various Concentrations (ppm) of DOW DBNPA							
		2.5	5.0	7.5	10	12.5	25	50	Control (No Biocide)
Pseudomonas fluorescens NRRL B-4290									
	24 Hours	+ +	– –	– –	– –	– –	NR[2]	NR	+ +
	96 Hours	+ +	+ +	+ –	– –	– –	NR	NR	+ +
Bacillus cereus NRRL B-4278									
	24 Hours	– –	– –	– –	– –	– –	NR	NR	+ +
	96 Hours	+ +	+ –	+ –	– –	– –	NR	NR	+ +
Desulfovibrio desulfuricans Mid-Continent Strain A									
	4 Days	+ + + +	+ + + +	NR	- - - -	NR	- - - -	- - - -	+ + + +
	8 Days	+ + + +	+ + + +	NR	- - - -	NR	- - - -	- - - -	+ + + +
	12 Days	+ + + +	+ + + +	NR	- - - -	NR	- - - -	- - - -	+ + + +
	18 Days	+ + + +	+ + + +	NR	- - - -	NR	- - - -	- - - -	+ + + +

[1] *Test Method API RP-38, "Recommended Practice for Analysis of Subsurface Injection Waters."*
[2] *NR—Not run.*

Why MIC tests give misleading data for DOW Antimicrobials 7287 and 8536

It's important to understand that standard Minimum Inhibitory Concentration (MIC) tests—designed to simulate actual system-operating conditions do not actually do so with DOW Antimicrobials 7287 and 8536. During MIC tests, microorganism innoculants are added to nutrient agar plates already containing biocides. The time lag between preparation of the testing medium and the addition of the innoculant is sufficient to cause degradation of DOW Antimicrobials 7287 and 8536 and greatly reduces their apparent microbial action.

Under normal conditions, DOW Antimicrobials 7287 and 8536 are added to systems already containing microorganisms, so killing is extremely rapid and effective. In contrast, slower-acting biocides may take ten to twelve hours to achieve the antimicrobial results attained by DOW Antimicrobials 7287 and 8536 within thirty minutes of treatment.

Convenient packaging in quantities to fit your needs

DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are available in a variety of container sizes ranging from 5-gallon pails to 350-gallon tote bins. Tank truck quantities are also available. Tank truck shipments are made only in Dow-approved tank trucks and are limited to 4,000 gallons (about 40,000 pounds net) per truck load.

Containers holding 55 gallons or less are all polyethylene, providing the advantages of low weight, durability, and easy disposal. Containers holding 55 gallons or less are equipped with a vented bung, which vents the small amounts of carbon dioxide formed during storage. These bungs also make pouring more convenient by allowing incoming air to displace outgoing liquid.

Recirculating water cooling towers

Recirculating water systems are commonly contaminated with fungal and bacterial organisms, and occasionally with algae. In addition, their spores and reproductive cells are continuously present in the air, so the likelihood of repeated innoculation is extremely high from a biological standpoint.

With their extremely fast killing action, DOW Antimicrobials 7287 and 8536 effectively control entering microorganisms before they can create problems. Because most microorganisms are killed very soon after exposure, there usually isn't time for daughter generations to develop. Fast kill means first generation kill, which goes a long way toward preventing adaptation to the biocide or defense through secretion of biofilm.

Kill rate outpaces degradation rate

DOW DBNPA typically yields a 99.999 percent kill before it degrades sufficiently to lose effectiveness. Figure 1 shows the degradation profile of DOW DBNPA for various temperature and pH combinations.

At neutral pH and normal system operating temperatures, DOW DBNPA exhibits a half-life of about nine hours. As pH increases, the rate of degradation of DOW DBNPA increases, but virtually complete microbial kill is achieved well before significant degradation occurs. As shown in Figure 2, DOW DBNPA easily achieves 99.999% kill in under three hours even in alkaline systems.

Figure 1 – Half-life of DOW DBNPA vs. pH (Hydrolysis)

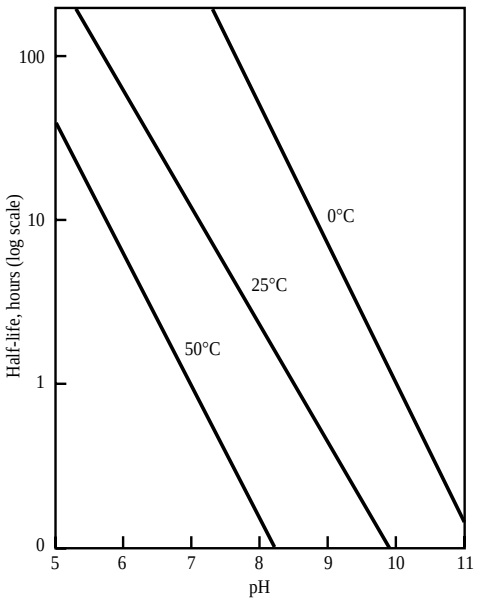
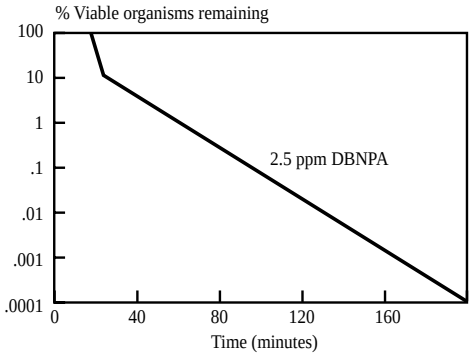


Figure 2 – Rate of Microorganism Kill by 2.5 ppm DOW DBNPA in High pH (8.5) System



100 ppm Alkalinity *pH = 8.5*
500 ppm Hardness *2.2E8 Initial CFU/ml*

Compatible and synergistic with chlorine treatment

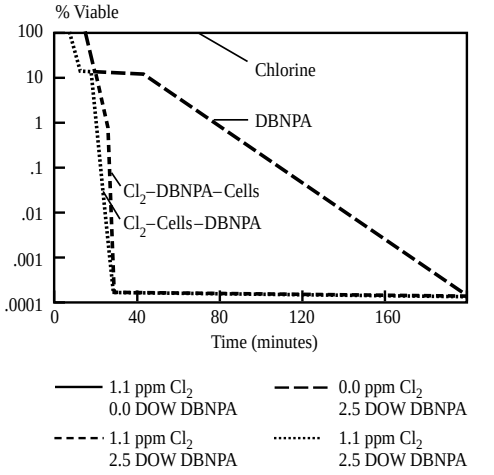
DOW Antimicrobial 7287 and DOW Antimicrobial 8536 provide excellent results in co-treatment programs with chlorine. Neither substance reacts with, degrades, or inhibits the antimicrobial activity of the other.

In combined treatment programs in larger systems, DOW DBNPA antimicrobials help control a broader variety of microorganisms than chlorine treatment alone.

Moreover, DOW DBNPA and chlorine exhibit remarkable synergistic performance in combination. Figure 3 illustrates a typical example of this synergistic performance in a model system at neutral pH. Note that the DOW DBNPA/chlorine combination achieved 99.999% microbial kill over six times as fast as DOW DBNPA alone — while straight chlorine treatment at l.1 ppm had virtually no antimicrobial activity at all.

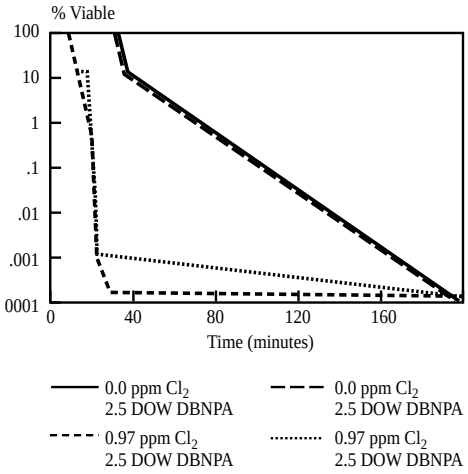
The synergism of DOW DBNPA and chlorine also functions in alkaline systems, as shown in Figure 4.

Figure 3 – Synergistic Antimicrobial Activity of DOW DBNPA and Chlorine at Neutral (7) pH



100 ppm Alkalinity
150 ppm Hardness
pH= 7
2.3E8 Initial CFU/ml

Figure 4 – Synergistic Antimicrobial Activity of DOW DBNPA and Chlorine at Alkaline (8.5) pH

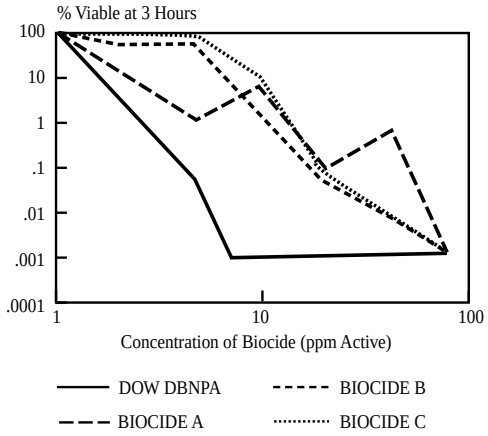


100 ppm Alkalinity
500 ppm Hardness
pH= 8.5
2.2E8 Initial CFU/ml

Microbial control at lower concentration than other biocides

Figure 5 compares the performance of DOW DBNPA and three competing biocides in typical recirculating cooling water systems. In this high TDS, alkaline system, DOW DBNPA achieves 99.999% microbial control at only 7.5 ppm, far lower than any of the competing materials tested.

Figure 5 – Antimicrobial Efficacy of DOW DBNPA and Competing Biocides, 500 ppm Total Hardness, pH 8.5



DOW DBNPA and control of *Legionella pneumophila*

Since the identification of *Legionella pneumophila* as the etiologic agent of "Legionnaire's Disease," the U.S. Public Health Service Center for Disease Control (CDC) has recommended that cooling towers and evaporative condensers be maintained effectively in order to minimize the possibility of these systems serving as routes of transmission of the disease.

DOW Antimicrobial 7287 (20 percent DBNPA) has been tested in the laboratory against *L. pneumophila*. The CDC published interim results of a laboratory study on the efficacy of six biocides against *L. pneumophila* in the June 22, 1979 Morbidity and Mortality Weekly Report. Dow Antimicrobial 7287 was effective in preventing recovery of the target organism from the test water.

