



Biocide Comparisons: Bellicide vs Competitors

The intent of this comparison is to illustrate the key differences between popular biocide products, to enable the consumer to make the best decision for them.

Making The Right Choice

Biocides kill living organisms by design. As such, they are tightly regulated by both state and Federal agencies. As such, it's much more difficult and expensive to bring and maintain a biocide formulation in the marketplace than with any other type of fuel treatment. And that's probably the way it should be. But it means that there aren't that many choices for consumers looking at a biocide solution to knock out their fuel microbe problems.

Biocide Choices

For our purposes here, we're going to touch on comparisons between Bellicide and three of the other most well-known and best-selling biocide chemistries out there, plus a non-biocide alternative that is often mistaken for a biocide.

These biocide chemistries are:

- *Thiocyanate* – Bellicide biocide offered by Bell Performance since 2010.
- *Carbamate* – Aquatreat DNM-30 and Pri-ocide are best-known examples.
- *Isothiazone/Isothiazalone* - Kathon FP 1.5 is best known example.
- *Borane/Dioxyborinane* – Biobor JF is the best known example.
- *Non-Biocidal Water Controller* – i.e. Star Tron. Their product claims involve removing water from stored fuel in order to reduce the typical conditions necessary for microbes to grow and thrive. Some may even imply that removing the water will kill living microbes by itself.

What To Look For

The best biocides should score highly in the following characteristics:

Kills quickly

Once mixed into the fuel or fluid, the most effective biocides will achieve the most complete kill rate in the shortest time. The best biocides (once properly mixed into the liquid so they can achieve contact with the microbes) can achieve a complete kill in as little as a couple of hours.

Maintains a complete kill for the longest period of time

The best biocides will maintain their complete kill rates for the longest time possible. Of course, how long this may be maintained is somewhat situation-dependent. But the most effective biocides will, all other things being equal, maintain a high kill rate for as long as four weeks, sometimes longer. Less effective biocides lose their kill potency in shorter periods of time.

Resistance to pH changes

The best biocides will work equally well in both acidic (pH < 7.0) and basic (pH > 7.0) environments. Maintaining effectiveness in acidic environments is especially important due to severe microbial infestation producing acidic conditions. So a biocide that is less effective in an acidic environment would not be a good choice.

Integrity of Biocidal Molecule In Water

The presence of a water phase (a layer of water under the fuel) is highly correlated with microbial growth because microbes need the water phase to grow and thrive. Some biocides see their “biocidal molecule” (the molecule or molecules identified in their technical registration as the ones that kill the microbes) undergo a reaction upon contact with water. In our opinion, the best biocidal chemistries will use biocidal molecules that remain intact even in contact with water.

Low treat rate

Biocides offer benefits that have great monetary value to their users – the value gained from solving or preventing potentially costly problems. The best biocides should be effective at low treat rates, typically 1:5000 or better. The lower the treat rate, the more cost-effective they are to use.

Choosing the right biocide is important.

Solving bacteria and fungus problems in fuel is serious business.
 It's important to make the right choice. Here's what you need to know.

BIOCIDE TREATMENT		BELLCIDE	ISOTHIAZALONE (i.e. Kathon FP 1.5)	BORON-BASED (i.e. Bio-Bor)	CARBAMATE (i.e. Priocide, Aquatreat)	WATER ABSORBER (i.e. Star-tron)
	Cost to treat (how much will it cost you to solve the problem?)	 As low as \$0.02/gal.	Up to \$0.10/gal	Up to \$0.12/gal		
	Contact time to a complete kill (how long does it take to work?)					WILL NOT KILL MICROBES
	Effectiveness after 1 week (is it still working after one week?)					WILL NOT KILL MICROBES
	Effectiveness after 4 weeks (is it still working after four weeks?)					WILL NOT KILL MICROBES
	Sensitivity to pH (do microbial acids in the fuel keep it from working?)					WILL NOT KILL MICROBES
		 = Best Choice		 = Acceptable Choice		

Bellicide vs. The Competition

Now that we've defined what separates a good biocide from a less effective one, let's compare Bellicide to some of the most popular biocide names in the marketplace and see how they stack up. Bellicide was formulated to be the absolute best product for the needs of its users.

