

## Product Information

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

### Bellacide® 355 - High Performance, Multifunctional and Surface Active Biocide for Industrial Water Systems

**Bellacide 355** high performance biocide is a fast acting, broad spectrum biocide with superior activity compared to other non-oxidizing biocides. In particular, its unique properties set it aside from cationic ammonium and phosphonium biocides.

Bellacide 355 is designed for the control of microbiological fouling in cooling water, industrial and institutional cleaning, oil field waters, papermaking and other industrial water applications.

Bellacide 355 is effective in preventing the build-up of microbiological slimes and can be applied to clean heavily fouled systems.

#### Advantages of Bellacide 355

- **Cost effective, broad spectrum of activity**

Bellacide 355 has a high activity at low dose levels against aerobic bacteria (including *Legionella pneumophila*), anaerobic bacteria, algae and fungi with typical MIC values of 2 and 10 ppm for algae and fungi respectively.

- **Good cleaning action due to surface active properties**

The excellent biocidal effects, high surface activity and low foaming properties make Bellacide 355 particularly suitable for cleaning cooling systems which are heavily fouled with microbiological slimes.

- **Highly effective against problematic organisms**

Bellacide 355 MCC (minimum cidal concentration) against sulphate reducing bacteria (SRB) is 10 ppm in 1 hour. Bellacide 355 MIC for *Legionella pneumophila* is 6.25 to 12.5 ppm solids.

- **Compatible and easy to use across broad pH range**

Bellacide 355 mixes uniformly in water and is not affected by the pH of the system water it can be used from pH 5 to 12. At normal use levels it is compatible with other water treatment additives commonly found in open recirculating cooling water systems and can be used with oxidising agents such as chlorine. Bellacide 355 is stable in neutral, alkaline and acidic solution and is not susceptible to degradation by ultraviolet light.

- **No contribution to TOC loading and filtration aid in closed loop systems**

The bacterial population within a closed loop system is eliminated and re-growth is dramatically reduced since Bellacide does not contribute to the total organic carbon (TOC) load and thus reducing the total amount of bacterial nutrients within the system. Bellacide 355 also acts as a microbe binding agent thus forming bacterial

clusters that are easily removed from the system using by-pass filtration.

#### Typical properties

Bellacide 355 is a 5% aqueous solution of tributyl tetradecyl phosphonium chloride (TTPC).

Appearance	Clear, colorless liquid
Specific gravity at 20°C	1.0
pH	6.0-8.0
Odor	Slight
Solubility: Water	Completely miscible
Methanol	>50%
Isopropanol	>50%
Ethylene glycol	>50%

#### Activity of Bellacide 355

Bellacide 355 has superior activity compared to other biocides at low dose rates against a broad spectrum of micro-organisms. Figures 1 and 2 delineate that Bellacide 355 out performs other commonly available industrial biocides.

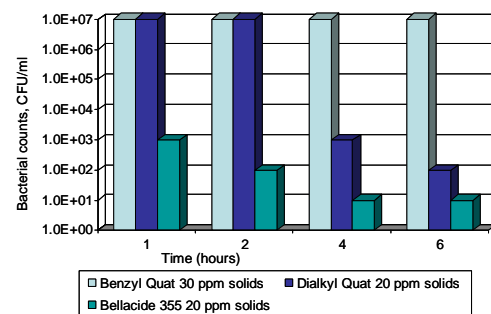


Figure 1: Comparative efficacy against a mixed culture of bacteria (*P. aeruginosa*, *E. aerogenes*, *P. vulgaris*, *S. aureus*, *B. cereus*, *E. coli*)

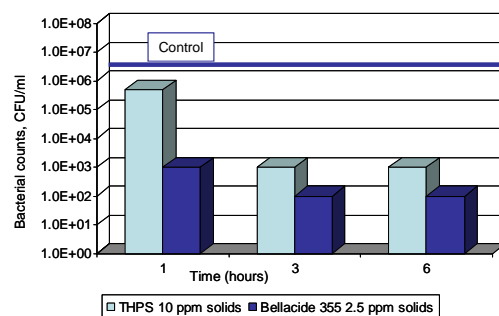


Figure 2: Comparative efficacy of Bellacide 355 and THPS against *Pseudomonas aeruginosa*

### Bactericidal activity

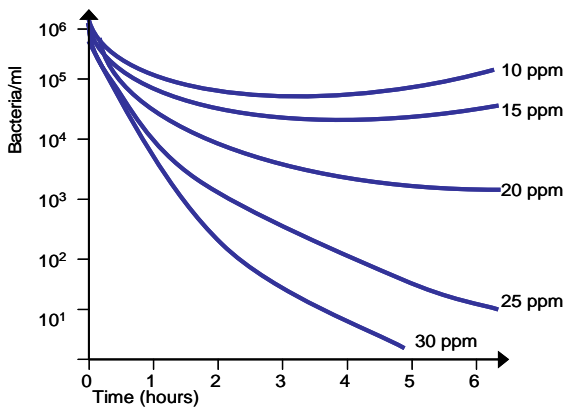
The remarkable bactericidal activity of Bellacide 355 has been demonstrated in a number of studies. Bellacide 355 biocide has been shown to be more effective against *Legionella Pneumophila* than other commonly used biocides in industrial water systems, Table 1.

