

THE TESTING OF POLY-BIO-MARINE INC.'S FILTER MEDIA AND SYSTEM UNDER EPA STANDARDS AND ANALYSIS METHODS PERFORMED IN STATE & FEDERAL CERTIFIED TOXICOLOGY LABORATORY

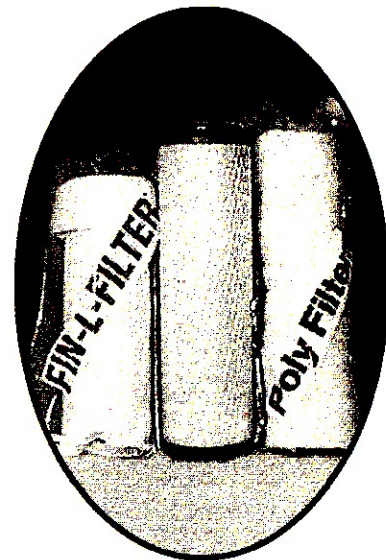
By Kenneth A. Howery

FOREWORD

Sampling:

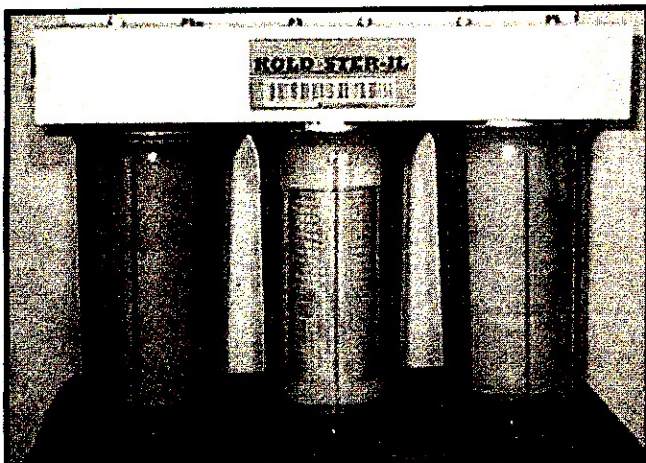
All product samples, with the exception of Poly-Bio-Marine, Inc.'s Discs, carbons, carbon-resin mixtures, ion exchange resins, and synthetic marine salt were purchased through a single supplier. The supplier's name "That Fish Place" and their wholesale operation "Fish Net, Inc," is located at

237 Centerville Rd., Lancaster, PA. In addition, all copper disease treatments were purchased via "Fish Net, Inc." These products were shipped into Poly-Bio-Marine, Inc., through ground freight, carrier United Parcel Service. The products were then transported, in total, down to UMDNJ Toxicology Lab and stored until required for testing. All product seals were broken by the

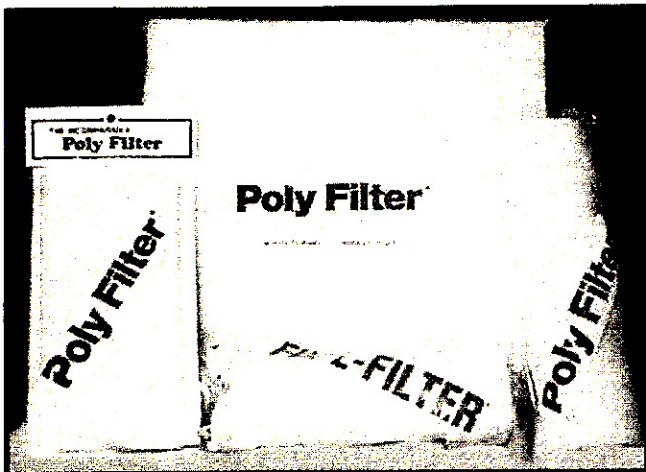


This photo shows the three types of filter media used by the Kold Ster-ii® system.