Sensitivity to pH – Bellicide and Biobor JF JF (borane) are the two chemistries that are least sensitive to pH levels of fuel or liquid. Isothiazalone (Kathon FP 1.5) and Carbamate (Aquatreat & Pri-ocide) tend to lose effectiveness in more acidic environments, making them less effective in the presence of severe microbe problems in fuel. Water absorbers like Star-Tron fare least well because they do not kill microbes, making them unsuitable for use as biocides.

Integrity of Biocidal Molecule in Water – Bellicide, Kathon FP 1.5, and Aquatreat/Pri-ocide all utilize chemistries with a biocidal molecule that remains intact upon contact with water. Biobor JF, in stark contrast, sees its biocidal molecule undergo a chemical change once it moves into the water phase of a storage tank.

Cost to treat – Based on common retail pricing of typical consumer package sizes, the isothiazalone (Kathon FP 1.5) and Biobor JF JF (borane) products can be the most expensive to use. Bellicide costs the least to use at as little as \$0.02 per gallon to treat. The treat cost for carbamate (Aquatreat & Pri-ocide) falls in between this, as does the treat cost for Star-Tron (which does not kill microbes at all).

Attributes of Biocide Efficacy: Kill Studies Background

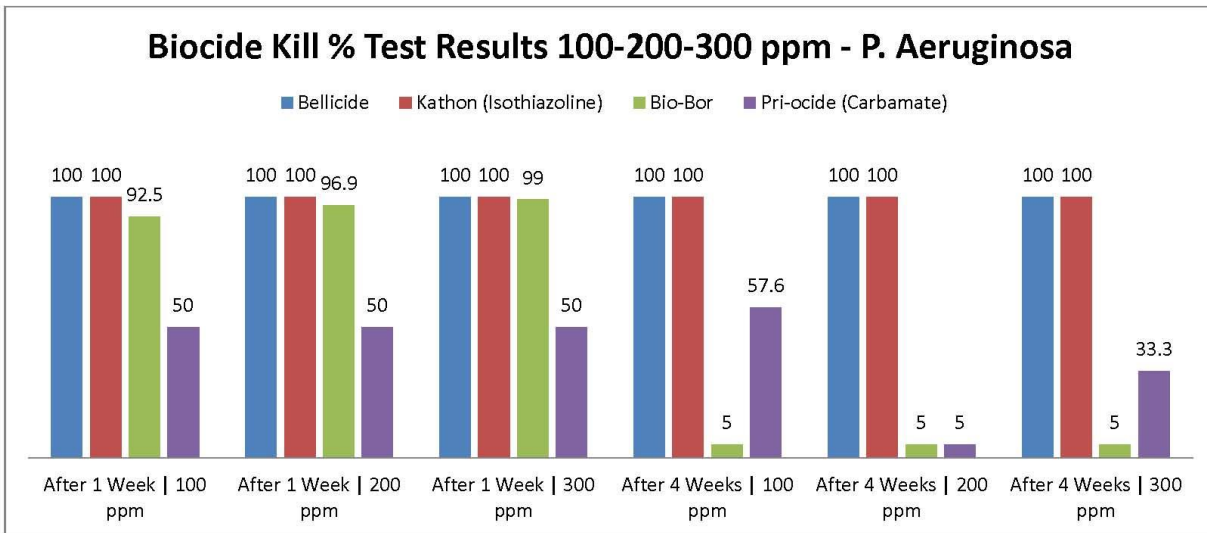


Because the purpose of a biocide is to kill microbes, the data relating to how fast and how completely it kills microbes is going to be the primary determiner of biocide value. Thus, the three remaining data points in the infographic comparison – *Contact Time / Effectiveness After 1 Week / Effectiveness After 4 Weeks* – are derived from the results of comparative kill studies conducted at independent testing laboratories.