**Table 1: Comparative efficacy of Bellacide 355 against *Legionella Pneumophila*\***

Biocide	MIC value ppm solids
Bellacide 355	6.25 - 12.5
Dialkyl quat	25 - 50
Isothiazolinone blend	28 - 56
BNPD	50 - 100
DBNPA	100 - 800

\*Source: Elsmore, R. 1986, Biocidal control of Legionellae, Israeli Journal of Medical Science, 22, 647-654

Bellacide 355 has shown exceptional performance against a mixed culture of slime-forming aerobic bacteria as shown in Figure 3. The culture used consisted of: *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Proteus vulgaris*, *Staphylococcus aureus*, *Bacillus cereus* var. *mycoides* and *Escherichia coli*.



**Figure 3: Bactericidal effect of Bellacide 355 against a mixed culture of slime forming aerobic bacteria**

Bellacide 355 also has high biocidal activity against anaerobic sulphate-reducing bacteria. In tests with *Desulphovibrio desulphuricans* Bellacide 355 has been shown to be bactericidal at 5 ppm solids with a contact time of only 1 hour.

### Activity against fungi

The minimal inhibition concentration (MIC) values of Bellacide 355 in liquid culture are shown in Table 2 (test concentrations 2, 5 and 10 ppm solids).

Table 2 illustrates that Bellacide 355 has a high activity against fungi, 5 ppm being the highest concentration required to inhibit the growth of the fungal strains tested.

**Table 2: MIC of Bellacide 355 against different strains of fungi**

Fungal strain	MIC value ppm solids
<i>Aspergillus niger</i>	5
<i>Aspergillus phoenicis</i>	5
<i>Penicillium funiculosum</i>	2
<i>Alternaria alternata</i>	5
<i>Cladosporium cladosporioides</i>	2
<i>Endomyces geotrichum</i>	2
<i>Areobasidium pullulan</i>	2
<i>Chaetomium globosum</i>	2

### Algistatic activity

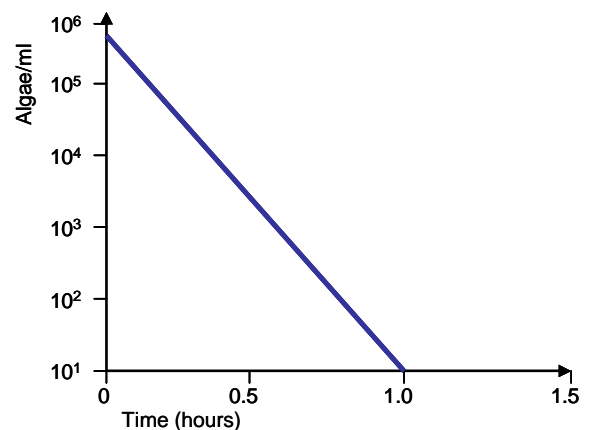
The MIC against 8 strains of algae are shown in Table 3

**Table 3: MIC of Bellacide 355 against different strains of algae**

Algal strain	MIC value ppm solids
<i>Oscillatoria geminata</i> DSM 1459-8	3
<i>Nostoc</i> sp DSM 1453-7	1
<i>Phormidium foveolarum</i> DSM 1462-1	1
<i>Chlorella vulgaris</i> DSM 211-11a	1
<i>Chlorella pyrenoidosa</i> DSM 211-3m	1
<i>Scenedesmus</i> sp DSM 267-7	1
<i>Ulothrix subtilissima</i> DSM 384-1	1
<i>Tribonema aequale</i> DSM 880-1	1

### Algicidal activity

The rapid algicidal effect of Bellacide 355 against the common troublesome strain *Chlorella vulgaris* is shown in Figure 4. In this test, 3 ppm of Bellacide 355 killed this strain in 1 hour.



**Figure 4: Algicidal effect of Bellacide 355 against *Chlorella vulgaris***

### Bleaching effect

Although Bellacide 355 is not an oxidizing biocide it has a bleaching effect on algae. Concentrations as low as 5 ppm of Bellacide 355 have been shown to bleach a mixed culture of the algae listed in Table 3 within 5 days.