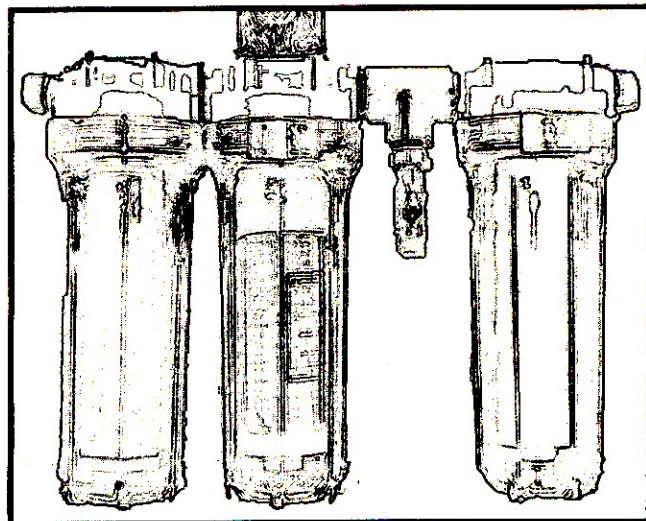
laboratory technician (C.A.P. Certified) performing the tests. Due to the high levels of particulates anticipated during



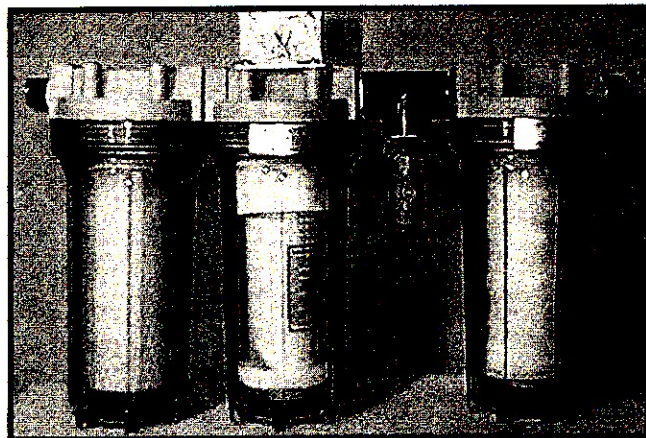
The current Kold Ster-ii® three state canister system containing 12 PMA discs specially processed in 1.0µS/cm (conductivity) water.



This photo shows the resale and commercial sizes of Poly-Filter plus a 12 pack of molecular absorption discs and the new wet 12 pack molecular absorption discs.



A black and white schematic of the original filter used for making the water to which the spike solutions were added.



A photo of the original filtration system used for filtering the medical school's potable water to which the contaminate spikes were added.

carbon usage and the ion-exchange resins' lack of containment, Poly-Bio-Marine, Inc. provided all other products one additional item. This item was a die-cut (2.75" diameter) polyester micro-rated fiber (2,300 microns thick) three micron (99.9%) autoclaved, prerinsed in sterile, pyrogen-free 1.0 microSiemens/cm conductivity water. This 99.9% particulate retention filter may have increased the competitive products' performance slightly. This would have occurred through particulates of chemical sorbents performing additional chemical filtration.

Poly-Bio-Marine, Inc. provided the following samples: Regular Poly-Filter (resale package), size: 4" x 8", custom die-cut into 2.75" diameter discs. Hand cutting of the rectangular Poly-Filters would have resulted in cutting abrasions releasing particulate matter. These misshapen, poorly fitting discs would have allowed fluid bypass. We avoided these problems by taking standard-finished Poly-Filters (resale grade), size: 4" x 8", placing them on a platen receiver covered by a (ultra high molecular weight polyethylene) plastic in a hydraulic press and compressing the Poly-Filters against a sharpened stainless steel rule die under 12,000 psig. force. This produced smooth-cut particulate-free discs for testing. The next product we provided were standard PMA-1 12/Pks. The last product we provided PMA 12/Pks specially processed in sterile, pyrogen-free 1.0 microSiemens/cm Conductivity water. All products were placed into heat-sealed 8-mil. polyethylene plastic bags and transported directly to UMDNJ Toxicology Lab. All product seals were broken by the laboratory technician (C.A.P. Certified) performing the tests. We did not use a prefilter media for particulate control post Poly-Filter discs.