Pertinent details on the comparative kill studies are listed here:

- Bellicide was tested in the laboratory to demonstrate its effectiveness against three other leading fuel oil microbicides.
- Multiple treat rates were used during the studies (100 ppm, 200 ppm, 300 ppm) to determine each biocide’s level of effectiveness at killing different strains of microbes relative to treat rate.
- The test method used is contained in the SIM publication #2, “*Proposed Procedures for the Screening of Microbial Inhibitors in Hydrocarbon/Water Systems.*”
- The microorganisms used in the study include the bacterium *Pseudomonas aeruginosa* (abbreviated as *P. aeruginosa* or *Ps. aeruginosa*) and the fungus *Hormoconis resinae* (formerly known as *Cladosporium resinae*, abbreviated as *H. resinae*). These microbe strains were selected because they are common contaminants in the field, they grow well in large numbers, and they grow well both in water and at the fuel-water interphase.

Kill Study Results Comparison – Multiple Treat Rates (100, 200 and 300 ppm)



From these results, we can see the following:

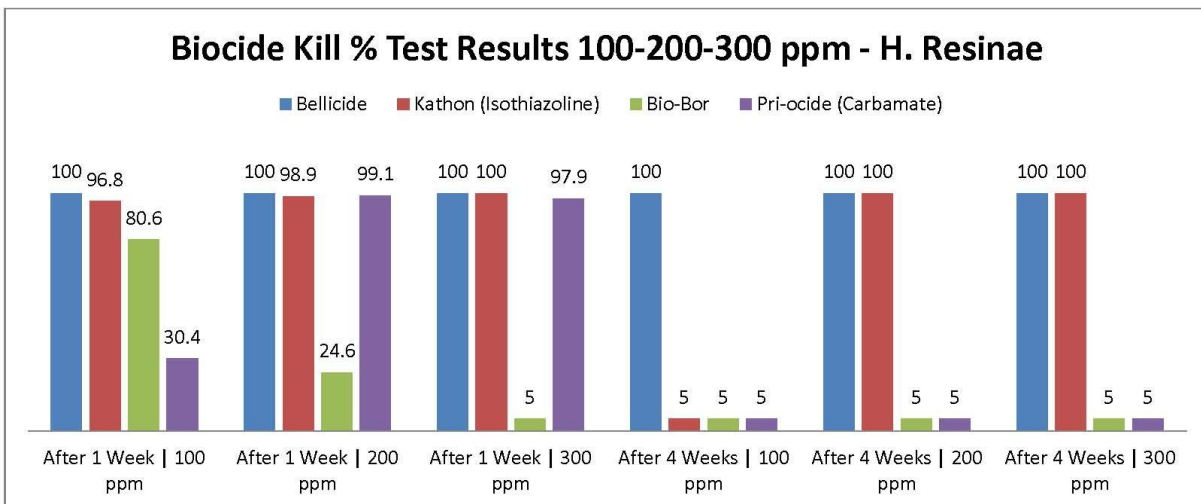
Results After 1 Week

- Both Bellicide and Kathon maintained a full 100% kill rate at all treat rates (100, 200 and 300 ppm).
- Biobor JF was reasonably effective through 1 week at all treat rates. But Biobor JF lost almost all effectiveness before the conclusion of 4 weeks, even at the highest treat rate (300 ppm).
- Pri-ocide and Aquatreat DNM-30 (both carbamates) were the least effective, only killing 50% of microbes after just 1 week at all treat rates (even the highest 300 ppm).

Results after 4 Weeks



- Both Bellicide and Kathon maintained a full 100% kill rate at all treat rates (100, 200 and 300 ppm).
- Biobor JF lost almost all effectiveness before the conclusion of 4 weeks, even at the highest treat rate (300 ppm).
- The treat rate for Pri-ocide and Aquatreat DNM-30 (both carbamates) had to be increased to 300 ppm in order to maintain even a 33% kill rate after 4 weeks, which is least satisfactory in comparison to the other chemistries tested.



