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Biocide Comparisons: Bellicide vs Competitors

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 today. This is where we're going to show you why that is true.

Introduction

Changes in fuel composition seen over the past 5-10 years have completely altered the game for fuel users, especially those that store diesel fuel. The ultra-low sulfur requirement in diesel fuel (ULSD) is coming up on ten years old (in 2016) and has greatly benefitted the environment with billions of pounds of sulfur prevented from entering the environment over that time span.

But, as with many things, there is bad to go with the good. The large-scale removal of fuel sulfur at the refinery has created diesel fuel that, among other things, is much more prone to microbial growth. And microbial growth in diesel fuel is a serious problem for which there is only one real solution. You need an effective biocide in the fuel to kill the growth.

For fuel storage customers, they can try to control water buildup through periodic tank draining and the addition of chemical water absorbers, both of which are useful to reduce the conditions under which microbes are likely to take hold. But once a colony is established and growing, a quality biocide is the only thing that will get rid of it.

What Biocides Are Used For

Biocides kill living organisms by design. As such, they are tightly regulated by both state and Federal agencies. They have strict reporting requirements and are required to be registered annually with multiple agencies, all in the name of making sure that they are used properly so as not to endanger the public's health.

So, 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 many choices for consumers looking at a biocide solution to knock out their fuel microbe problems.

Recognizing correctly that you need a biocide to solve a stored fuel problem is the first step. Choosing the best biocide solution is the second, and it's not always easy to get that part right. Not many people know the differences between a nitromorpholine or a diborinane or an isothiazalone. Those terms mean nothing to them. So let's clear up that confusion and give you some tools you can use to choose the right biocide for you.

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Description of Biocide Chemistries

Because of the extensive regulations, there aren't that many biocide "chemistries" available in the marketplace. We use the term chemistries because many of the different biocide product names are just relabels of the same chemicals. 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 – that is, some consumers will purchase it with the mistaken assumption that it will knock out an existing fuel microbe problem when, in fact, it has no ability to do so.

These biocide chemistries are:

Thiocyanate – Bellicide biocide offered by Bell Performance since 2010.

Carbamate – Aquatreat DNM-30 and Pri-ocide are the best-known examples.

Isothiazone/Isothiazalone - Kathon FP 1.5 is the best known example.

Borane/Dioxyborinane – Biobor JF is the best known example.

Non-Biocidal Water Controller – There are numerous examples of these, 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 imply that removing the water will kill living microbes by itself. But this is a false biocidal claim and is not allowed by regulatory agencies.

What To Look For

The job of a biocide is to kill existing living microbes in fuel or whatever liquid they are in. We say 'whatever liquid they are in' because biocides are also used across the marketplace in other places besides stored fuel – in drilling fluids, cooling water applications, in whatever places that microbial growth tends to happen and in which said growth can damage things that you don't want to be damaged. For example, corrosion is a common result of microbes and their biological processes. Drilling fluids infected by microbial colonies can experience expensive corrosion damage to sensitive drilling equipment. This creates a need within the oil and gas industry to use biocides to keep their drilling fluids microbe-free.

If you know you have a microbe problem, and you know you need a biocide to solve that problem, this doesn't help you very much (yet). Which chemistry should you choose? To make the best decision, it's helpful to know where biocides can differ and what makes the best choice over a no-so-good choice.

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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 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.

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.

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. We can summarize how they compare with the infographic listed below, followed by a summary description of how each type of biocide performs in each desired trait. Bellicide was formulated to be the absolute best product for the needs of its users.

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Summary of Biocide Performance

The infographic gives a summary of how different biocide chemistries perform with respect to the most important attributes related to biocide efficacy. Let's run down these performance data, starting with the data not related to kill rates and timing.

Sensitivity to pH – Bellicide and Biobor 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.

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.