### Summary of biocidal activity

A tabular synopsis of the biocidal superior activity achieved through the use of Bellacide 355 as compared to the foremost non-oxidizing biocides is seen below in Table 4.

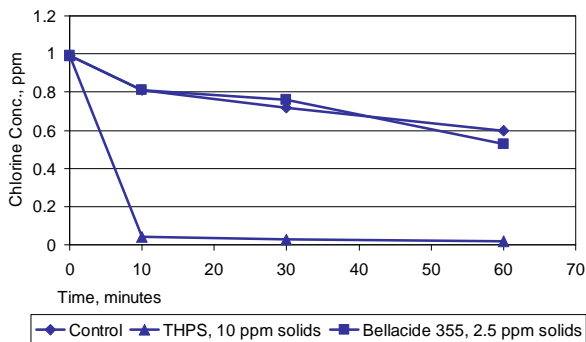
**Table 4: Summary of biocidal activity for primary non-oxidizing biocides**

Biocide	Biocidal Effectiveness							
	Algae	Aerobic Bacteria	Anerobic Bacteria	Sulfate Reducing Bacteria	Legionella pneumophila Bacteria	Biofilm Removal	Fungi	Mollusks
Bellacide 355	☼☼☼☼	☼☼☼☼	☼☼☼☼	☼☼☼☼	☼☼☼☼	☼☼☼☼	☼☼☼☼	☼☼☼☼
Isothiazoline	☼☼	☼☼☼☼	☼☼☼☼	☼	☼☼	☼☼	☼☼☼☼	☼
Glutaraldehyde	☼	☼☼☼☼	☼☼☼☼	☼☼☼☼	☼☼☼☼	☼☼☼☼	☼	☼
WSCP	☼☼	☼☼	☼☼	☼☼	☼	☼	☼☼☼	☼☼☼☼
DBNPA	☼	☼☼☼☼	☼☼☼☼	☼	☼	☼☼	☼	☼
THPS	☼	☼☼	☼☼	☼	☼☼	☼☼	☼	☼
Carbamate	☼	☼	☼	☼	☼	☼	☼☼☼☼	☼

**Properties in use**

**Compatibility with chlorine**

Bellacide 355 can be used in chlorinated waters without any adverse effect. Figure 5 shows the loss of free chlorine on mixing a solution containing 1 ppm free chlorine with one containing a biocidally effective concentration of 2.5 ppm solids Bellacide 355. It can be seen that Bellacide 355 does not have any significant chlorine demand. In contrast, the presence of a biocidally effective concentration of 10 ppm solids of THPS results in a rapid depletion of free chlorine levels.

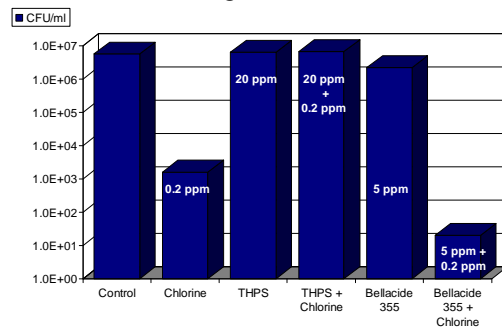


**Figure 5: Compatibility of Bellacide 355 with chlorine**

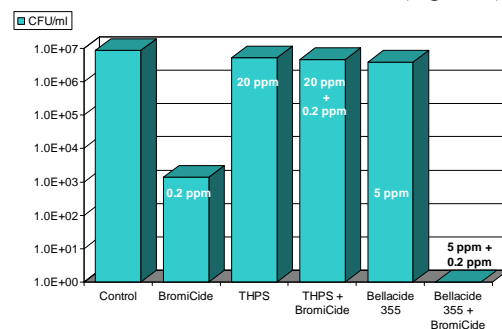
As Bellacide 355 high performance biocide is not affected by the presence of halogen based oxidizing biocides efficient and cost effective utilization of both biocides is possible thus reducing the overall cost of the treatment program.

Figure 6 demonstrates, after only 10 minutes contact time at pH 7.5, Bellacide 355, unlike THPS, working effectively with chlorine to quickly and substantially reduce bacterial counts.

**Figure 6: Cost effective activity of Bellacide 355 with chlorine based oxidizing biocides**



Similar cost effective activity is seen with BWA Water Additive's bromine based BromiCide® oxidizing biocide, at pH 8.5 and a contact time of 10 minutes (Figure 7).



