



Biocide Comparisons: Bellicide vs Pri-ocide & Aquatreat DNM-30

The following is a comparative analysis between two popular biocide chemistries – Bellicide (Bell Performance) and carbamate chemistry, the chemistry behind two other notable biocide product names, Pri-ocide (Petro Labs) and Aquatreat DNM-30 (Akzo Nobel). The intent of this comparison is to illustrate the key differences between the products, to enable the consumer to make the best decision for them.

Bellicide & Pri-ocide/Aquatreat DNM-30: Introduction and Background

Pri-ocide and Aquatreat DNM-30 both utilize a type of chemistry called carbamate. There are additional biocide product names that utilize the same chemistry, but Pri-ocide and Aquatreat are two of the most well known. Pri-ocide is distributed by Power Research Inc. of Houston, TX. Aquatreat DNM-30 is distributed by a network owned by Akzo Nobel.

Since 2010, Bell Performance has offered its biocide solution Bellicide for stored fuel users needing an effective solution to knock out fuel microbial problems. It's the best biocide on the market. This is where we're going to show you why that is true.

Essential Characteristics of Biocides

The best biocides should score highly in the following characteristics:

<p><i>Kills quickly</i></p> <p>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. It should be noted that quickness of total kill does depend on factors including the level of microbial contamination and the kinds of microbes being targeted.</p>
<p><i>Maintains a complete kill for the longest period of time</i></p> <p>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.</p>
<p><i>Resistance to pH changes</i></p> <p>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 because fuels and liquid with severe microbial contamination will tend to be acidic, due to the acids produced by microbial respiration as they grow and thrive in the liquid. So a biocide that is less effective in an acidic environment would not be a good choice.</p>
<p><i>Effectiveness in both fuel and water phases</i></p> <p>This is essential when using a biocide in stored fuel. The presence of a water phase (a layer of water under the fuel) is always associated with microbial growth because microbes need the free water phase to grow and thrive. Some biocides have reduced effectiveness in the presence of water because their active "biocidal" ingredients react with water and change into neutral components. The most effective biocides will be equally effective at killing microbes</p>



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in both phases and will not lose effectiveness in the presence of 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. It should be noted that the effective treat rate that will be needed depends on factors including the level of microbial contamination and the kinds of microbes being targeted.

Bellicide vs. The Carbamates

Now that we’ve defined what separates a good biocide from a less-than-stellar one, we can compare Bellicide to the carbamate products (Aquatreat DNM-30 and Pri-ocide) with respect to performance in these critical areas.

BIOCIDE TREATMENT		BELLCIDE	CARBAMATE (i.e. Pri-ocide, Aquatreat DNM-30)
	Contact time to a complete kill (how long does it take to work?)		
	Effectiveness after 1 week (is it still working after one week?)		
	Effectiveness after 4 weeks (is it still working after four weeks?)		
	Sensitivity to pH (do microbial acids in the fuel keep it from working?)		
		 = Best Choice	 = Acceptable Choice



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Summary of Biocide Comparison: Bellicide vs. Aquatreat & Pri-ocide

The above infographic gives a summary of how Bellicide and the carbamates perform with respect to the most important attributes related to biocide efficacy. We start with the data not related to kill rates and timing.

Sensitivity to pH – Bellicide is one of the least sensitive biocide chemistries to pH levels of fuel or liquid. Carbamates (Aquatreat & Pri-ocide) can tend to lose effectiveness in more acidic environments, making them less effectiveness in the presence of severe microbe problems in fuel.

Effectiveness in water phase – This is not listed on the infographic but should be commented on. Bellicide and Aquatreat/Pri-ocide are all effective chemistries in the presence of water. This is not the case with every biocide; in fact, one of the most well-known biocides on the market is less effective in contact with water because its active biocidal ingredient reacts with water and is converted into neutral components.

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.

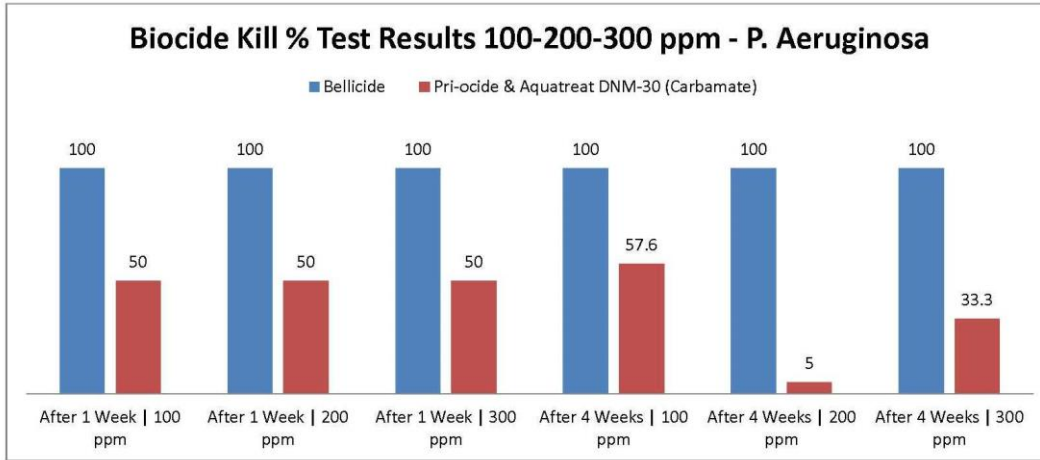
Pertinent details on the comparative kill studies are listed here:

- 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 Data

The data for kill effectiveness on the two microbe strains (*P. aeruginosa* and *H. resinae*) can be summarized by the charts below. The data is expressed in terms of percent kill (at 1 week and 4 weeks) of the total microbe count relative to the count in identical untreated fuel oil samples. For perspective, the average microbial count (between the two microbe strains) at 1 week in untreated fuel was about 6.4×10^6 per ml of fuel, and the average count at 4 weeks in untreated fuel was 6.0×10^5 per ml of fuel.

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

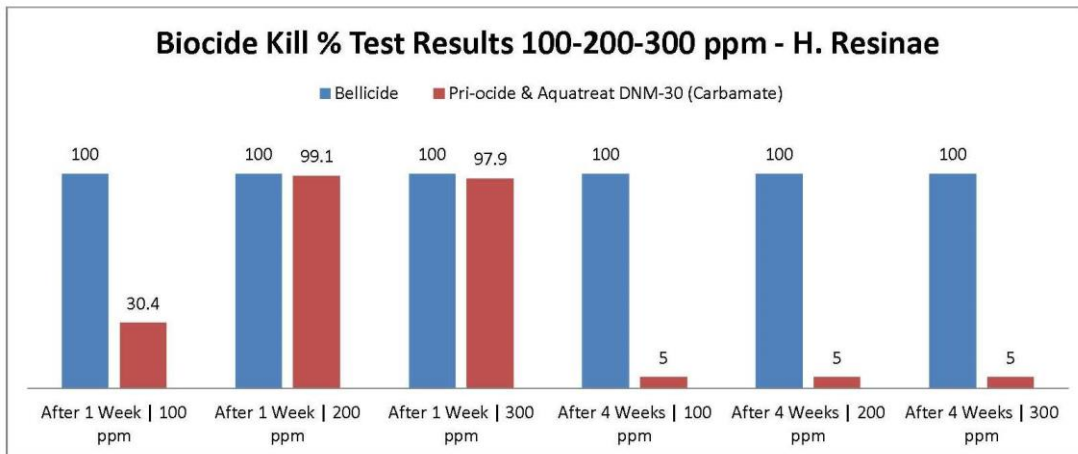


Results After 1 Week

- Bellicide maintained a full 100% kill rate at all treat rates (100, 200 and 300 ppm).
- Pri-ocide and Aquatreat DNM-30 (both carbamates) were much less effective, only killing 50% of microbes after just 1 week at all treat rates (even the highest 300 ppm).

Results After 4 Weeks

- Bellicide maintained a full 100% kill rate at all treat rates (100, 200 and 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.



From these results, we can see the following:

Results After 1 Week

- Bellicide maintained a full 100% kill rate at all treat rates (100, 200 and 300 ppm).
- 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.
- Aquatreat/Pri-ocide were ineffective at maintaining any significant kill effectiveness over 4 weeks, with kill rates approaching 0-5% even at the highest treat rate.

Kill Study Conclusions

The overall conclusion reached from this testing was that the Bellicide significant outperformed the carbamate chemistry at all levels tested. 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).

Aquatreat DNM-30 and Pri-ocide, and Bio-Bor were only sporadically effective at lower treat rates and did not demonstrate satisfactory effectiveness for as long a time period as Bellicide.

Bellicide vs. Pri-ocide & Aquatreat		
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	CARBAMATE (i.e. Pri-ocide, Aquatreat DNM-30)
Contact time to a complete kill (how long does it take to work?)		
Effectiveness after 1 week (is it still working after one week?)		
Effectiveness after 4 weeks (is it still working after four weeks?)		
Sensitivity to pH (do microbial acids in the fuel keep it from working?)		
= Best Choice = Acceptable Choice		

Comments on Attributes of Biocide Efficacy

The above kill study data thus informs the conclusions on biocide effectiveness that were expressed in the previous infographic.

Contact Time to a Complete Kill – Market data shows that Bellicide achieves maximum microbe kill in as little as 2 hours. Pri-ocide and Aquatreat) achieved maximum microbe kill in 4-6 hours.

Effectiveness After 1 Week – Bellicide maintained the best level of 1 week kill effectiveness across both microbe strains. Pri-ocide and Aquatreat were less effective.

Effectiveness After 4 Weeks –Bellicide maintained its 100% kill rate for the longest period of the time – the entire 4 week test period. Pri-ocide and Aquatreat were markedly ineffective after 4 weeks.

Summary and Conclusion

- Bellicide kills faster and at a higher initial rate than Pri-ocide and Aquatreat DNM-30.
- Bellicide maintains a complete kill rate significantly longer than Pri-ocide and Aquatreat DNM-30.

In our opinion, it should be apparent from the data and the analysis that Bellicide is far superior to both Pri-ocide and Aquatreat DNM-30 in meeting the most important criteria for an effective biocide. As noted before, Bellicide is the best biocide treatment in the marketplace.