The Department of Biology at Memphis State University has also evaluated DOW Antimicrobial 7287 against *L. pneumophila.* In an uncompromised environment used in their laboratory procedure (0.85 percent saline), DOW Antimicrobial 7287 gave complete inhibition of *L. pneumophila* at 20 ppm and 2-hour exposure (Developments in Industrial Microbiology, Volume 21). However, the ability of this formulation to control the growth of or inactivate Legionnaire's Disease causing bacteria in operating water cooling

towers exposed to ultraviolet light, organic material, other microbial contamination, and aeration, has not been documented. These preliminary findings also do not address the problem of long-term preventive maintenance of water cooling towers.

Recommended method of addition

Both DOW Antimicrobial 8536 and DOW Antimicrobial 7287 are best added to the basin of the system with the use of a metering pump. As shown in Tables 4 and 5, these antimicrobials can be added on a continuous basis or intermittently, as necessary to maintain control. Control should be based on visual inspection, microbiological analyses, or the experienced observations of a water treatment representative.

Table 4 – Treatment Levels of Industrial Recirculating Water Cooling Towers with DOW Antimicrobial 7287

		Use This	or	This	or	This
		fl. oz. 7287 per 1000 gallons		ml 7287 per 1000 gallons		gallons 7287 per 1000 gallons
Bacterial Control	Intial[a] Dose	0.6 to 1.2		18 to 36		0.0048 to 0.0095
	Subsequent[b] Slug Doses	0.3 to 1.2		9 to 36		0.0024 to 0.0095
	or					
	Subsequent[c] Continuous Feed Doses	0.12 to 0.6		3.6 to 18		0.00095 to 0.0048
Fungal/Algal Control	Initial[a] Dose	6.1 to 12.2		180 to 360		0.048 to 0.095
	Subsequent[d] Slug doses	3.7 to 12.2		110 to 360		0.029 to 0.095
	or					
	Subsequent[c] Continuous Feed Doses	3.7 to 12.2		110 to 360		0.029 to 0.095

[a] Badly fouled systems must be cleaned before treatment is begun.
[b] Treat every 4 days or as needed.
[c] Treat daily.
[d] Treat daily or as needed.

Table 5 – Treatment Levels of Industrial Recirculating Water Cooling Towers with DOW Antimicrobial 8536

		Use This	or	This	or	This
		fl. oz. 8536 per 1000 gallons		ml 8536 per 1000 gallons		gallons 8536 per 1000 gallons
Bacterial Control	Intial[a] Dose	2.4 to 4.9		72 to 144		0.019 to 0.038
	Subsequent[b] Slug Doses	1.2 to 4.9		36 to 144		0.0095 to 0.038
	or					
	Subsequent[c] Continuous Feed Doses	0.49 to 2.4		14.4 to 72		0.0038 to 0.019
Fungal/Algal Control	Initial[a] Dose	25 to 49		730 to 1440		0.192 to 0.380
	Subsequent[d] Slug Doses	15 to 49		440 to 1440		0.116 to 0.380
	or					
	Subsequent[c] Continuous Feed Doses	15 to 49		440 to 1440		0.116 to 0.380

[a] Badly fouled systems must be cleaned before treatment is begun.
[b] Treat every 4 days or as needed.
[c] Treat daily.
[d] Treat daily or as needed.

Pulp, paper, and paperboard mills

Laboratory and field tests show DOW DBNPA antimicrobials to be very effective in controlling the typical bacteria, fungi, and yeasts that cause slime formation in paper mills. DOW Antimicrobials 7287 and 8536 also offer compatibility with papermaking chemicals and equipment and convenient handling properties.

DOW DBNPA antimicrobials minimize environmental concerns

Perhaps most important, DOW Antimicrobials 7287 and 8536 offer an unsurpassed environmental package, making it far easier for papermakers to conform to the increasingly strict environmental regulations governing their industry.

To begin with, DOW DBNPA antimicrobials are used in low concentrations. And unlike other mill slimicides, they exhibit fast degradation to carbon dioxide, ammonia, and bromide ion — all of which are considered innocuous in the environment at the low levels encountered.

Meets FDA requirements

Both DOW Antimicrobial 7287 and DOW Antimicrobial 8536 meet the requirements of the Food and Drug Administration (FDA) for use as a slimicide in the manufacture of paper and paperboard intended to contact food when used at a maximum level of 0.1 lb 2,2-dibromo-3-nitrilopropionamide/ton of dry weight fiber, per 21 CFR 176.300 (formerly under 2I CFR 121.2505).

Fast kill minimizes quality problems

DOW Antimicrobials 7287 and 8536 provide exceptionally fast microbial kill rates — faster than virtually any other slimicide. When the first signs of microbial contamination (pinholes, fisheyes) appear in finished paper, DOW Antimicrobials 7287 and 8536 can be added to the pulpstock to arrest a minor contamination problem before it becomes more serious.

Works at exceptionally low concentrations

In addition to quick action, DOW DBNPA gives effective action at very low concentrations. The data in Figure 6 was obtained in laboratory tests based on ASTM E 600-77 (Efficacy of Slimicides for the Paper Industry — Bacterial Slime). At all three pH levels tested, DOW DBNPA yielded 99.999% kill of the test organism at only a fraction of the concentration of competing slimicides.

Figure 6 – Biocide Concentrations Required for 99.999% Kill of *Klebsiella pneumoniae* in Aspen Groundwood Pulpstock, Three-hour Test

Biocide	pH	Concentration Necessary for a 99.999% Kill (ppm)
DOW DBNPA	5.55	1
	7.00	5
	8.35	10
A	5.55	>60
	7.00	100
	8.35	75
B	5.55	>300
	7.00	200
	8.35	300

Recommended method of addition

You can feed either product, DOW Antimicrobial 7287 or DOW Antimicrobial 8536, with a metering pump at any point where uniform mixing can be attained. Please consult Section III, “Corrosivity,” for suggestions concerning equipment. Typical addition points are the beaters, jordan inlet or discharge, broke chests, furnish chests, save-alls, and/or white-water tanks.

In addition, DOW Antimicrobial 7287 or DOW Antimicrobial 8536 can be added prior to contaminated areas in the system. Both slimicide products can be added continuously or periodically, with adjustments in the intervals between additions and dose levels dependent on visual inspections, microbiological analyses, and/or experienced observations of a water treatment representative.

Treatment levels

For the control of bacterial, fungal, and yeast growth in pulp, paper, and paperboard mills, add DOW Antimicrobial 7287 or DOW Antimicrobial 8536 at the rates given in Table 6 or Table 7.

Table 6 – Suggested Treatment Levels in Pulp and Paper Systems, DOW Antimicrobial 7287[a]

		Use This	or This	or This
		gal. 7287 per ton of paper (dry basis)	fl. oz. 7287 per ton of paper (dry basis)	ml 7287 per ton of paper (dry basis)
Heavily Fouled[b] Systems	Dose After Boiling Out	0.014 to 0.034	1.8 to 4.4	53.0 to 128.7
Moderately Fouled System	Initial Dose	0.034 to 0.05	4.4 to 6.4	128.7 to 189.3
	Subsequent Dose	0.014 to 0.034	1.8 to 4.4	53.0 to 128.7
Slightly Fouled Systems	Initial Dose	0.014 to 0.034	1.8 to 4.4	53.0 to 128.7
	Subsequent Dose	0.014 to 0.034	1.8 to 4.4	53.0 to 128.7

[a] Choice of continuous or intermittent addition will depend on observed results.
[b] Heavily fouled systems should be cleaned before treatment is begun.

Table 7 – Suggested Treatment Levels in Pulp and Paper Systems, DOW Antimicrobial 8536[a]

		Use This	or This	or This
		gal. 8536 per ton of paper (dry basis)	fl. oz. 8536 per ton of paper (dry basis)	ml 8536 per ton of paper (dry basis)
Heavily Fouled[b] Systems	Dose After Boiling Out	0.06 to 0.15	7.7 to 19.2	227.1 to 567.8
Moderately Fouled System	Initial Dose	0.15 to 0.21	19.2 to 26.9	567.8 to 794.9
	Subsequent Dose	0.06 to 0.15	7.7 to 19.2	227.1 to 567.8
Slightly Fouled Systems	Initial Dose	0.06 to 0.15	7.7 to 19.2	227.1 to 567.8
	Subsequent Dose	0.06 to 0.15	7.7 to 19.2	227.1 to 567.8

[a] Choice of continuous or intermittent addition will depend on observed results.
[b] Heavily fouled systems should be cleaned before treatment is begun.

Once-through industrial cooling water systems

The use of DOW Antimicrobials 7287 and 8536 in once-through cooling systems as part of a total water management program can effectively control microbial contamination and prevent the problems associated with these growths.

DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are EPA-registered for once-through systems

DOW Antimicrobials 7287 and 8536 are two of only a few biocides with environmental properties allowing them to be registered with the EPA for once-through cooling systems. Their rapid degradation after microbial control is the key. Discharge of effluent water containing DOW Antimicrobials 7287 and 8536 into public water is permissible if done in accordance with an NPDES permit.

Synergistic performance with chlorine

As with recirculating cooling systems, chlorine and DOW DBNPA are not only compatible in once-through cooling systems, but exhibit a strong synergistic effect and more rapid kill rates. Figure 3 on page 8 shows how powerful this synergism can be in neutral pH systems.

Recommended method of addition

Add the DOW DBNPA formulations to the heat-exchanger inlet water, based on the flow rate through the system, or before any other contaminated area. Addition should be made with a metering pump; it may be intermittent or continuous depending on the severity of contamination and the retention time in the system. Because cooling water passes through the heat-exchange surfaces of a once-through system on a one-time basis, slug feeding of a biocide to the inlet water would generally not be practical or effective. Control should be based on visual inspection, microbiological analyses, or the experienced observations of a water treatment representative.

Treatment levels

For the control of bacterial, fungal, and algal growth in once-through cooling systems, add DOW Antimicrobial 7287 or DOW Antimicrobial 8536 at the rates given in Table 8 or Table 9.