**Figure 7: Cost effective activity of Bellacide 355 (as solids) with bromine based oxidizing biocides**

**Surface activity**

Biocides that have surface active properties can be effective in cleaning biologically fouled systems by penetrating existing biofilms.

At low concentrations, Bellacide 355 has a greater surface activity than typical quaternary ammonium compounds, such as alkyl dimethyl benzyl ammonium chloride which is why Bellacide 355 is more effective in removing biological slimes.

### Low foaming properties

A major disadvantage with the use of surface active chemicals is the tendency to produce large amounts of stable foam when the water is agitated and aerated in the cooling tower. Extensive laboratory tests and field trials have shown that the use of routine treatment levels of Bellacide 355 can give small amounts of unstable foam which is quickly dissipated, whereas quaternary ammonium compounds cause major problems due to the formation of large amounts of stable foam.

### pH stability

Bellacide 355 is hydrolytically stable over a wide pH range and its effectiveness is not impaired by a change in the pH of the cooling water.

### UV stability

Bellacide 355 is not degraded by light, even strong ultraviolet light.

### Compatibility with other water treatment additives

Problems can arise when cationic chemicals such as quaternary ammonium compounds are used in cooling water systems, as these products are often incompatible with anionic polymers that are used in many cooling water treatment formulations. Laboratory tests have shown that at the concentrations normally used most of the anionic water treatment products are compatible with Bellacide 355 and there is no loss of activity of either the inhibitor or Bellacide 355.

### Bellacide 355 in combination with other biocides

Bellacide 355 is an aqueous solution and is readily miscible with many other types of biocide. Due to the high surface activity and broad spectrum of activity of Bellacide 355 it can be used in conjunction with other traditional biocides to enhance their overall effectiveness.

### Summary of Bellacide 355 characteristics

Bellacide 355 lends a number of beneficial characteristics, as abridged in Table 5, which make it the preferred non-oxidizing biocide.

Table 5: Summary of Bellacide 355 characteristics

Biocide	Other Characteristics					
	Persistence	Penetration	Easy to Handle	Environmental Impact	Synergistic with Halogens	Anionic Polymers Compatibility
Bellacide 355	☼☼☼☼	☼☼☼☼	☼☼☼☼	☼☼	☼☼☼☼	☼☼☼☼
Isothiazoline	☼☼☼☼	☼	-	☼☼	☼	☼☼☼☼
Glutaraldehyde	☼☼	☼☼☼☼	☼	☼☼☼☼	☼	☼☼☼☼
WSCP	☼☼☼☼	☼☼	☼☼☼☼	☼☼	☼☼	-
DBNPA	☼	☼	☼☼☼☼	☼☼☼☼	☼	☼☼☼☼
THPS	☼☼	☼	☼☼☼☼	☼☼☼☼	-	☼☼☼☼
Carbamate	☼☼☼☼	☼	☼	☼☼☼☼	-	☼☼☼☼

The consolidation of Tables 4, 5 and 6 clearly show that Bellacide 355 is the high performance, multifunctional, surface active, cost effective biocide of choice.

### Recommended dose rates

The amounts of Bellacide 355 required to clean a cooling system and control biological growth will depend of several factors, the most important of which is the amount of biological fouling already present. However, the following rate of addition should be used as a general guideline.

To clean a fouled system	10-30 ppm solids twice a week
Routine treatment of a clean system	5-15 ppm solids once a week

The actual rates of addition should be based on the volume of water in the system.

### Determination of Bellacide 355

A simple volumetric method is available for the determination of Bellacide 355 in industrial cooling waters. Please contact BWA Water Additives for details.

### Packaging

Bellacide 355 is available in 20 kg polycontainers, 190 kg drum and 1000 kg IBC.

### Handling

Always read the label and material safety data sheet before using Bellacide 355.

Use chemical resistant gloves and safety glasses or goggles when handling.

Harmful if swallowed. Causes burns, avoid contact with eyes, skin and clothing.

Always use biocides safely.

**Precaution**

Toxic to aquatic organisms, ensure system discharge containing Bellacide 355 goes to a waste water treatment plant. Prevent spills from entering drains and water courses, absorb in vermiculite, dry sand or earth, place in sealed containers and label with contents. Dispose of collected spillage in licensed waste facilities only.

**Storage**

Keep containers tightly closed when not in use.

Store at moderate temperatures, in a dry, well ventilated area.

Protect from light, including direct sunlight.

**Disposal**

Waste from Bellacide 355 should be disposed of at an approved waste disposal facility.

Containers should be triple rinsed and offered for recycling or disposed of in accordance with local regulations.

**Patents**

BWA Water Additives (BWA) owns or is the licensee of patents and patent applications, which may cover the products and/or uses described in this brochure.

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