



Antimicrobial Treatment of Cooling Tower Water Using Pathex™ Filter Media

ASF Tech Report 1.3
March 2009

Objective

Bacteria have long been known to be a destructive force in cooling towers and their related systems. Disinfection has historically been accomplished through the use of chemical biocides such as bromine or chlorine. While effective against microorganisms, these chemicals can have a detrimental effect on equipment and the surrounding environment. In response to ever increasing environmental concerns, A S Filtration™ has developed an innovative patent pending technology designed to remove waterborne pathogens by use of an environmentally neutral antimicrobial Pathex™ filter media. This report provides clear analysis of performance data obtained from independent laboratory tests for the reduction of *Escherichia coli* (*E. coli*) and *Legionella*; and, field testing of cooling tower water for total coliform and total aerobic bacteria reduction.

Technology Description

Pathex™ utilizes a proprietary antimicrobial integrated system, which includes an EPA-registered antimicrobial agent proven to be effective against bacteria. Microorganisms are completely destroyed on contact with the filter media. Treatment does not rely on physical trapping; thus, the dead microorganisms can pass through the Pathex™ filter media without clogging.

The antimicrobial agent is not consumed, does not dissipate, and does not produce toxic metabolites. Pathex™ is safe to handle and leaves no environmental residue and does not require an external power source.

Laboratory Testing

A number of independent comprehensive laboratory efficacy tests have been performed against *E. coli*, *Legionella* and total aerobic bacteria. These testing programs are described below.

Summaries of the influent *E. coli* concentrations (colony forming units per 100 milliliters), loading rates (gallons per minute per square foot), and efficacy (kill percentage) from laboratory simulations are included in Table 1. Influent *E. coli* stock concentrations ranged from 150 to 36,000

col/100ml. Efficacies of >99.9% were achieved for these eight simulations.

Table 1. Summary of *E. coli* Efficacy Tests

Influent <i>E. coli</i> Concentration (col/100ml)	Loading Rate (gpm/ft ²)	Removal Efficiency (%)
150	19	>99.9
1,180	30	>99.9
2,120	9	>99.9
2,150	22.5	>99.9
3,000	10	>99.9
3,500	10	>99.9
4,300	18	>99.9
36,000	10	>99.9

Another laboratory test was performed using a closed loop configuration designed to reflect treatment in a side stream cooling tower system. This test was performed over a 48 hour period, simulating 1,250 gallons of treated water passing through a 3.2 ft² filter cartridge at a loading rate of 20 gpm/ft². Both control and test stock solutions of total aerobic bacteria were prepared. Corrections to influent concentrations were made based on natural drops in concentrations of the control stock over 24 and 48 hour periods. Natural concentration reductions were determined to be 13% over 24 hours and 16% over 48 hours. Using these corrected concentrations after 24 hours, the influent concentration was 1,192 col/ml and the effluent concentration was 100 col/ml, representing a 92% reduction in total aerobic bacteria. After 48 hours, the corrected influent concentration was 1,151 col/ml and the final concentration was 57 col/ml, resulting in a 95% reduction. Figure 1 illustrates the total aerobic bacteria influent and effluent concentrations over 24 hours and 48 hours for the side stream simulation.

Independent laboratory efficacy tests using a stock solution of *Legionella pneumophila* (CDC #BC1636) has been performed. Table 2 summarizes influent and effluent *Legionella* concentrations and the associated removal efficiencies. *Legionella* testing was performed using established methods developed by the Centers for Disease Control and Prevention, Atlanta, GA, 1983.

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Total Aerobic Bacteria

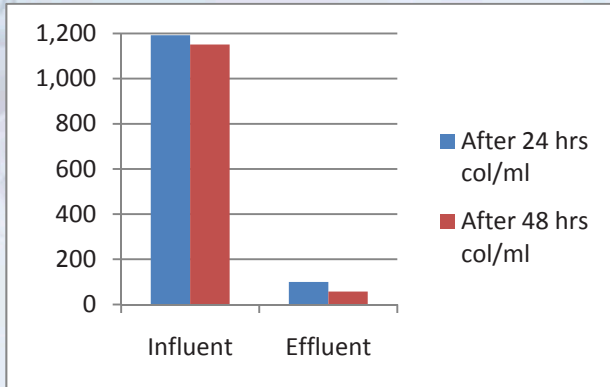


Figure 1: Total Aerobic Bacteria suppression was maintained over a 48 hour test simulating 1,250 gallons of treated water in a closed loop (side stream) system.

Table 2. Summary of Legionella Efficacy Tests

Influent Concentration (col/ml)	Effluent Concentration (col/ml)	Removal Efficiency (%)
650	30	95.4
570	<10	99.1

The stock solutions were passed via gravity flow through the filtration cartridge at a loading rate up to 10 gpm/ft². Influent concentrations ranged from 570 to 650 col/ml. Efficacies of 95.4 to 99.1% were achieved for these tests. With respect to cooling towers, the influent *Legionella* concentrations represent a level of moderately high concern such that outbreaks may occur, and cleaning and/or biocide treatment is likely indicated. The effluent concentrations represent levels of low to little concern (refer to OSHA *Legionella* guidelines).