Table 8 – Suggested Treatment Levels in Once-through Cooling Systems, DOW Antimicrobial 7287

		Use This fl. oz. 7287 per 1000 gallons	or This ml 7287 per 1000 gallons	or This gallons 7287 per 1000 gallons	to equal This ppm 7287 based on system flow
Bacterial Control	Intial[a] Dose	0.77 to 1.54	22.7 to 45.4	0.006 to 0.012	6 to 12
	Subsequent Slug Doses	0.38 to 1.54	11.4 to 45.4	0.003 to 0.012	3 to 12
	or				
	Subsequent Continuous Feed Doses	0.13 to 0.77	3.8 to 22.7	0.001 to 0.006	1 to 6
Fungal/Algal Control	Initial[a] Dose	7.7 to 15.1	227 to 447	0.06 to 0.118	60 to 118
	Subsequent Intermittent Doses	4.6 to 15.1	136 to 447	0.036 to 0.118	36 to 118
	or				
	Subsequent Continuous Feed Doses	4.6 to 15.1	136 to 447	0.036 to 0.118	36 to 118

[a] *Dose continuously or at minimum intervals of 15 minutes.*

Table 9 – Suggested Treatment Levels in Once-through Cooling Systems, DOW Antimicrobial 8536

		Use This	or This	or This	to equal This
		fl. oz. 8536 per 1000 gallons	ml 8536 per 1000 gallons	gallons 8536 per 1000 gallons	ppm 8536 based on system flow
Bacterial Control	Intial[a] Dose	3.1 to 6.1	91 to 182	0.024 to 0.048	24 to 48
	Subsequent Intermittent Doses	1.5 to 6.1	45 to 182	0.012 to 0.048	12 to 48
	or				
	Subsequent Continuous Feed Doses	0.5 to 3.1	15 to 91	0.004 to 0.024	4 to 24
Fungal/Algal Control	Initial[a] Dose	30.7 to 60.4	908 to 1785	0.24 to 0.47	240 to 472
	Subsequent Intermittent Doses	17.9 to 60.4	530 to 1785	0.14 to 0.47	144 to 472
	or				
	Subsequent Continuous Feed Doses	17.9 to 60.4	530 to 1785	0.24 to 0.47	144 to 472

[a] *Dose continuously or at minimum intervals of 15 minutes.*

Industrial air washer systems

The addition of DOW DBNPA Antimicrobials to air washer water systems can effectively control bacteria and fungi, maintaining optimal washer performance.

Both DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are registered with the EPA for use in air washers. When used as directed in systems that maintain effective mist-eliminating components, these formulations have been found to be free of undesirable foaming and odor characteristics, and they are safe from the standpoint of inhalation exposure, when used in accordance with good handling procedures and label recommendations.

Recommended method of addition

DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are best added to the air washer sump with the use of a metering pump. These antimicrobials can be added on a continuous basis or intermittently, as necessary to maintain control. Control should be based on visual inspection, microbiological analyses, or the experienced observation of a water treatment representative.

Treatment levels

For the control of bacteria and fungi in industrial air washer systems, add DOW Antimicrobial 7287 or DOW Antimicrobial 8536 at the rates given in Table 10 or Table 11.

From the standpoint of economics and worker comfort, it is important to avoid exceeding the maximum recommended dosages given here. Moderate overtreatment may cause the formation of unpleasant odors in the workplace, while severe overtreatment may cause lachrymation.

Table 10 – Suggested Treatment Levels in Industrial Air Washer Systems, DOW Antimicrobial 7287

		Use This	or This	or This
		gal. 7287 per 1000 gal. water in system	fl. oz. 7287 per 1000 gal. water in system	ml 7287 per 1000 gal. water in system
Intermittent or Slug Method	Initial[a] Dose	0.003 to 0.095	0.38 to 12.2	11.4 to 360.0
	Subsequent[b] Dose	0.0015 to 0.047	0.19 to 6.0	5.7 to 178.0
Continuous Feed Method	Initial[a] Dose	0.003 to 0.095	0.038 to 12.2	11.4 to 360.0
	Subsequent[b] Dose	0.0015 to 0.047	0.19 to 6.0	5.7 to 178.0

[a] *Badly fouled systems must be cleaned before treatment is begun.*
[b] *Treat every 2 days or as needed to maintain control.*
NOTE: For use only in industrial air washer systems that maintain effective mist-eliminating components.

Table 11 – Suggested Treatment Levels in Industrial Air Washer Systems, DOW Antimicrobial 8536

		Use This	or This	or This
		gal. 8536 per 1000 gal. water in system	fl. oz. 8536 per 1000 gal. water in system	ml 8536 per 1000 gal. water in system
Intermittent or Slug Method	Initial[a] Dose	0.156 to 0.250	20.0 to 32.0	590.0 to 946.0
	Subsequent[b] Dose	0.0078 to 0.125	1.0 to 16.0	29.5 to 473.0
Continuos Feed Method	Initial[a] Dose	0.156 to 0.250	20.0 to 32.0	590.0 to 946.0
	Subsequent[b] Dose	0.0078 to 0.125	1.0 to 16.0	29.5 to 473.0

[a] *Badly fouled systems must be cleaned before treatment is begun.*

[b] *Meter continuously on a daily basis or at time intervals necessary for control.*

NOTE: For use only in industrial air washer systems that maintain effective mist-eliminating components.

Enhanced oil recovery systems

DOW Antimicrobials 7287 and 8536 will kill microorganisms in injection water for subsurface enhanced oil recovery. DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are registered with the EPA for use in the control of slime-forming bacteria, sulfide-producing bacteria, yeasts, and fungi in oilfield water, polymer or micellar floods, water-disposal systems, and other oilfield water systems.

Special note on sulfate-reducing bacteria

When tested according to the test method of the American Petroleum Institute (API) RP-38, "Recommended Practice for Analysis of Subsurface Injection Water," 10 ppm DBNPA provides effective control of *Desulfovibrio desulfuricans*.

However, DOW DBNPA can be deactivated chemically in the presence of strong reducing agents such as hydrogen sulfide (H_2S) — and to a much lesser extent by residual oxygen scavengers such as sodium bisulfite and ammonium bisulfite. So while DOW DBNPA will kill sulfate-reducing bacteria if they have not yet formed H_2S, its antimicrobial performance will be severely restricted or eliminated if the bacteria have already produced H_2S.

Recommended methods of addition

For microbial control in oilfield water, add DOW Antimicrobial 7287 or DOW Antimicrobial 8536 with a metering pump either continuously or intermittently. Additions may be made at the free water knockouts, before or after the injection pumps and injection well headers.

Recommended treatment levels

For controlling slime-forming bacteria, sulfide-producing bacteria, yeasts, and fungi in oilfield water, polymer or micellar floods, or other oilfield water systems, add either DOW Antimicrobial 7287 or DOW Antimicrobial 8536 at the rates given in Table 12 or Table 13.

Table 12 – Suggested Treatment Levels in Oilfield Water Systems, DOW Antimicrobial 7287

		Use This	To Equal	This
		gal. 7287 per 2400 bbl oilfield water		ppm 7287 based on system volume
Intermittent or Slug Method	Initial[a] Dose	0.8 to 6.4		10 to 80
	Subsequent[a] Dose	0.8 to 6.4		10 to 80
Continuous Feed Method	Initial[b] Dose	0.8 to 6.4		10 to 80
	Subsequent[c] Dose	0.1 to 1.2		1 to 15

[a] Add intermittently for 4 to 8 hours per day, and from 1 to 4 times per week, or as needed depending on the severity of contamination.

[b] Add continuously until the desired degree of control is achieved.

[c] Add continuously or as needed to maintain control.

Table 13 – Suggested Treatment Levels in Oilfield Water Systems, DOW Antimicrobial 8536

		Use This	To Equal	This
		gal. 8536 per 2400 bbl oilfield water		ppm 8536 based on system volume
Intermittent or Slug Method	Initial[a] Dose	3.6 to 28.6		40 to 320
	Subsequent[a] Dose	3.6 to 28.6		40 to 320
Continuos Feed Method	Initial[b] Dose	3.6 to 28.6		40 to 320
	Subsequent[c] Dose	0.4 to 5.4		4 to 60

[a] Add intermittently for 4 to 8 hours per day, and from 1 to 4 times per week, or as needed depending on the severity of contamination.

[b] Add continuously until the desired degree of control is achieved.

[c] Add continuously or as needed to maintain control.

Use with Biopolymers

DOW Antimicrobial 7287 has been found to be effective in controlling bacteria, yeast, and fungi in aqueous solutions of biopolymer used in flooding operations. Add 15-80 ppm of DOW Antimicrobial 7287 (1.2-6.4 gal of 7287 per 2400 barrels of water) or 60-320 ppm of DOW Antimicrobial 8536 (5.4-28.6 gal of 8536 per 2400 barrels of water).

Additions should be made with a metering pump immediately after preparation of the aqueous biopolymer solution to control the organisms that cause viscosity loss, or odor, or that are potential corrosive agents.

Metalworking fluids containing water

The addition of a DOW DBNPA antimicrobial as part of a total metalworking fluids management program can effectively control bacteria, fungi, and yeasts, extending the useful life of fluids, eliminating odors, and killing pathogenic bacteria.

DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are registered for use in oil emulsion, synthetic, and semi-synthetic metalworking fluids. DOW DBNPA must be added to the metalworking fluid after the concentrate has been diluted with water (tankside addition). DOW DBNPA is not appropriate for addition to the metalworking fluid concentrate. Both DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are effective in metalworking fluids concentrates that have been diluted in water in ratios of 1:4-1:100.

Excellent performance in low pH systems

The biocidal activity of DOW DBNPA antimicrobials is best in metalworking fluid systems of lower pH. For example, it would perform well in fluids used in two-piece aluminum can forming, in which the fluid pH will generally be near 6.

Recommended method of addition

DOW Antimicrobials 7287 or 8536 can be fed directly into the collection tank with a metering pump. Avoid adding slug doses with a pail or open container, especially at the maximum recommended use level; this practice can cause the local evolution of irritating vapors. Both products can be added continuously or periodically as needed to maintain control of microbial growth. Control should be based on visual inspection, microbiological analyses, and/or experienced observations of a water treatment representative.

Recommended treatment levels

Bacterial, yeast, and fungal growths that may deteriorate metalworking fluids containing water can be controlled by adding DOW Antimicrobial 7287 or DOW Antimicrobial 8536 at the levels shown in Table 14 or Table 15.

Table 14 – Suggested Treatment Levels in Metalworking Fluids, DOW Antimicrobial 7287

	Use This	or	This	or	This
	gal. 7287 per 1000 gallons metalworking fluid		fl. oz. 7287 per 1000 gallons metalworking fluid		ml 7287 per 1000 gallons metalworking fluid
Initial[a] Dose	0.25		32.0		946.0
Subsequent[b] Dose	0.1 to 0.2		12.8 to 25.6		378.0 to 757.0

[a] Add daily or as needed to maintain control.
[b] Add continuously on a daily basis, or as needed to maintain control

Table 15 – Suggested Treatment Levels in Metalworking Fluids, DOW Antimicrobial 8536

	Use This	or	This	or	This
	gal. 8536 per 1000 gallons metalworking fluid		fl. oz. 8536 per 1000 gallons metalworking fluid		ml 8536 per 1000 gallons metalworking fluid
Initial[a] Dose	1.1		141.0		4160.0
Subsequent[b] Dose	0.44 to 0.88		56.3 to 113.0		1665.0 to 3330.0

NOTE: *These data and use suggestions are based on information we believe to be reliable. However, because of the many varied chemical interactions that are possible in metalworking fluids, we recommend that the prospective user of DOW antimicrobial determine the suitability of our products and suggestions before adopting them on a commercial scale.*

III. Physical/Chemical Properties

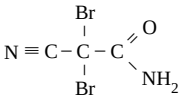
The compound 2,2-dibromo-3-nitrilopropionamide (DBNPA) is the active ingredient in DOW Antimicrobial 7287 and DOW Antimicrobial 8536. These products are formulated with DOW Polyglycol E-200 and/or tetraethylene glycol and water.