BACKGROUND INFORMATION Sample Filtration

A ten-gallon plastic tank (Nalgene) polyethylene food grade was prefitted with bulkhead fittings (food grade) with 3/8" Npt hose fitting outside the tank. All flexible tubing consisted of PVC tubing (reinforced) nontoxic FDA, NSF Approved capable of 100 psig. All pipe fittings (except for hose directly connected to the Nalgene tank) were polypropylene (threaded) FDA Approved for potable water and ultra pure water contact. Each fitting

was wrapped with FDA Approved virgin Teflon tape for leak containment. All tubing was carefully piped in series, on the positive (pressure) side to the pump, into the above test apparatus. However, upon exiting the second Fin-L-Filter canister, the water fitting was pushed onto a Teflon wrapped fitting and then clamped via 316 stainless hose clamps. The test filter media apparatus consisted of two Fin-L-Filter Model PMA-1cl canisters piped together in series, controlled by a two-way ball valve which, when open, allowed the water to continue back into the tank (continuous loop) or to exit the system (if a containment ball valve was in the open position). This system draws water, from the bottom side, of the ten-gallon tank (suction side) into the pump and then through two Fin-L-Filter canisters, continuing back into the top of the 10-gallon Nalgene tank. The pump is designed for providing pressured potable water for recreational vehicles and week-ending/liveaboard boats. It is an all-plastic (food grade) four stage piston pump available in both 115 volt AC/12 volt DC, designed to provide 3.78 gallons per minute constant flow rate, and pressuring up an entire system to its 40 psig. shut-off point.

The 3.78 gallons per minute (14.20 liter per minute) flow rate offers a realistic flow rate for drinking water, showers, and fish tanks. Note: A small aquarium power filter (hang-on-the-back type) flows more than 226.8 gallons per hour. The NSF International requires all canister filters be tested at 0.60 gallons per minute (2.271 liters per minute) or 136.26 liter per hour (36 gallons per hour) for potable water testing. We thought 630% faster flow rates than NSF Standards required should be sufficient to demonstrate the systems' unique properties.

Sampling and Supervision

Water samples were taken in 1000ml glass jars previously prepared via hydrochloric acid washes and ultra-pure water rinses, oven-dried and remaining in the oven until sample usage. All samples were taken and labeled by an instructor at Toxicology Center of UMDNJ. Each set(s) of samples were prepared for cold storage according to methods provided via the EPA Standards. In addition, dual controls were independently prepared for each test method. Mohamed S. Abdel-Rahman, Ph.D., B.C.F.E., Director of the Toxicology School and

a Professor of Pharmacology, University of Medicine and Dentistry New Jersey, directly supervised all test procedures, reviewed all data, and confirmed the final report. Dr. Abdel-Rahman trained at Ohio State for his Masters of Science and Doctorate of Pharmacology and Toxicology and has over three hundred published papers and chapters of books concerning water, drinking water, chlorination, and trihalomethane toxicity.

TAP WATER FILTRATION The System

Kold Ster-il® Filtration System (U.S. Patent Pending). Consisting of the following: (#1) PMA-1 canister filled with 12 specially prepared (sterile, 1.0 microSiemens/cm water) discs. (#2) PSM-1 canister filled with 1 specially prepared (sterile, 1.0 microSiemens/cm water) 0.20 micron bag 99.9%. (#3) 0.50 micron carbon core filled with a special molecular sieve media for heavy metals. Prerinsed in double distilled water and specifically designed for low hardness water applications, i.e., post nanofiltration and hyperfiltration.