Toxicity Testing

Independent 48-hour acute toxicity laboratory testing was performed following EPA guidelines to support that the antimicrobial agent does not leach, and the effluent (treated) water is non-toxic. Test organisms were fathead minnows (*Pimephales promelas*) and water fleas (*Ceriodaphnia dubia*). An influent *E. coli* stock concentration of 2,150 col/100ml was passed via gravity flow through a filtration cartridge over a 24 hour period at a loading rate of 22.5 gpm/ft², or 180 gpm (259,200 gpd). Efficacy was >99% for this test event.

Zero mortality of the test organisms was recorded at the conclusion of the toxicity test period. The effluent water, having exhibited an efficacy >99% against a high influent *E. coli* stock concentration, was determined to be non-toxic.

Field Testing

Four field verification tests of the Pathex™ filter media have been performed in three cooling towers at separate north Georgia manufacturing facilities. Table 3 summarizes the analytical results of the field tests.

Table 3. Summary of Cooling Tower Field Tests

Size (tons)	Avg. Total Coliforms (col/ml)	Avg. Total Aerobic Bacteria (col/ml)	Volume (million gal)	# Days
200	0.49	NA	80.0	90
640	NA	5,130	73.2	53
300	NA	614	0.7	16
200	16.6	3,660	76.0	88

A discussion of the four cooling tower field tests is provided below.

Field Test #1

Pathex™ filter media was installed in a 200 ton cooling tower at an urban north Georgia facility for the purpose of reducing bacteria in lieu of chemical treatment. Prior to Pathex™ installation, independent laboratory analysis of water samples collected during a 62 day baseline period determined an average total coliforms concentration of 424 col/ml. Following installation of the Pathex™ filter media, independent laboratory analysis of 18 water samples collected over a 90 day test period determined an average total coliforms concentration of 0.49 col/ml (Figure 2). Thus, a 99.88% reduction in the total coliforms concentration was achieved for the duration of the testing period.

Total Coliforms vs. Time

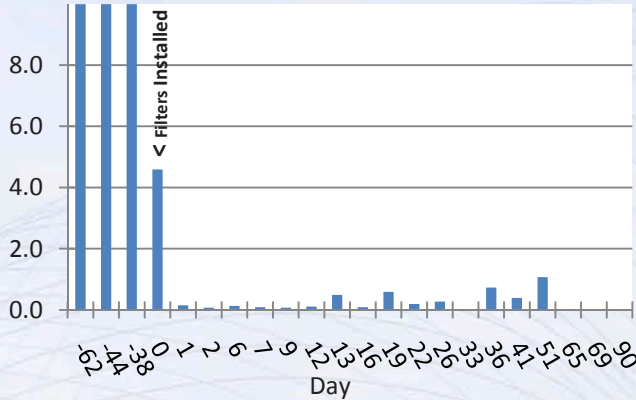


Figure 2: Total Coliforms versus days of treatment for a 200 ton cooling tower. Bacteria reduction was maintained for 90 days for approximately 80 million gallons of treated water. Note log scale.

Total Aerobic Bacteria vs. Time

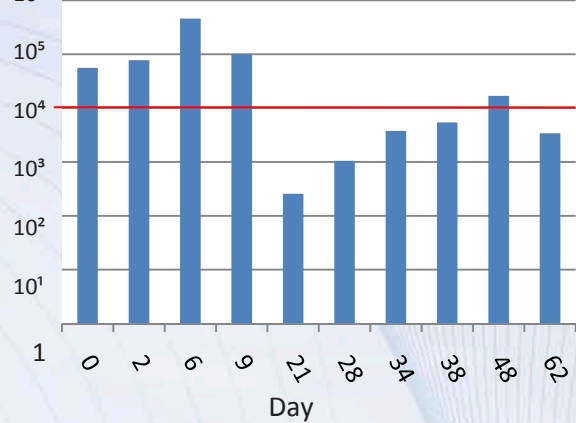


Figure 3: Total Aerobic Bacteria versus days of treatment for 640 ton process cooling tower. Note log scale.

Field Test #2

A Pathex™ filter media test was performed in a cooling tower at a separate rural north Georgia manufacturing facility. This process cooling tower operates approximately 12 hours per day. Baseline sampling performed over a nine day period indicated an average total aerobic bacteria count of 173,000 col/ml. Subsequent to the baseline sampling, Pathex™ filters were installed, and water sampling continued for a period of 53 days. Average total aerobic bacteria counts during this test period were 5,130 col/ml (Figure 3). Thus, a 97.03% reduction in the total aerobic bacteria concentration was achieved for the duration of the testing period. Testing took place over summer months with water flow through the filters occurring approximately half the time. Estimated water volume circulated after filter installation was 73,267,200 gallons.

Notice that the maximum desired level of total aerobic bacteria is 10^4 (10,000) col/ml as indicated in the following figures.