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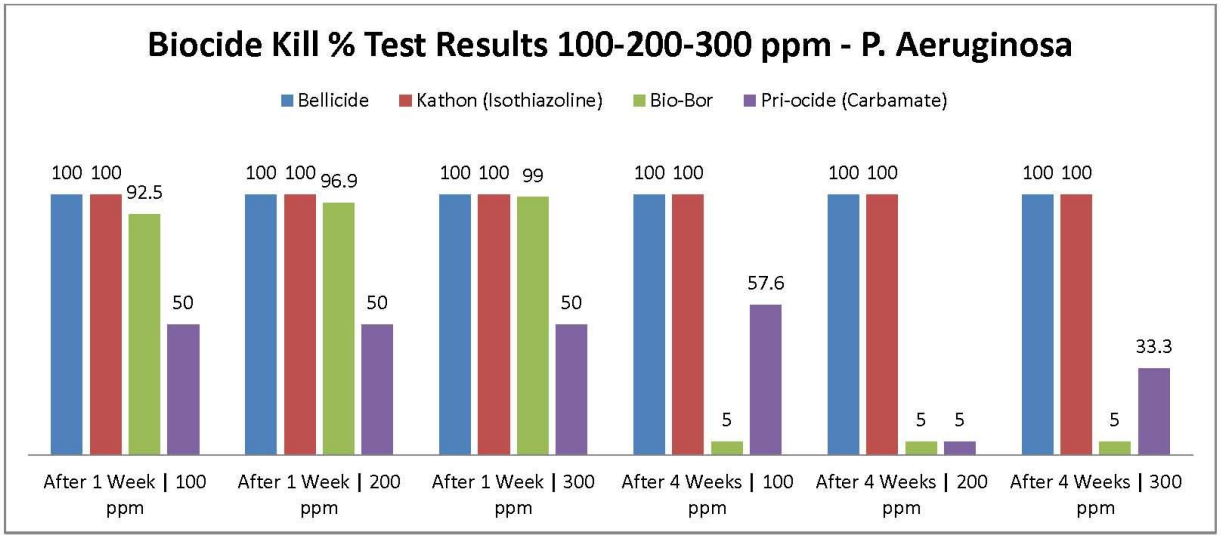
For perspective, the average microbial count (between the two microbe strains) at 1 week in untreated fuel was about 6.4 x 10^6 per ml of fuel, and the average count at 4 weeks in untreated fuel was 6.0 x 10^5 per ml of fuel.

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.

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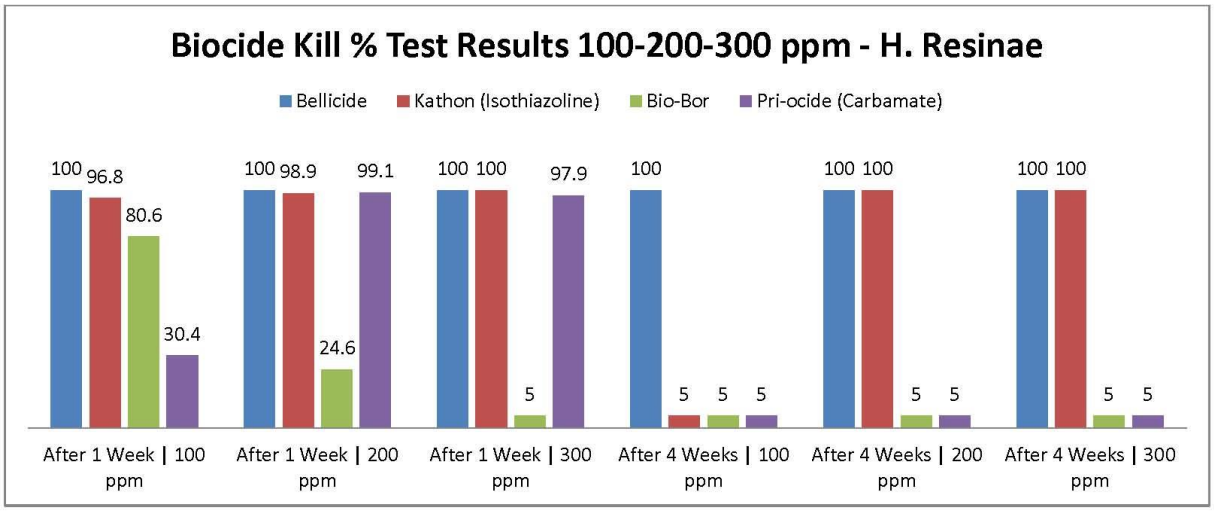

From these results, we can see the following:

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 Studies Primary Conclusions

The overall conclusion reached from this testing was that the Bellicide chemistry provided the best efficacy at all levels tested. The isothiazalone (Kathon FP 1.5) chemistry was the runner-up, only matching Bellicide's kill effectiveness at a significantly higher treat rate. The borane (Biobor JF) and carbamate (Aquatreat and Pri-ocide) chemistries provided the lowest effectiveness at killing microbes in these tests, losing much of their effectiveness in less than 4 weeks.