Method of Spike [Test Contaminate(s)] Preparation: Metal dissolved in acid(s) solution, prepared standards for check/calibration of AA/ICP¹ equipment, manufactured by Aldrich Chemical Co.³ Concentrations(s) 990µg/ml², 995µg/ml², 1010µg/ml².

Lead (Pb)	1010µg/ml	Lot No 07307PG.
Cadmium (Cd)	995µg/ml	Lot No 07823AN
Mercury (Hg)	990µg/ml	Lot No 04111A
Copper (Cu)	1010µg/ml	Lot No 05224CN
Zinc (Zn)	990µg/ml	Lot No 05313DF
Iron (Fe)	1010µg/ml	Lot No 05212BP

¹ AA/ equipment Atomic Absorption, Graphite Furnace Technique Spectroscopy. ICP Inductively Coupled Argon Plasma Emission Spectroscopy.

² 990, 995, 1010 µg/ml. To convert µg/ml into mg/L, multiply each side by 1000. Therefore, 990µg/ml = 990mg/L, 995µg/ml = 995mg/L, 1010µg/ml = 1010mg/L.

³ A small calculated sample of the standard solution was added to the Nalgene tank containing 10 gallons (37.85 Liters) of prefiltered water, producing a known concentration of contaminate(s) (spike solution) in 10 gallons volume of water.

Lead Testing at 3.78 gpm fluid flow
We prepared 10 gallons

(37.85 Liters) of highly filtered tap water. The base tap water* filtered by the Kold Ster-il® contained 6.04µg/L (ng/ml) lead. Key: ng/ml = µg/L* (Newark City tapwater: 6.19 pH, Conductivity 125 microSiemens/cm).

We added a calculated amount (115ng/ml of pure Lead in a nitric acid solution) to the 10 gallons plus 1.5ml (2.5N) of sodium hydroxide buffer. 116.85ng/ml (Spike) Lead Solution. The lead spike solution now tested at 7.75 pH. This solution contained 7.79 times more than the 15/ng/ml federal lead limit.

We filtered all test solutions through a 4-stage piston pump that delivered a constant 3.78 gpm (14.2 Liters per minute) fluid flow into (2) canister filters (Fin-L-Filter Model PMA-1). Resale grade Poly-Filters were cut into (2) 12/Pks, run for 34 seconds filtering (>7.1 Liters of test solution). This demonstrated 62.45% lead removal (lead filtrate) 43.87ng/ml @ 3.78 gpm (14.2 Liters per minute) flow rate.

Important Note:

All other filter media test @ 0.60 gpm or 2.271 Liters per minute. This means 15.9% of our 14.2 Liters per minute flow rate. Reason for lower flow rate testing: van der Waal's Forces prevent all other media from sorbing Lead effectively at the higher flow rates.

Our next test demonstrated the van der Waal's Forces effect. (Base Lead level 12.34ng/ml and how one higher grade 12/Pk will outperform Two lower grade 12/Pks.) We added a calculated amount of pure Lead in nitric acid solution 248.38ng/ml Lead into 10 gallons of synthetic seawater (1.023 specific gravity @ 60°F). This is 16.5 times more than the potable water limit of 15/ng/ml lead concentration. We recirculated (18.9L) of the solution through (1) 12/Pk of discs for 14 minutes and 16 seconds or (53.44 total gallons) reducing the lead to 90.72ng/ml concentration. A 63.47% lead reduction occurred @ 3.78 gpm flow rate or 645% faster flow rate than NSF Standard 53b. To clearly demonstrate the difference between our filter media and ion-exchange resins, at the higher flow rate (van der Waal's Forces), we took the other half of the original synthetic seawater solution (18.9 Liters) containing 248.38ng/ml of lead and filtered it through 500ml volume of ion exchange resin (10" cartridge) for 14 minutes and 16 seconds @ 3.78 gpm or 53.44 total gallons. The resin only sorbed 16.68%

of 248.38ng/ml of lead to produce 206.94ng/ml lead filtrate. In addition, the ion-exchange resin, strong cation resin, acidified the filtrate dramatically from the original 8.12 pH down to 3.26 pH. In comparison, our (1) 12/Pk raised the pH slightly (8.12) to 8.39 pH.