Field Test #3

Pathex™ filter media test was performed in a side-stream filter system on a 300 ton process cooling tower at another north Georgia manufacturing facility. This side stream filter system uses well water and is rated at 30 gpm, while the system water volume is approximately 1,350 gallons. Testing was initiated following a thorough tower cleaning. Over a 16 day testing period (ongoing), the total aerobic bacteria count average was 614 col/ml (Figure 4).

Total Aerobic Bacteria vs. Time

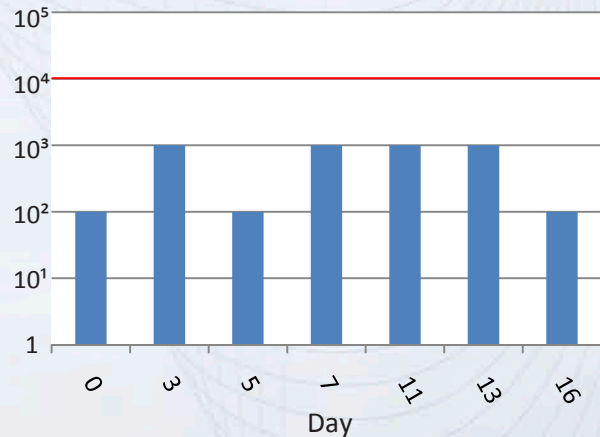


Figure 4: Total Aerobic Bacteria versus days of treatment for a 300 ton process cooling tower utilizing a side stream filter system. Note log scale.

Field Test #4

As a means to study the effects of seasonal weather conditions on performance, a second round of testing (fourth test) was performed on the first test 200 ton cooling tower. Pathex™ filter media was reinstalled after a 163 day period whereby no treatment other than one chemical shock occurred. The system was measured for total aerobic bacteria and total coliforms over an 88 day period. The total aerobic bacteria average was 3,660 col/ml (Figure 5), and the total coliforms concentration average was 16.6 col/ml (Figure 6). Water volume over the course of this test period was approximately 76,032,000 gallons.

Conclusions

Pathex™ filter media has demonstrated superior performance for the elimination of *E. coli* and *Legionella* in comprehensive laboratory investigations. Simulated side stream system testing also demonstrates effective suppression of total aerobic bacteria. Four field verification tests performed in cooling tower water further demonstrate effective suppression of total aerobic bacteria and total coliforms. The integrated antimicrobial technology provides treatment over an extended period of time. The use of Pathex™ filter media, with its EPA-registered antimicrobial agent, can be applied to effectively reduce a wide spectrum of waterborne pathogens. It is clear that the A S Filtration™ Pathex™ technology can provide for the highly effective, long term, and safe control of waterborne pathogens in cooling tower water. Pathex™ effectively serves to protect side stream filters and their internal components, thereby achieving optimal system performance while minimizing operating costs.

Total Aerobic Bacteria vs. Time

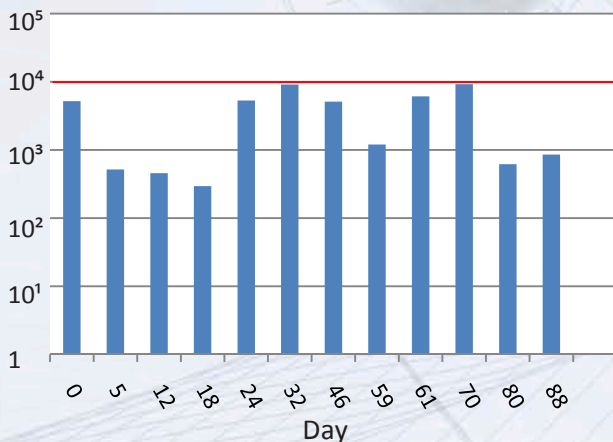


Figure 5: Total Aerobic Bacteria versus time for a 200 ton cooling tower (first test site). Note log scale.

Total Coliforms vs. Time

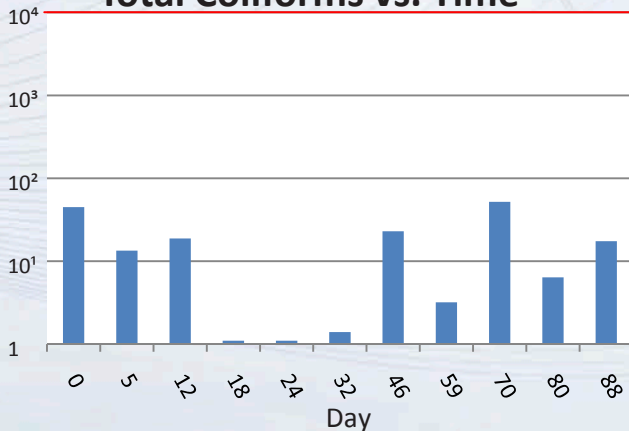


Figure 6: Total coliforms versus days of treatment for a 200 ton cooling tower (first test site). Note log scale.

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