These formulations are the subject of U.S. Patents 3,689,660; 3,928,575; and 4,163,798, and replace those formulated with Polyglycol E-200 only. Other patents are pending.

Chemical Name:

2 ,2-dibromo-3-nitrilopropionamide

Structural Formula:



MW = 242

Figure 7 – Viscosity of DOW DBNPA Formulations

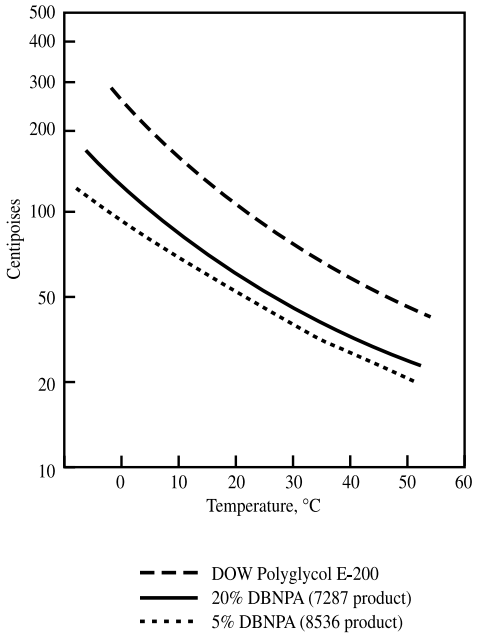


Table 16 – Physical Properties of Formulations

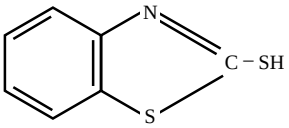
Active Ingredient	2,2-dibromo-3-nitrilopropionamide
CAS Number of DBNPA	1022-01-2
Percent Active Ingredient	20 percent for DOW Antimicrobial 7287 5 percent for DOW Antimicrobial 8536
Inert Ingredients	Polyethylene glycol/water
Color	Clear to amber
Appearance	Liquid
Odor	Low, mildly antiseptic
Freezing Point	About -50°C (per ASTM D-97)
Pour Point	About -45°C (per ASTM D-97)
Free Flowing	About -30°C (per ASTM D-97)
Freeze -Thaw Stability	Passed 7 cycles at -15° to +20°C
Boiling Point	>120°C for solution, but active ingredient decomposes
Specific Gravity	1.24-1.27 g/ml @ 23°C for (7287) 1.14-1.17 g/ml @ 23°C for (8536)
Miscibility	Miscible with water in all proportions
Vapor Pressure (DBNPA)	2 x 10^{-5} mmHg @ 25°C
Flash Point	None detected (COC)
Partition Coefficient	P=0.1 for mineral oil/water
Storage Stability	Analysis shows that 95 percent of the original concentration of the active ingredient in both 7287 and 8536 remains in appropriate storage containers after 12 months.

Compatibility with other water treatment chemicals

DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are compatible with most water treatment chemicals, most paper chemicals, and are tolerant of high organic loads. They are also compatible with chlorine and exhibit a significant synergistic antimicrobial effect when either is used as a co-treatment with chlorine (See also Section II).

Please note that DOW Antimicrobial 7287 and DOW Antimicrobial 8536 will react with and may be inactivated by: 1) strong reducing agents and/or nucleophilic reagents; 2) sulfur containing nucleophiles, including H_2S which is often encountered in oilfields, and occasionally in metalworking fluids; 3)sulfites, bisulfites, and compounds containing sulfhydryls (e.g., 2-mercaptobenzothiazole, MBT).

2-Mercaptobenzothiazole



NaMBT (sodium salt of above)

However, compounds similar to 2-mercaptobenzothiazole, such as benzotriazole and tolytriazole do not affect DBNPA activity, and corrosion inhibitors suffer no loss of function.

DOW antimicrobials based on DBNPA have been tested extensively in the laboratory and under conditions of actual use. They have been demonstrated to be effective and safe to use in the following environments.

Pulp stock suspension
Industrial cooling water systems
Numerous metalworking fluids containing water
Mineral oil
Organic material, 10 percent (horse serum test\
Alkylaryl sulfonate. 1percent (typical surfactant)
Sodium tripolyphosphate
Sodium hexametaphosphate
Starch, 2 percent
$CaCl_2$. 0.25 percent
NaCl, 10 percent

Some notable exceptions are compounds that are strong reducing agents, such as basic, electron-rich nucleophilic reagents. Such compounds will tend to deactivate DOW DBNPA antimicrobials (via debromination) to biologically inactive cyanoacetamide. Several groups of compounds of this type have been evaluated with DOW DBNPA to determine compatibility.

Questions concerning compatibility of DOW Antimicrobial 7287 and DOW Antimicrobial 8536 with specific chemicals should be addressed to The Dow Chemical Company. For example, if low levels of nucleophilic substances are known to be present, it would be wise to perform lab tests to determine the acceptability of DOW Antimicrobial 7287 and DOW Antimicrobial 8536 in the system.

Corrosivity

In concentrated form, DOW Antimicrobials 7287 and 8536 are corrosive to most metals. Mild steel, 304 stainless steel, nickel 200, and aluminum rapidly corrode or pit and may cause degradation of DOW Antimicrobials 7287 and 8536. Although it is less susceptible, 316 stainless steel will corrode where prolonged contact is expected. If 316 stainless steel is used for short-term storage of DOW antimicrobials containing DBNPA, it should be thoroughly flushed with water following use.

Titanium and Hastelloy[1] C-276 alloy (Haynes International Corporation) are acceptable for use with DOW Antimicrobial 7287 and DOW Antimicrobial 8536. Glass-lined metal vessels are also acceptable providing that the lining is intact. Metals which are normally unacceptable may be used if they are coated properly in advance. These coatings include Heresite P-403 high bake phenolformaldehyde resin (Heresite Chemical Co.. Manitowac, Wl), Amercoat 23 ambient cure vinyl resin (Ameron Corp., Brea, CA), and Plasite 4005 protective coating (Wisconsin Protective Coating Corp.). Rubber-lined vessels are not acceptable for use with concentrated solutions of DOW Antimicrobial 7287 and DOW Antimicrobial 8536 because the rubber and the antimicrobial undergo slow reaction.

Most non-metallic materials exhibit good long-term resistance to corrosion from concentrated solutions of DOW antimicrobials containing DBNPA:

Polyethylene	DERAKANE* 411-45 resin
Polypropylene	DERAKANE* 470-45 resin
Saran* resin	Kynar[2] resin
Teflon[3] resin	Viton[3] resin
Asbestos	Chlorinated polyethylene (CPE)

Table 17 – Summary of Materials Acceptable for Bulk Handling and Shipping of DOW Antimicrobial 7287 and DOW Antimicrobial 8536

Storage Tank and Tank Truck	Pipe Linings and Hosing
Titanium	Polypropylene
Hastelloy C-276 alloy	Kynar resin
Glass-lined steel	Teflon resin
316 Stainless steel, preferably with a protective coating	Saran resin
DERAKANE 411-45 resin or DERAKANE 470-45 resin (coated fiberglass)	Braided reinforced hosing of Teflon (stainless steel on outside)
Polyethylene	
Polypropylene	

Pumps	Gasket Materials
Titanium 316 SS	Chlorinated polyethylene (CPE)
Solid Kynar resin	Viton resin
Solid Teflon resin	Teflon resin
	Asbestos

Further information available from Dow

Any other questions pertaining to the acceptability of materials for handling DOW Antimicrobials 7287 and 8536 should be addressed to Dow. Similarly, questions about the proper design and construction of equipment for handling quantities of DOW Antimicrobials 7287 and 8536 should be addressed to Dow.

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[1] Trademark of Haynes International Corporation
[2] Trademark of Pennwalt Corporation
[3] Trademark of E.I. DuPont de Nemours & Co., Inc.

Routine handling and protective equipment

As with all chemicals, handle DOW Antimicrobials 7287 and 8536 only after hazards are thoroughly understood. Always use safe chemical handling procedures and appropriate protective equipment.

Please read the Material Safety Data Sheets for these products and understand the potential hazards before using DOW DBNPA antimicrobials. Facsimiles of these sheets are included in this section. The sheets are updated periodically so be certain to read the ones which accompany the products to be sure you have the most recent copy.

Personal hygiene — Personnel should avoid eating, drinking, and smoking while handling DOW Antimicrobials 7287 and 8536. Good personal hygiene habits should always be practiced when handling DOW Antimicrobials 7287 and 8536.

Eye protection — *Chemical workers' goggles must be worn to minimize the possibility of eye exposure.* The most significant handling concern with DOW Antimicrobials 7287 and 8536 is eye contact. Laboratory studies show the potential for very serious eye damage, including the possibility of permanent impairment or loss of vision, should concentrated DOW DBNPA antimicrobial contact the eyes.

Protective clothing — Short-term contact, even with concentrated solutions, is not likely to cause injury to the skin. However, even accidental short-term contact should be avoided if possible. Prolonged contact or contact with abraded skin may result in a chemical burn. For these reasons, clean, long-sleeved and long-legged clothing should be worn at all times when handling concentrated solutions. If there is a chance of repeated or extended exposure to DOW Antimicrobial 7287 or DOW Antimicrobial 8536, impervious gloves and foot protection should also be worn.

Ventilation — To minimize the possibility of exposure to vapors in the container headspace, drums should be opened and stored in an area with adequate general ventilation. If the DOW DBNPA products are stored in large tanks, the vapors should be vented to the atmosphere or to a scrubber, depending on local air regulations.

Container labeling — All containers of DOW Antimicrobials 7287 and 8536, including dilutions and formulations, must be clearly labeled in accordance with the standards set by the Environmental Protection Agency (EPA).