Conversions: ng/ml (nonogram per milliliter) equals µg/L (microgram per liter) Part-Per-billion. To convert ng/ml to mg/L, multiply each side of the equation by 1000, Part-per million or Milligrams per Liter. Example: 100ng/ml = 0.100mg/L.

Formation of a Synergistic Solution Comprising Three Metals: Lead, Mercury, and Cadmium in Potable Water.

After having performed Lead, Mercury, and Cadmium tests in Potable Water, it was determined that testing of mixed solution should be performed to determine if any synergistic reactions occurred. This test series offered several unique parts: first, the acidity of the test solution decreased the normally low pH tap water (6.12 pH) to a 5.90 pH level. Since our previous work was buffered to 7.75 pH Lead, 7.76 pH Mercury, it was decided to perform filtration on a naturally acid sample. We would also perform another synergistic filtration test in synthetic seawater which was naturally alkaline (8.12-8.35 pH Range).

Several unique features occurred during the synergistic solution tests. Lead adsorption/absorption decreased more than 3% during the initial 65 seconds of filtration. Mercury intake into the filter media increased dramatically from 14.73ng/ml sorbed (36.74%) of 40.09ng/ml to 78.32ng/ml (63.74%) of 122.86ng/ml. Cadmium performed similar remarkable increases in absorption/adsorption. Initially, Cadmium was not sorbed out of potable water at a 6.30 pH. However, in the synergistic solution (5.90 pH) Cadmium was sorbed 50.22 ng/ml (63.21%) of 79.44ng/ml over 85 seconds filtration time and the filtrate's pH increased to 6.40 pH. **During previous filtration tests the media seemed to prefer sorbing the metal + hydroxide [OH⁻] yet, here we see the solution's pH increase.** We then continued the test with the same filter media installed in the test apparatus. The new test solution was not the filtrate but, rather, the other half of the originally prepared test solution.

As we continued the experiment this

time for 14 minutes and 16 seconds, the following was noted: Lead sorption continued to 88.95 (75.45%) reduction of a 117.89 Lead concentration. Mercury sorption decreased less than 3% (44.54ng/ml) to (48.04ng/ml) out of 122.86ng/ml Mercury concentration. Cadmium sorption continued 58.51ng/ml (73.65%) out of 79.44ng/ml Cadmium concentration. This clearly demonstrated that the Poly-Filter PMA-1 disc media sorbed 88.95ng/ml Lead + 74.82ng/ml Mercury + 58.51ng/ml Cadmium during 14 minutes and 16 seconds filtration @ 3.8 gpm flow rate. This means the Poly-Filter disc media sorbed 222.28ng/ml of Lead, Mercury, Cadmium @ 5.90 pH. In comparison, a top rated NSF filter contained carbon block + molecular sieve media saturated with only 213.70ng/ml of Cadmium during 14 minutes and 16 seconds of filtration. The solution's pH increased from 8.11 pH to 9.15 pH during the 14 minutes and 16 seconds of filtration. This clearly demonstrates how van der Waal's forces effect filtration media performance. The carbon block + molecular sieve media is rated under NSF Standard 53b to deliver a minimum of 1,000 gallons of water >91% removal of Cadmium flow rate 0.60 gpm. Subjected to 3.8 gpm flow rate the van der Waal's Forces effect stopped the NSF Certified Filter after 54 gallons.