From these results, we can see the following:

Results After 1 Week

- Bellicide and Kathon (isothiazoline) were the only chemistries to maintain virtually 96.8 -100% kill rate at all treat rates (100, 200 and 300 ppm). Bellicide was the only one to maintain full 100% kill rate.
- Biobor JF killed 80% after 1 week at the lowest treat rate (100 ppm), but saw its 1 Week effectiveness drop rapidly as its treat rate was increased to 200 and 300 ppm (which is the opposite of what one would expect to see). Regardless, the conclusion may be that Biobor JF was markedly less effective than Bellicide or Kathon after 1 week.
- Pri-ocide and Aquatreat DNM-30 (both carbamates) only killed 30% of microbes after 1 week at 100 ppm. Increasing their treat rate to 200 and 300 ppm provided a full kill rate.

Results after 4 Weeks

- Bellicide clearly performed best, as the only product to maintain full 100% kill rate after 4 weeks, even at the lowest 100 ppm treat rate.
- Kathon was ineffective after 4 weeks at 100 ppm. Doubling the treat rate to 200 ppm and above restored the Kathon kill rate to a full 100% over this time period.
- Biobor JF and Aquatreat/Pri-ocide proved least effective at maintaining kill effectiveness over 4 weeks, with kill rates approaching 0-5% even at the highest treat rate.

Kill Study Conclusions

The data of the kill studies relative to treat rate should indicate that Bellicide was the most effective biocide at both killing microbes in the first week and (more importantly) maintaining a full kill for up to 4 weeks, both at the lowest treat rate (100 ppm).



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Kathon also showed better-than-average effectiveness, though it appears an increase in treat rate to 200 ppm was needed to ensure complete 4 week effectiveness.

Aquatreat DNM-30, Pri-ocide, and Biobor JF were all only sporadically effective at lower treat rates and did not demonstrate satisfactory effectiveness for as long a time period as Bellicide and Kathon FP 1.5.

Comments on Attributes of Biocide Efficacy

Given the above kill study data, the following conclusions on biocide effectiveness expressed in the infographic may be expressed.

Choosing the right biocide is important.						
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Contact time to a complete kill (how long does it take to work?)					WILL NOT KILL MICROBES	
Effectiveness after 1 week (is it still working after one week?)					WILL NOT KILL MICROBES	
Effectiveness after 4 weeks (is it still working after four weeks?)					WILL NOT KILL MICROBES	
Sensitivity to pH (do microbial acids in the fuel keep it from working?)					WILL NOT KILL MICROBES	
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Contact Time to a Complete Kill – Market data shows that Bellicide achieves maximum microbe kill in as little as 2 hours. Biobor JF and the carbamates (i.e. Pri-ocide/Aquatreat) achieved maximum microbe kill in 4-6 hours. Kathon FP 1.5 took the longest time period (>8 hours) to achieve its maximum kill.

Effectiveness After 1 Week – The kill study data was clear that Bellicide maintained the best level of 1 week kill effectiveness across both microbe strains. Kathon was the runner-up and Pri-ocide/Aquatreat finished third. Biobor JF performed least well by a significant margin.

Effectiveness After 4 Weeks – The kill study data was equally clear that Bellicide maintained its 100% kill rate for the longest period of the time – the entire 4 week test period. Kathon was the runner-up, but needed higher dosing levels to maintain equal performance. Both Biobor JF and Pri-ocide/Aquatreat were markedly less effective after 4 weeks.

Note also that the water absorber (i.e. Star Tron) had no data for the microbial kill tests because it does not kill microbes and would have proven ineffective at doing so in the test.

Summary and Conclusion

Bellicide outperforms other biocide choices in the most important performance areas. It kills the fastest, kills most completely, and keeps fluids microbe-free for the longest period of time. All while maintaining its biocidal integrity in water. If you need a biocide and you want the best, Bellicide is your only choice.