Bulk handling information

DOW Antimicrobials 7287 and 8536 are temperature sensitive. Therefore, all external sources of heat or energy must be eliminated or controlled to ensure product stability and safety. The following are potential sources of heat or energy: sunlight, radiation, warehouse lights and heaters, agitators and pumps, and steam used to thaw a frozen line or drum. Remember that the storage volume has a direct effect on the rate of product decomposition. Customers should examine their operations carefully and consider these points.

Screening tests have established suitable materials of construction for handling DOW Antimicrobial 7287 (20 percent DBNPA in polyethylene glycol). The polyethylene glycol is essentially noncorrosive, therefore, the corrosion potential of the two formulated products is a function of increasing DBNPA concentration. DOW Antimicrobial 7287 (20 percent DBNPA) represents the worst case, but the conclusions and recommendations presented here also should be followed for DOW Antimicrobial 8536 (5 percent DBNPA) to ensure an adequate margin of safety.

Temperature/decomposition rates

DOW DBNPA antimicrobials are effective and environmentally safe as biocides when properly administered. However, the active component, dibromonitrilopropionamide, is temperature sensitive and will decompose exothermically (liberate heat) at elevated temperatures. In addition, its decomposition rate increases with increasing temperature once the exothermic reaction begins.

If DBNPA antimicrobials are stored under adiabatic conditions where this heat cannot be transferred to ambient air rapidly enough, the liquid temperature in the container will increase with decomposition, and this in turn will increase the decomposition rate.

In general, there is no severe hazard with the bulk handling of the water-glycol 20 percent and 5 percent formulations of DBNPA.

However, to ensure safe handling and product quality, it is important to determine which storage systems are nearly adiabatic, and once identified, to monitor the temperature within those storage containers. In relation to tank size, heat transfer from a bulk liquid decreases as its total volume increases because heat transfer is always a surface phenomenon: heat can be lost or gained to a system only through the surface. When volume increases relative to a surface area, there is a "self-insulating" effect, allowing temperature to build up within the storage facility.

It is for this reason that adiabatic conditions exist most commonly in large storage tanks and tank trucks. Also, adiabatic conditions can be found in large pumps or pumps made of (or coated with) Teflon resin, such as the kinds used to unload tank trucks.

Field experience indicates that DOW DBNPA antimicrobials can be stored safely and shipped in tanks and tank trucks with capacities up to 4,000 gallons. However, very large tanks and tank trucks (>4,000 gallons) should be avoided to ensure product quality because adiabatic conditions are possible in these large storage facilities. You can receive additional information on bulk handling of DOW Antimicrobial 7287 and DOW Antimicrobial 8536 by contacting your Dow representative.

- When filling bulk containers, keep the loading temperature of the DOW DBNPA product at 30°C (86°F) or less. Use a side-arm heat exchanger if necessary to maintain this temperature.
- Do *not* store DOW DBNPA products in tank trucks for more than 6 days from the time of filling because of potential temperature rise and subsequent decomposition.
- Use gravity flow or air pressure transfer wherever possible.
- If pumping is necessary, be certain there are interlocks to prevent operation of the pump when valves are closed or when a line is plugged. This can be accomplished by installing a temperature probe in the pump. A high temperature alarm should be set at 50°C (122°F) to indicate any malfunction.
- Avoid the use of pumps lined with Teflon resin for large volume transfer. These pumps are unacceptable for large volume transfer because the lining tends to separate over time, and there is the potential for overheating of the entrapped DBNPA product. Small pumps lined with Teflon, or pumps with solid Kynar, and used for metering the product into a storage handling system are acceptable.
- Do *not* recirculate DOW Antimicrobials 7287 or 8536 in bulk storage tanks unless a source of cooling is provided. The mechanical energy is transformed into heat and the tank will continue to increase in temperature because of the adiabatic conditions within.
- Install pressure-relief devices in all pumps handling DOW Antimicrobials 7287 or 8536.

Storage and shipment

As a class of materials, non-metallics such as polypropylene, polyethylene, Kynar resin, Teflon, and fiberglass reinforced plastic (FRP) are superior to metallic materials. Hastelloy C-276 alloy, titanium, and 316 SS (short-term storage or shipping), however, are satisfactory metallic materials for storage and shipment containers. In general, mild steel, aluminum, 304 SS and nickel 200 were unsatisfactory primarily because of excessive corrosion or pitting.

Prolonged storage of the DOW DBNPA formulations in 316 SS, especially at elevated temperatures, can discolor the product and cause pitting of the metal at the liquid-vapor interface. This can be prevented by keeping the residence time in the tank or vessel to a minimum, and then thoroughly flushing with water after usage. If flushing is not possible, a protective coating should be applied to the stainless steel, especially if longer term storage is necessary. There are three acceptable coatings for the manufacture and storage of DOW DBNPA formulations.

Heresite[1] P-403 high bake phenol-formaldehyde resin
Amercoat[2] 23 ambient cure vinyl resin
Plasite[3] 4005 protective coating

These coatings provide excellent protection when properly applied, but they are not indestructible and should be inspected periodically for damage.

If an FRP tank or tank lining is required for product storage or transfer, check with Dow to be sure that the resin being used is acceptable. Resins that have performed well are DERAKANE* 411-45 vinyl ester resin and DERAKANE* 470-45 resin. Rubber-lined vessels are not acceptable because the rubber swells excessively and discolors the product. However, glass-lined vessels are generally acceptable.

Transfer

The preferred construction materials for pumps used to transfer DOW Antimicrobial 7287 from a truck to storage are titanium, solid Kynar resin, or 316 SS. Pumps lined with Teflon are unacceptable for large volume transfer because there is the tendency for the lining to separate over time. However, small pumps lined with Teflon — used for metering the product into a system — are acceptable because of the lower volume displacement and the resulting reduction in equipment stress.

Gasket materials

We recommend gasket materials made of Viton resin, Teflon, chlorinated polyethylene (CPE), and asbestos. Other materials tend to discolor the product. We also recommend that any elastomer be checked for discoloration in a sample of the antimicrobial before using it in gaskets.

Pipes and hosing

Materials of construction acceptable for lining piping used with DOW Antimicrobial 7287 are polypropylene, Kynar, Teflon, and Saran resins. Braided reinforced hosing of Teflon (stainless steel on the outside) is a very suitable hosing material.

Disposal of DOW antimicrobials containing DBNPA

The DOW DBNPA products described in this technical bulletin must be disposed of in accordance with applicable federal, state, and local regulations. If residual product cannot be disposed of by use according to label instructions, contact your state Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

Empty drums should be properly discarded as per recommendations on the label. Add water to empty containers — even 1 to 5 gallons of water in an empty 55-gallon drum can minimize the formation of noxious vapors due to decomposition.

Products containing DOW DBNPA may also be disposed of by appropriate industrial incineration, provided that all federal, state, and local regulations for disposal are met.

For assistance in emergencies, human exposure, or disposal of degraded material, call The Dow Chemical Company, (517) 636-4400.

Facsimile material safety data sheets

On pages 27 and 28 facsimiles of portions of the Material Safety Data Sheets for DOW Antimicrobial 7287 and DOW Antimicrobial 8536 are included for your reference. Similar sheets on all DOW Antimicrobial products are available from your Dow sales representative.

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[1] Trademark of Haynes International Corporation
[2] Trademark of Pennwalt Corporation
[3] Trademark of E.I. DuPont de Nemours & Co., Inc.

Figure 8 – Facsimile of page 1 of Material Safety Data Sheet, DOW Antimicrobial 7287

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M A T E R I A L   S A F E T Y   D A T A   S H E E T
--------------------------------------------------------------------------------
Dow Chemical U.S.A.*   Midland, MI 48674  Emergency Phone: 517-636-4400

Product Code: 08463                                                    Page: 1
Product Name: ANTIMICROBIAL 7287

Effective Date: 07/18/91   Date Printed: 07/16/92          MSD: 000716


1.  INGREDIENTS: (% w/w, unless otherwise noted)

      Active ingredient:
       2,2-Dibromo-3-nitrilopropionamide      CAS# 010222-01-2  20%
      Inert ingredients:                                        80%
       Tetraethylene glycol or polyethylene   CAS# 000112-60-7
        glycol mixture                        CAS# 025322-68-3
      Water                                  CAS# 007732-18-5
      Sodium bromide                         CAS# 007647-15-6
      Monobromo-3-nitrilopropionamide        CAS# 001113-55-9   1%
      Dibromoacetonitrile                    CAS# 003252-43-5   1%
      2,2-Dibromomalonamide                  CAS# 073003-80-2   1%

      This document is prepared pursuant to the OSHA Hazard
      Communication Standard (29 CFR 1910.1200).  In addition, other
      substances not 'Hazardous' per this OSHA Standard may be listed.
      Where proprietary ingredient shows, the identity may be made
      available as provided in this standard.

2.  PHYSICAL DATA:

      BOILING POINT:  Decomp. >120C
      VAP PRESS:  4 x 10(-5) mmHg
      VAP DENSITY:  <1 (water)
      SOL. IN WATER:  Appreciable
      SP. GRAVITY:  1.24-1.26 @ 23C
      APPEARANCE:  Amber liquid.
      ODOR:  Light, anesthetic odor.

3.  FIRE AND EXPLOSION HAZARD DATA:

      FLASH POINT:  >200F
      METHOD USED:  TCC

      FLAMMABLE LIMITS
      LFL:  Not determined
      UFL:  Not determined

      EXTINGUISHING MEDIA:  Water fog, alcohol foam, dry chemical.

      FIRE & EXPLOSION HAZARDS:  Not available.


(Continued on Page 2)
(R) Indicates a Trademark of The Dow Chemical Company


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Important Note: *The sheet reproduced here represents only a single page from a multiple-page document. These Material Safety Data Sheets are updated regularly. Be certain you have the most recent, complete copies in your possession.*

Figure 8A – Facsimile of page 1 of Material Safety Data Sheet, DOW Antimicrobial 8536

M A T E R I A L S A F E T Y D A T A S H E E T

Dow Chemical U.S.A.* Midland, MI 48674 Emergency Phone: 517-636-4400

Product Code: 08468 Page: 1
Product Name: ANTIMICROBIAL 8536

Effective Date: 07/18/91 Date Printed: 07/16/92 MSD: 000833

1. INGREDIENTS: (% w/w, unless otherwise noted)

Active ingredient:		
2,2-Dibromo-3-nitrilopropionamide	CAS# 010222-01-2	5%
Inert ingredients:		95%
Tetraethylene glycol or polyethylene glycol mixture	CAS# 000112-60-7 CAS# 025332-68-3	
Water	CAS# 007732-18-5	
Sodium bromide	CAS# 007647-15-6	

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.