Synergistic Heavy Metals Solution Sorbed at 3.78 gpm Fluid Flow

We prepared 20 gallons of filtered tap water containing 27.26ng/ml Lead, 4.12ng/ml Cadmium, and 0.0ng/ml Mercury. *The Lead base normally was 6.05ng/ml *Note: The extra Lead and Cadmium can be attributed to the high concentration of nitric acid (during storage) dissolved part of the glass bottle used for sampling. Added: 100ng/ml of Lead, 100ng/ml of Mercury, 100ng/ml Cadmium pure metals dissolved in nitric acid to the prepared 20 gallons. Spike level concentration: 117.89ng/ml Lead, 122.86ng/ml Mercury, 79.44ng/ml Cadmium. The filtered tap water solution further acidified from 6.12-5.90 pH. The mixture was pumped through (2) 12/Pks of discs @ 3.78gpm. Only 10 gallons of the mixture was used during the first series. The first sample was taken 65 seconds of 3.78 gpm (14.2 Liters) fluid flow, which produced 48.52ng/ml Lead filtrate. ' 'This demonstrated 58.84%

Lead reduction. The third sample was taken after 90 seconds (18.925 + Liters) fluid flow which produced 44.54 ng/ml Mercury filtrate.³ This demonstrated 63.74% Mercury reduction. The second sample was taken 85 seconds (18.925 Liters) fluid flow which produced 29.22ng/ml Cadmium filtrate.² This demonstrated 63.27% Cadmium reduction.

The next series was to demonstrate how well the (2) 12/Pks, used in the first test series, would filter during 14 minutes and 16 seconds. Recirculation of a new additional 10 gallons (unused) of the original synergistic solution. Flow rate 3.78 gpm. New volume filtered: 53.44 gallons. The fourth test sample was taken for lead (53.44 gals). 28.94ng/ml Pb=75.45% reduction. The fifth test sample was taken for Mercury (53.44 gals) 48.04ng/ml Hg = 60.89% reduction. The sixth test sample was taken for Cadmium (53.44 gals) 20.93ng/ml Cd = 73.65% reduction. There is no published data on any other filter media that has tested a synergistic mixture for heavy metals removal under any A.S.T.M. or E.P.A. Standard.

We tested under Clinical Standards for Human Blood and Urine Concentrations under C.A.P. Regulations (College of American Pathology) in a similar method to EPA with stricter quality controls on operators, supervisors, and analytical equipment.

Our media sorbed 222.28ng/ml mixture (Pb, Hg, Cd) @ 3.78 gpm flow rate and was still able to filter additional heavy metals. We also tested a top rated filter cartridge certified under NSF Standards, 42, 53, 53b, 63 the Ametek CBR2-10. The Ametek CBR2-10 saturated with 213ng/ml Cadmium only (not the synergistic mixture) allowing 29.50ng/ml Cadmium to break through the filter and appear in the filtrate. The Ametek CBR2-10, the best cartridge filter certified by NSF, International, clearly demonstrated the effect of 3.78 gpm flow rates on van der Waal's Forces which inhibits adsorption.

Lead Controls:	75ng/ml detected as 150ng/ml detected as	70.90ng/ml Lead
Mercury Controls:	10ng/ml detected as	157.05ng/ml Lead
dilutions (1:2), 1:5 spike:	20ng/ml detected as	11.16ng/ml Mercury
Cadmium Controls:	15ng/ml detected as	21.83 ng/ml Mercury
dilutions (1:2) x 3:	30ng/ml detected as	16.14ng/ml Cadmium
		29.88ng/ml Cadmium

Copper Testing at 3.78 gpm Fluid Flow

We prepared 10 gallons (37.85 Liters) NSF filtered tap water.