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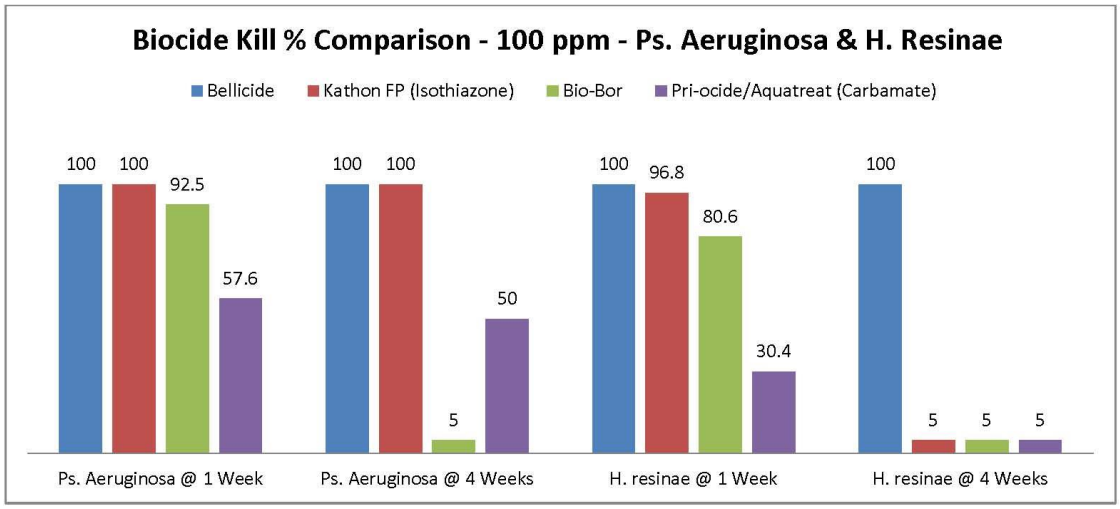
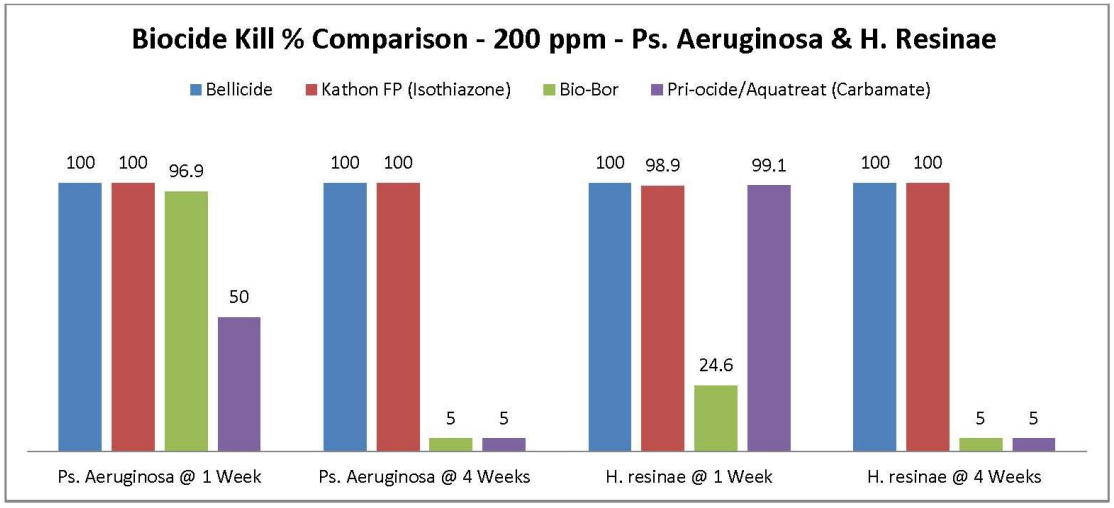
Kill Study Results Comparison – Multiple Treat Rates (100, 200 and 300 ppm)

Another way to look at the data is to compare the kill rates over time (1 week and 4 weeks) for the four chemistries vs. both microbes together, at single treat rates running from lowest (100 ppm) to highest (300 ppm). Looking at the data this way should lead us to the same conclusions as above, albeit expressed in a different way.