2. PHYSICAL DATA:

BOILING POINT: Decomp. >120C
VAP PRESS: 4 x 10(-5) mmHg
VAP DENSITY: <1 (water)
SOL. IN WATER: Appreciable
SP. GRAVITY: 1.14-1.17 @ 23C
APPEARANCE: Amber liquid.
ODOR: Light anesthetic odor.

3. FIRE AND EXPLOSION HAZARD DATA:

FLASH POINT: >200F
METHOD USED: TCC

FLAMMABLE LIMITS
LFL: Not determined
UFL: Not determined

EXTINGUISHING MEDIA: Water fog, alcohol foam, dry chemical.

FIRE & EXPLOSION HAZARDS: Not available.

FIRE-FIGHTING EQUIPMENT: Wear positive-pressure self-contained breathing apparatus and goggles.

(Continued on Page 2)

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Important Note: *The sheet reproduced here represents only a single page from a multiple-page document. These Material Safety Data Sheets are updated regularly. Be certain you have the most recent, complete copies in your possession.*

Summary toxicologic profile

Table 18 – Summary Toxicologic Profile of DOW DBNPA

Test	Species	Results
Acute Oral	Rat	LD_{50}, DOW Antimicrobial 7287 = approximately 800 mg/kg LD_{50}, DOW Antimicrobial 8536 = greater than 1000 mg/kg
Eye Irritation	Rabbit	Corneal injury, iritis, and severe conjuctival irritation; severity greatest with DOW Antimicrobial 7287. Injuries did not heal within 15 days. Chemical workers' goggles must be worn while handling and using these products.
Skin Irritation	Rabbit	DBNPA has been shown to have moderate skin irritation potential on contact with abraded skin. A marked irritation could result from prolonged or frequently repeated exposure.
Skin Absorption	Rabbit	LD_{50} is greater than 2000 mg/kg for the active ingredient.
Skin Sensitization	Guinea Pig	7 of 10 animals display skin sensitization reaction in response to application of a 5% aqueous solution of DBNPA.
Skin Sensitization	Human	Out of 26 subjects, there were no sensitization reaction to an aqueous solution containing 1250 ppm active DBNPA.
Inhalation	Rat	No adverse effect noted after a six hour exposure to vapors generated by bubbling air through an aqueous solution of 2000 ppm DBNPA.
Mutagenicity	Varies	Negative when tested by the Ames Test, Rat Hepatocyte Unscheduled DNA Assay, Mouse Bone Marrow Micronucleus Test, and Chinese Hamster Ovary Cell/Hypoxanthine (Guanine) Phosphoribosyl Transferase (CHO/HGPRT) Forward Mutation Assay.

Summary of decomposition reactions

DOW DBNPA possesses two characteristics that make it unique among nonoxidizing biocides: *extremely fast antimicrobial action and rapid degradation to relatively non-toxic end products*. The dominant degradation pathway under use conditions involves reaction with nucleophilic substances or organic material invariably found in water.

Additional degradation reactions include pH dependent hydrolysis, reaction with soil, and breakdown via exposure to ultraviolet radiation.

Figure 9 shows the typical degradation pathways for DOW DBNPA.

Rate of hydrolysis of DOW DBNPA

The uncatalyzed hydrolysis of DBNPA has been studied in dilute solutions at various pH levels. The reaction proceeds via decarboxylation to dibromoacetonitrile. The rate of hydrolysis is a function of pH and temperature, and increasing either or both will increase the decomposition rate. Hydrolysis is relatively rapid at neutral to slightly alkaline pH. This is important because natural waters in most rivers, especially in industrial areas, are (typically) slightly alkaline.

In determining the hydrolysis products of DOW DBNPA, the concentrations of DOW DBNPA (ca. 12,000-15,000 ppm) were, of necessity, considerably higher than those of use conditions (ca. 1 ppm). The pH profile for the hydrolysis of DOW DBNPA at 25°C is shown in Figure 10.

Figure 10 – pH vs. Rate of Hydrolysis of DOW DBNPA at 25°C

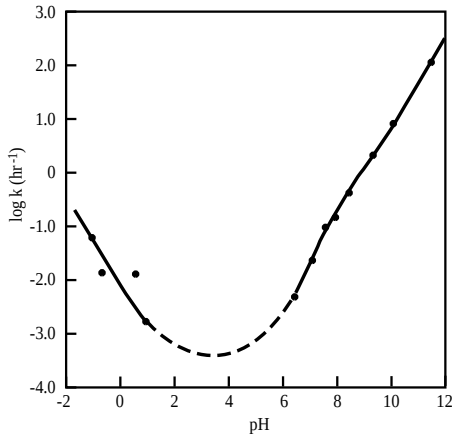
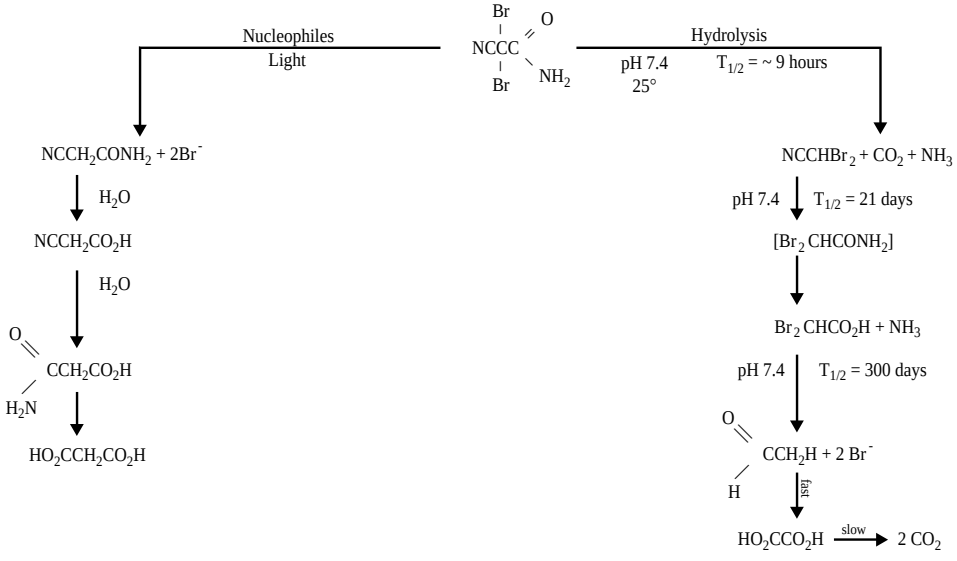


Figure 9 – Decomposition Pathways of DOW DBNPA



Degradation of DOW DBNPA in the presence of soil

DBNPA is also degraded by a number of nucleophiles such as sulfite, bisulfite, thiosulfate, and sulfide. These compounds debrominate DBNPA instantaneously to form cyanoacetamide. Soil, which is a source of a number of nucleophiles, also accelerates the degradation of DBNPA. This has been demonstrated in a number of experiments in which traces of DBNPA were added to an aqueous suspension of a number of different types of soil. Typically, half-lives of 4 hours were observed at neutral pH, and 15 hours at pH 5.

The disappearance of DOW DBNPA solutions in the presence of soil (Table 19) could be due to absorption, chemical degradation, microbial degradation, or hydrolysis. Microbial degradation of DBNPA has been demonstrated by the use of tracer techniques. Rapid reaction in the soil occurs with a variety of nucleophilic reagents to form cyanoacetamide, a compound which is biodegradable and which can hydrolyze further to biodegradable materials such as malonic acid.

Microbial degradation of DBNPA

In addition to degradation by hydrolysis. photodegradation, and reaction with nucleophiles, DBNPA also degrades to carbon dioxide under microbial attack. This microbial degradation has been documented under varying laboratory conditions by tracer techniques. The fate of the degradates of DBNPA is further hydrolysis and biodegradability.

Reaction of DOW DBNPA with sunlight

Decomposition tests show that DBNPA is degraded by sunlight with the formation of inorganic bromide ion. In one experiment, dilute aqueous DBNPA was maintained in a sealed tube in an outdoor environment for 28 days (pH 4). Less than 1 percent of the DBNPA remained and more than 95 percent of the theoretical amount of bromide was formed. The half-life was thus estimated to be 7 days under ambient climatic conditions. Exposure of a dilute solution of DBNPA to a sunlamp in a laboratory resulted in a half-life of less than 1 day.

The amount of DOW DBNPA remaining after exposure to sunlight for 28 days is less than 1 percent of an original test concentration of 4000 ppm. The percent of DOW DBNPA from the same solution after 28 days in darkness is 91 percent. Thus, photolytic degradation of DOW DBNPA is rapid, and in fact, is significantly fast relative to hydrolysis at pH less than 5.

Table 19 – Half-life of DOW DBNPA in Various Soil Types

Description	% sand	% silt	% clay	% organic carbon	pH of aqueous slurry	$T_{1/2}$hr
Sandy Loam	72.4	23.2	4.4	0.46	~7.5	4
Loam	38.0	41.0	21.0	2.37	4.8	12
Silty Loam	13.6	64.0	22.4	2.26	5.8	15
Sandy loam	59.0	28.0	13.0	1.16	6.5	15
Loamy sand	83.0	11.6	5.4	5.70	5.8	6
Silty clay loam	10.0	62.0	28.0	1.68	5.1	25
Loam	28.6	47.0	24.4	1.86	4.8	15

Fish and wildlife toxicology

Table 20 provides information about the toxicity of DOW DBNPA to aquatic, marine, and avian wildlife.

