

## ZEOBEST Ultra

### Evaluation of Propriety Treated Zeolite in Pilot Filters For Removal and Inactivation of Microorganisms

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A set of pilot filters packed with treated Zeolite filter media were provided by Coating Systems Laboratories, Inc, Chandler, Arizona, and Northern Filter Media, Muscatine, Iowa for antimicrobial performance evaluation. A series of microbial challenge studies were conducted at the National Science Foundation Water Quality Center at Arizona State University to verify the proof of concept for microbial inactivation capabilities of the provided pilot filters.

The microorganisms used in this study included bacteriophages; MS2, PRD1, bacteria; *Klebsiella terriena*, *E. Coli*, algae; *Chorella vulgaris* (ATCC 16487), and protozoan parasite; *Cryptosporidium parvum*. The standard procedures were followed for microbial maintenance, propagation, and samples assays.

The experimental apparatus consisted of a set of three filters attached to a manifold, which included fittings for hose connections, and sample ports at the inlet and outlet for each filter. An inline mixer was included in the pipe assembly before inlet port to maximize microbial monodispersity. The challenge test water was pumped into each filter at a flow rate of 330 ml/min using a thermally protected pump. The dechlorinated municipal tap water (Tempe, AZ) was used for the spiked experiment and also for flushing the system before and after challenge study.

The data from these proofs of concept studies shows that Zeolite coated with proprietary chemical can inactivate or remove the microorganisms in challenge test water.

## RESULTS AND DISCUSSION

### Bacteria

A number of independent challenge tests using *Klebsiella terriena*, and *E. Coli* (ATCC 25922) were performed and the removal data are presented in Appended Figures. The influent and effluent samples were examined using membrane filtration technique with 0.45  $\mu$ m pore size filter (Millipore, Molsheim, France). A consistent removal for *Klebsiella* and *E. coli* was observed in all the filters. The removal for *Klebsiella* ranged from 99.37% (2.2 log) to 99.60% (2.4 log) with an average of 99.50% (2.3 log), whereas, the removal for *E. coli* ranged from 99.96% (3.50 log) to 99.99% (4.39 log) with an average of 99.98% (3.88 log).

### Bacteriophages

The log removal and inactivation for MS2 and PRD1 ranged between 99.60% (2.40 log) to 99.89% (2.96 log), and 96.83% (1.50 log) to 99.46% (2.27 log), respectively. In general MS2 showed better removal and inactivation compared to PRD1. The overall average removal for MS2 and PRD1 were 99.84% (2.8 log) and 99.00% (2.0 logs), respectively. The difference in inactivation can be attributed either to the bacteriophage protein coat structure or to the difference in nucleic acid core (DNA vs. RNA). The data proves that treated Zeolite can inactivate or remove bacteriophage in tap water.

### *Cryptosporidium*

The cumulative removal and inactivation of infectious *C. parvum* oocysts averaged at 97.9% (1.68 log) for all three filters. The removal and inactivation performance by each filter were 95.4% (1.34 log),

99.3% (2.15 log), and 98.9% (1.96 log) for filters 1, 2, and 3, respectively. The physical removal (only) of oocysts averaged at 71.3% (0.54 log) with an individual removal of 75.9% (0.62 log), 65.5% (0.46 log), and 72.4% (0.56) for filters 1, 2, and 3, respectively. It is obvious that physical processes and inactivation yielded a good removal of *Cryptosporidium* oocysts.

### Algae

The average physical removal of 99.11% (2.05 log), 98.74% (1.90 log) and 98.74% (1.90 log) were observed for filter 1, 2, and 3, respectively. The average of three inactivation measurements for filter 1, 2, and 3 were 11% (0.05%), 12% (0.06 log) and 22% (0.11 log), respectively. Despite variation in the inactivation data, it is clear that physical and inactivation processes removes algae by the filters.