These results show the kill effectiveness of these biocides at the lowest treat rate – 100 ppm, which is equivalent to a 1:10000 or 1 oz: 80 gallons volumetric treat rate. From these results, we can see the following:

- Bellicide was the only chemistry to maintain 100% kill rate for both microbes over 1 and 4 weeks.
- Kathon killed 100% of *Pseudomonas* but lost effectiveness on *H. resinae* within 4 weeks.
- Biobor JF killed over 80% of both microbes during the first week but was ineffective on both after 4 weeks.
- Pri-ocide/Aquatreat only killed 50% of *Pseudomonas* over 4 weeks and was largely ineffective on *H. resinae.*



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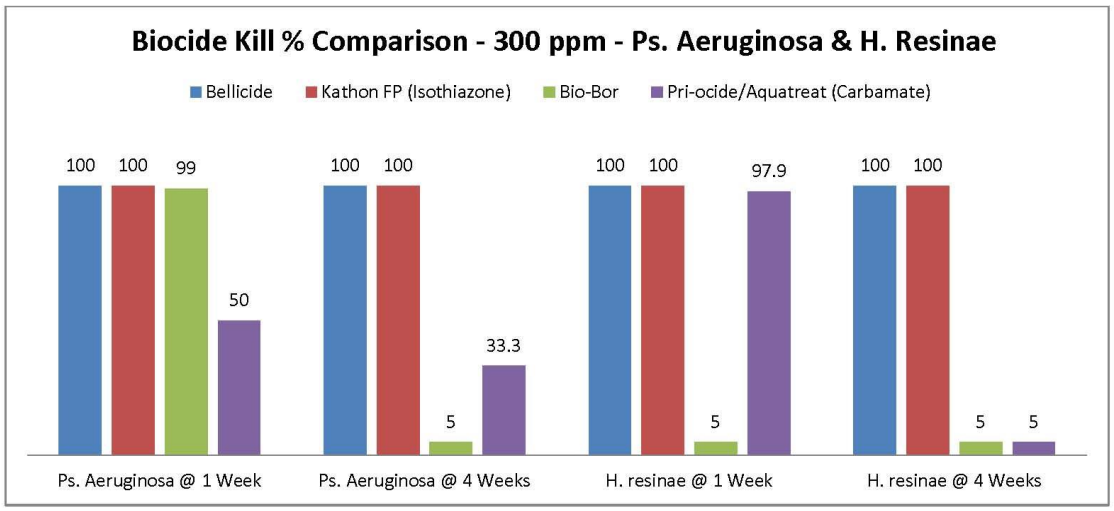
These results show what happened after the treat rate was doubled to 200 ppm – equivalent to 1:5000 or 1 oz: 40 gallons volumetric. From these results, we can see the following:

- Bellicide was 100% effective on both microbes through 4 weeks.
- Kathon maintained its 100% effectiveness on *Pseudomonas* and was able to achieve 100% effectiveness on *H. resinae* after 4 weeks. It was ineffective here at only 100 ppm.
- The effectiveness of Biobor JF actually dropped with the higher treat rate – there was no significant improvement on *Pseudomonas* – it was still in effective after 4 weeks.
- The increased treat rate had no effective on Pri-ocide/Aquatreat's effectiveness. The carbamates still remained ineffective after 4 weeks.



These results show effectiveness at the highest treat rate, 300 ppm, equivalent to 1:3333 or 1 oz: 23 gallons. From these results, we can see the following:

- Bellicide and Kathon FP 1.5 still remain 100% effective through 1 week and 4 weeks. This is to be expected at the highest treat rate.
- The highest treat rate had no beneficial effect on Biobor JF's ability to maintain kill rate through 4 weeks. It was still ineffective in this time frame.
- The highest treat rate had no meaningful effect on the ability of the carbamates (Pri-ocide/Aquatreat) to kill microbes for 4 weeks.

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). 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.

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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. 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

In choosing the right biocide, you want to choose the one that kills quickly and completely while maintaining its complete kill for the longest period of time. And you want it to maintain its effectiveness in high acid environments while utilizing a biocidal molecule that stays intact in the presence of water.

The data should show that Bellicide from Bell Performance fulfills all of these criteria to a greater and more complete extent than any of its name-brand competitors.