Table 20 – Evaluation of Hazard of 2.2-dibromo-3-nitrilopropionamide (DBNPA) to Wildlife

Aquatic Life	
Bluegill sunfish, 96-hour LC_{50}	1.3[1] (1.0-1.6)[2] mg/l
Rainbow trout, 96-hour LC_{50}	1.0 (0.6-1.5) mg/l
Fathead minnow, 96-hour LC_{50}	1.36 (1.24-1.48) mg/l
Daphnids, 48-hour LC_{50}	1.24 (1.06-1.94) mg/l
Largemouth bass finerlings, 96-hour LC_{50}	1.63 (1.54-1.73) mg/l
Marine Life	
Eastern oyster[3] (larvae), 48-hour LC_{50}	>0.56, <1.0 mg/l
Fiddler crab, 96-hour LC_{50}	14 (5.3-36) mg/l
Pink shrimp, 96-hour LC_{50}	>1.8, <3.2 mg/l
Glass shrimp, 96-hour LC_{50}	11.5 (8.69-15.22) mg/l
Asiatic clam, 96-hour LC_{50}	>80 mg/l
Brackish water clam, 24-hour LC_{50}	20 mg/l
Sheepshead minnow, 96-hour LC_{50}	1.4 (1.0-2.0) mg/l
Avian Life	
Mallard duck, oral LD_{50}	
Male	205 mg/kg
Female	216 mg/kg
Bob White quail, oral LD_{50}	
Male	166 mg/kg
Female	150 mg/kg

[1] All values based on active DBNPA
[2] 95% confidence interval
[3] Percentage of abnormally developed larvae (not mortality)

Toxicity hazard to fish

Based on the several degradation pathways of DBNPA and its intermediate degradates, the proper use of DBNPA in industrial water systems results only in traces of the compound in discharge water. Chemical and biological decomposition, and dilution of the effluent water, result in rapid disappearance of these traces. Therefore, DBNPA does not present a serious fish toxicity hazard when used properly. However, all discharges of DBNPA into lakes, streams, ponds, or public waters must be in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. The current data indicate that DBNPA has the potential for localized fish kill only if a large amount of biocide is discharged into a lake or river. For further guidance, contact your local EPA regional office.

HPLC method for determining DBNPA at use concentrations

Dow Test Method, ML-AM-78-22, Date: 5-11-78

1. Scope

This method is applicable to the determination of 2,2-dibromonitrilopropionamide (DBNPA) in wastewater in the range of 1-5 ppm.

2. Safety

Dibromonitrilopropionamide is capable of causing severe eye damage and skin burn. Handle with extreme care. Do not get into eyes, on skin or clothing. In the event of skin or eye contact, promptly flush with copious amounts of water, then get medical attention. Some of the other reagents used may be hazardous to handle. Follow the precautions recommended by the supplier.

3. Principle

Dibromonitrilopropionamide is separated by reverse phase liquid chromatography on a Corasil/C_{18} column with 10% methanol/90% deionized water as mobile phase. Detection is by ultraviolet spectrometry at 210 nm. Concentration is measured by peak height using external standardization.

4. Apparatus and reagents

(a) Liquid chromatographic UV detector capable of operating at 210 nm. e.g., Perkin Elmer LC-55. Available from Perkin Elmer Corp., Norwalk, CT.
(b) Chromatographic columns and fittings, available from Anspec Co., Box 44, Ann Arbor, Ml 48107.
(c) Bondapak C_{18}/Corasil column packing, available from Waters Associates, Inc., Milford, MA 01757.
(d) Methanol, distilled, spectroscopic grade, available from Burdick and Jackson Laboratories, Inc., Muskegon, MI 49442.
(e) Dibromonitrilopropionamide, 99% pure or better. Available from The Dow Chemical Company, Midland, Ml 48674.
(f) Ammonium phosphate, ACS grade, available from Mallinckrodt, Inc., Hazelwood, MO 63042.
(g) Phosphoric acid, ACS grade (85%). Available from Mallinckrodt, Inc.

5. Liquid chromatographic conditions

(a) Column:	500 x 2.8 mm I.D. stainless steel or glass
(b) Packing:	Bondapak C_{18}/Corasil
(c) Eluent[1]:	10% methanol in deionized water, adjusted to pH 4.6 with $(NH_4)_3PO_4$
(d) Flow rate:	1.0 ml/min
(e) Injection:	50 microliters
(f) Detector:	UV @ 210 nm
(g) Sensitivity:	0.02 AUFS (absorption units full scale)

6. Calibration

(a) Prepare a stock solution of DOW DBNPA by weighing 10.0± 0.001 mg and diluting to I liter in a volumetric flask with methanol. This solution contains 10 ppm DOW DBNPA. Take aliquots of 4, 2, 1 and 0.5 ml and dilute each to 10 ml with methanol. These solutions result in concentration of 4, 2, 1, and 0.5 ppm respectively. Chromatograph these four solutions to obtain an absorption peak height for each solution concentration.

Then plot the four obtained absorption peak heights versus concentration in ppm. With proper experimental technique, equipment in good working order, and proper reagents, this plot should be linear like the example shown in Figure 11.

7. Procedure

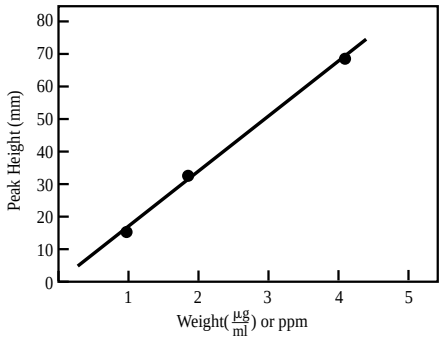
(a) Fifty microliters of sample is injected as received into the chromatographic column. Obtain chromatogram according to conditions outlined in 5 (a-g).

8. Calculations

Measure peak heights of analyzed sample and reference. Figure 12 provides an example. Calculate ppm DOW DBNPA in sample using the equation below.

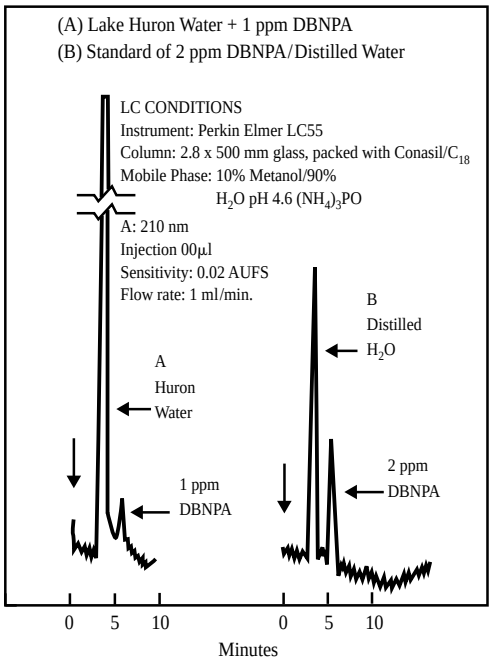
$$\text{ppm DOW DBNPA} = \frac{\text{peak height sample (mm)}}{\text{peak height standard}} \times \text{ppm std.}$$

Figure 11 – Linearity Study of Calibration Solutions of Dibromonitrilopropionamide (DBNPA)



[1] *Place a pH meter in container of eluent and add solution $(NH_4)_3PO_4$ and H_3PO_4 dropwise to the required pH.* ▶

Figure 12 – Liquid chromatograms of DOW DBNPA solutions



9. Precision

Data obtained by this method indicate a relative standard deviation of 5.58% at the 1 ppm level. Any single determination may be expected to differ from the average by not more than ±11.2% at the 95% confidence level.

10. Note

Because each wastewater may vary in composition, this method should be evaluated for each kind of wastewater.

The analytical procedures given herein have been adapted from literature sources or developed upon the basis of experimental data believed to be reliable. In the hands of a qualified analyst, they are expected to yield results of sufficient accuracy for their intended purposes but recipients are cautioned to confirm the suitability of the methods by appropriate tests. Recipients are also cautioned that The Dow Chemical Company makes no representation or warranty that the practice of the method described herein does not infringe third party patents. Anyone wishing to reproduce or publish the materials in whole or in part should request written permission from The Dow Chemical Company.

Spectrophotoiodometric method for determining DBNPA at use concentrations

Figure 13 – Absorption Spectrum of Triiodide in 5% KI in Water

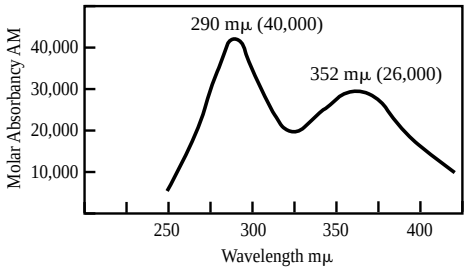


Figure 14 – Absorbance I_3 vs. DBNPA Concentration, 0-2 ppm DBNPA

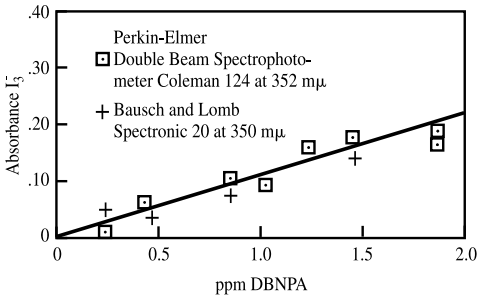
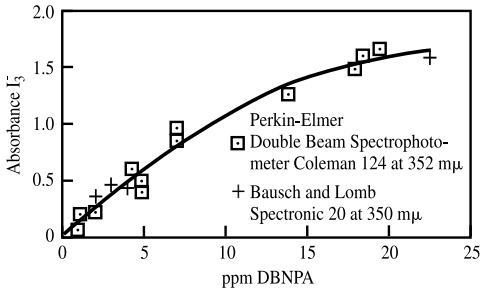


Figure 15 – Absorbance I_3 vs. DBNPA Concentration, 0-25 ppm DBNPA



1. Scope

The proper use of DOW Antimicrobial 7287 or DOW Antimicrobial 8536 containing 20% and 5% 2,2-dibromo-3-nitrilopropionamide (DBNPA), respectively, often requires an analytical technique for determining the concentration of DBNPA in water at use levels. In addition, it is sometimes desirable to determine low levels of DBNPA in effluent water.

The spectrophotoiodometric analysis technique described satisfies both requirements, enabling the determination of DBNPA concentrations from about 20 ppm down to about 1.0 ppm.

2. Safety

DBNPA is toxic. However, the small concentration used in the cooling water should present no hazard if good analytical technique is followed. Avoid ingestion and contact of the cooling water with skin. Some of the other reagents used may be hazardous to handle. Follow the precautions recommended by the supplier(s).

3. Principle

Potassium iodide in solution with 2,2-dibromo-3-nitrilopropionamide (DBNPA) produces a triiodide complex ion (I_3) with absorption peaks at 352 and 289 mμ (Figure 13). The peak at 352 mμ was chosen for this technique because it is in the visible — near ultraviolet region of the spectrum; therefore a portable spectrophotometer may be employed.

The absorbance due to the concentration of the I_3 complex liberated from the DOW DBNPA solution agrees with the general formula: ppm DOW DBNPA = 10 x absorption I_3 complex (Figures 14 and 15). This approximation holds true up to 10 ppm. The absorption readings were made using a Bausch and Lomb Spectronic 20 set at 350 mμ. These absorption readings were compared to those obtained from a Perkin Elmer Double Beam Spectrophotometer Coleman 124 set at 352 mμ (Figures 14 and 15). The absorbance cell path length was one centimeter.

4. Procedure

Remove a sample of the water to be tested for DBNPA concentration and measure a 500 ml aliquot into a volumetric flask. Add 1 ml, 1 N HCl and mix thoroughly. Add 1-2 g of solid analytical grade potassium iodide. Wait 5-10 minutes and read the absorbance at 350-352 mμ in a 1 cm path length cell. Concentration may then be estimated using the absorbance vs. concentration graphs (Figures 14 and 15).

This technique is most accurate if the absorbance is in the 0.1-1.0 range where DBNPA absorbance vs. concentration is linear. If DBNPA concentrations >10 ppm are expected, a known dilution of the sample with distilled water to bring the estimated concentration below 10 ppm should be made prior to following the above steps.

5. Apparatus

Bausch and Lomb Spectronic 20 Spectrophotometer instrument or equivalent. Reagent: Potassium iodide, ACS grade.

6. Troubleshooting

If the solution being tested is cloudy or if extraneous material or suspended solids are present, a background absorption should be determined and subtracted from the original absorption at 350 mμ. This can be done by adding a drop of 0.1 N sodium thiosulfate to the absorption cell contents and reading the absorption again without the I_3^- species present.

Interference resulting from the presence of manganese, iron, or nitrite may be minimized by buffering to pH 4.0 before the addition of potassium iodide.

The CrO_3^- ion, or other species that will oxidize the iodide ion, will give a high, incorrect reading. If incorrect values are suspected, the analysis should be checked with a more specific technique, such as Dow Analytical Method ML-AM-78-22, page 35.

The analytical procedures given herein have been adapted from literature sources or developed upon the basis of experimental data believed to be reliable. In the hands of a qualified analyst, then are expected to yield results of sufficient accuracy for their intended purposes but recipients are cautioned to confirm the suitability of the methods by appropriate tests. Recipients are also cautioned that The Dow Chemical Company makes no representation or warranty that the practice of the method described herein does not infringe third party patents. Anyone wishing to reproduce or publish the materials in whole or in part should request written permission from The Dow Chemical Company.

HPLC QC method for DOW Antimicrobial 7287 and DOW Antimicrobial 8536

Dow Test Method, ML-AM-76-32, Date: 6-24-76

1. Scope

This method is applicable to the determination of dibromonitrilopropionamide (DBNPA) in the 95-98% range. Other concentrations may be determined by changing the sample size and/or the injection volume.

2. Safety precautions

Dibromonitrilopropionamide is capable of causing severe eye damage and skin burn. Handle with extreme care. Do not get into eyes, on skin or clothing. In the event of skin or eye contact, promptly flush with copious amounts of water, then get medical attention. Some of the reagents used may be hazardous to handle. Follow the precautions recommended by the supplier.

3. Principle

Dibromonitrilopropionamide is separated from all known impurities on a column of strong cation exchange resin, eluted with dilute hydrochloric acid, and monitored by UV spectrophotometry at 215 nm.

4. Apparatus

(a) Ultraviolet spectrophotometer, modular unit with Beckman Model DU monochromator and Gilford Model 222 photometer and power supply, or equivalent. Available from Gilford Instrument Laboratories, Oberlin, OH 44072.
(b) Elevated cuvette chamber cover (No. 1045) and 10 mm flow-through cell with bubble trap (Model 203A). Available from Gilford Instrument Laboratories.
(c) Pump, Milton Roy Instrument minipump brand Model 196-131 or equivalent. Available from Milton Roy Company, P.O. Box 12169, St. Petersburg, FL.
(d) Chromatography columns and fittings. Available from Chromatronix, Inc., Berkeley, CA 94710. Local supplier, Anspec Company, P.O. Box 44, Ann Arbor, MI 48107.

5. Reagents

(a) Methanol, distilled. Available from Burdick and Jackson Laboratories, Inc., Muskegon, Ml 49442.
(b) Dibromonitrilopropionamide, 99% pure or better.
(c) Aminex 50w 4x (30-35μ) cation exchange resin (H^+). Available from Bio-Rad Laboratories, Richmond, CA 94804.

6. Instrumental Conditions

(a) Column: 230 x 9 mm I.D. glass
(b) Packing: Aminex 50w 4x (30-35μ) cation exchange resin (hydrogen form)
(c) Eluent: 0.02N hydrochloric acid
(d) Flow Rate: 1.0 ml/min
(e) Detector: UV @ 215 nm

7. Procedure

(a) Weigh 100-110 mg ±0.1 mg each of standard dibromonitrilopropionamide and sample into separate 50-ml volumetric flask. Add 1-2 ml methanol to dissolve the sample and standard, then dilute with distilled water to which 2 drops of 1:1 hydrochloric acid have been added. (Note 10a).
(b) Inject 50 microliters of each into the column and obtain chromatogram. (Note 10b). Figure 16 shows a sample chro matogram obtained by this method.
(c) Measure the peak heights of sample and standard.

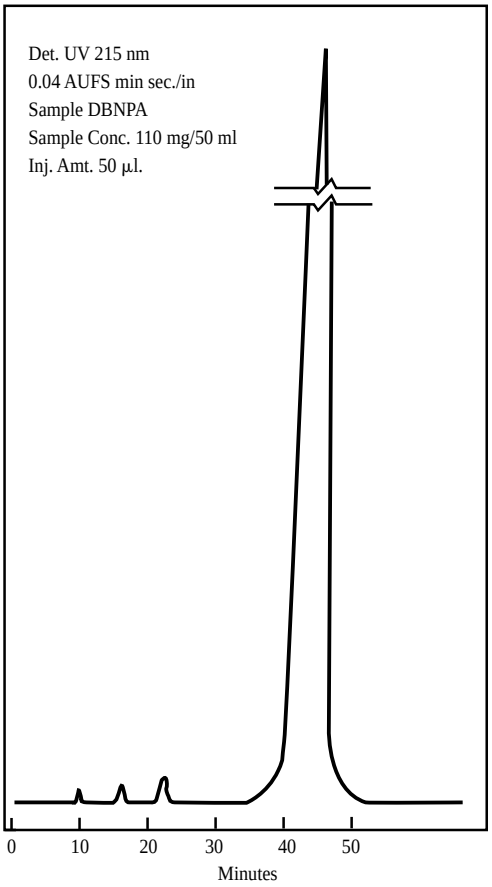
8. Calculations

$$\textbf{Wt \% DBNPA} = \frac{\textbf{peak height sample}}{\textbf{peak height standard}} \times \frac{\textbf{wt of standard}}{\textbf{wt of sample}} \times \textbf{100}$$

9. Precision

Data obtained by this method indicate a standard deviation (σ) of 0.6%. The values obtained may be expected to vary from the average by not more than ±1.2% at the 95% confidence level.

Figure 16 – Sample Chromatogram of DOW DBNPA Obtained on Ultraviolet Spectrophotometer



10. Notes

(a) Hydrochloric acid is added to maintain a pH of less than 4.

(b) The column should be conditioned by pumping through pure eluent for at least 10 min. prior to injection of sample.

The analytical procedures given herein have been adapted from literature sources or developed upon the basis of experimental data believed to be reliable. In the hands of a qualified analyst, they are expected to yield results of sufficient accuracy for their intended purposes but recipients are cautioned to confirm the suitability of the methods by appropriate tests. Recipients are also cautioned that The Dow Chemical Company makes no representation or warranty that the practice of the method described herein does not infringe third party patents. Anyone wishing to reproduce or publish the materials in whole or in part should request written permission from The Dow Chemical Company.

Titrimetric QC method for DOW Antimicrobial 7287 and DOW Antimicrobial 8536

Dow Test Method, ML-AM-78-11, Date: B27-78

1. Scope

This method is applicable to the determination of dibromonitrilopropionamide (DBNPA) in the 18-22% range. Other concentrations may be determined by changing the sample size.

2. Safety Precautions

Dibromonitrilopropionamide is capable of causing severe eye damage and a skin burn. Handle with great care. Do not get in eyes, on skin or clothing. Avoid breathing vapors.

Some of the other reagents may be hazardous to handle. Observe safety precautions as suggested by suppliers or other good sources in their handling.

3. Principle

Dibromonitrilopropionamide in an acidic solution will oxidize the iodide to yield two equivalents of iodine per bromine atom. The iodine is then titrated with standard sodium thiosulfate (hypo) solution.

4. Apparatus

Iodine flask. 125-ml.

5. Reagents

(a) Potassium iodide, ACS grade.
(b) Potassium iodide solution, 20% by weight. Dissolve 20 g potassium iodide, (5a), in 80 ml distilled water.
(c) Hydrochloric acid 6 N solution. Mix equal volumes of concentrated HCl and distilled water.
(d) Sodium thiosulfate, standard, 0.1 N solution. Dissolve 25 g of sodium thiosulfate pentahydrate in water and dilute to 1 liter. Add 0.5 ml chloroform as a preservative. Standardize at least weekly. The prepared solution is available from The Curtin Company, P.O. Box 1546, Houston, TX 77001
(e) Acetonitrile, reagent grade.

6. Procedure

(a) Weigh accurately to the nearest milligram 0.5000 g of sample into a 125-ml iodine flask. Add 25 ml of acetonitrile, 2 ml of 6 N hydrochloric acid, and 10 ml of potassium iodide solution. Stopper and swirl occasionally over a 5-minute period.
(b) Titrate with standard 0.1 N sodium thiosulfate solution to the disappearance of the yellow color.
(c) Titrate a reagent blank and adjust the sample titration to obtain the net milliliters of sodium thiosulfate used.

7. Precision

Data obtained by this method indicate a standard deviation (2σ) of 0.11% at the 95% confidence level.

8. Calculation

$$\frac{\text{net ml of hypo x normality x 0.0605 x 100}}{\text{grams of sample}} = \text{\% DBNPA}$$

The analytical procedures given herein have been adapted from literature sources or developed upon the basis of experimental data believed to be reliable. In the hands of a qualified analyst, they are expected to yield results of sufficient accuracy for their intended purposes, but recipients are cautioned to confirm the suitability of the methods by appropriate tests. Recipients are also cautioned that The Dow Chemical Company makes no representation or warrants that the practice of the method described herein does not infringe third party patents. Anyone wishing to reproduce or publish the materials in whole or in part should request written permission from The Dow Chemical Company.

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For additional information:

United States call: 1-800-447-4369
Fax: 1-989-832-1465
In other global areas: 1-989-832-1556
or
Visit our website
www.dowbiocides.com