Base level; 105.866ng/ml Copper. Source: Newark City tapwater through copper pipe 7.78 pH, Conductivity 135 µSiemens/cm. We added a calculated 600ng/ml of pure Copper in solution (HCl acid) 718.951ng/ml Copper. We also added a small quantity of sodium hydroxide to buffer the solution to 8.00 pH. We took (1) Poly-Filter 12/Pk (dry) and pumped the solution for 17 seconds through the 12/Pk, producing 489.04ng/ml filtrate with a 31.97% reduction in Copper and a 7.76 pH. We then took (2) Poly-Filter 12/Pk (dry) and pumped spike solution for 20 seconds through the (2) 12/Pks, producing 374.09ng/ml filtrate, a 47.96% Copper reduction and a 7.30 pH. **The dry filter (disc) media had not completely wetted during 17-20 seconds of filtration.** We next tested 170 grams of a prewetted zeolite synthetic resin for 17 seconds, producing 613.577ng/ml filtrate, a 14.65% Copper reduction, and an 8.80 pH. This zeolite resin was similar to resins for Iron and Copper used in water softeners. The last test was a 283 grams of a prewetted carbon/resin run for 30 seconds, producing 575.259ng/ml filtrate, a 19.98% Copper reduction, and a 7.17 pH. The carbon/resin mix released a large amount of particulate matter (i.e., carbon dust). During testing: a 1.0µm sterile polyester filter was placed after the zeolite and carbon/resin filter for particulate control which may actually have enhanced their sorbent performance.

Copper Controls:	650ng/ml detected as 637.270ng/ml
Analysis Method:	1300ng/ml detected as 1324.660ng/ml
	Atomic Absorption EPA Method 7201

Copper Controls:	95ng/ml detected as 96.286ng/ml
Analysis Method:	1100ng/ml detected as 1102.130ng/ml
ASTM D1688-90:	Atomic Absorption with chelation-extraction process
EPA Method 7201:	Test Method B (2ng/ml - 500ng/ml) low range
	(200ng/ml - 5000ng/ml) high range

We prepared 10 gallon of NSF filtered tap water + added synthetic sea salt (33,000 µSiemens/cm Conductivity), pH 8.18, 31.700ng/ml base Copper level. Mardel's proprietary chelated Copper sulfate solution, when added, produced 1570.160ng/ml Copper spike solution and a pH 8.19. For this test, we used (2) 12/Pks and recirculated 5 gals. of spike solutions for 14 minutes and 16 seconds, which produced 841.85ng/ml filtrate, a 46.38% reduction in chelated Copper,

and a 8.50 pH. The solution(s) normal pH range = 8.30-8.50 pH 3.78 gpm x 14 minutes and 16 seconds = 53.44 gallons total fluid volume passing through filter media. For a valid comparison of ion-exchange resin behavior at 3.78 gpm, we doubled the resin volume to 1000ml (filling [2] test cylinders) + added (1) 1.00µm sterile polyester filter to the bottom of each cylinder for resin containment. The 5 gallons of spike solution recirculated for 14 minutes and 16 seconds. The filtrate contained 1365.580ng/ml chelated Copper, for a reduction of 13.02% chelated Copper with a more acidic 7.91 pH. Note: this resin is a commercial product presently selling into the Aquarium Industry for heavy metals removal. 3.78 gpm x 14 minutes and 16 seconds = 53.44 gallons total fluid volume passing through filter media.

Iron and Zinc Testing at 3.78 gpm Fluid Flow

We prepared 10 gallons (37.85 Liters) NSF filtered tap water containing an Iron level. Newark City tap water: 6.65 pH, Conductivity 122µ/Siemens/cm, 42.923ng/ml Iron. We added 200ng/ml concentration of pure Iron in solution (Hydrochloric acid) + added 1 milliliter of NaOH(2.5N) (sodium hydroxide — electronics grade) to slightly rebuffer to 8.00 pH. The spike solution contained 272.136ng/ml Iron. We took (1) 12/Pk (prewet) and pumped the solution through for 34 seconds, which produced 243.485ng/ml Iron filtrate. This resulted in 10.53% Iron

reduction and dropped the pH slightly to 7.86 pH. Next we tested (2) 12/Pks (prewet), pumping the solution for 34 seconds, which resulted in 214.833ng/ml Iron filtrate, a 21.05% reduction and a drop in pH to 7.29 pH. This clearly demonstrates a unique property: heavy metals removal without loading up on dissolved Iron solute. Next, 10 gallons of synthetic seawater were prepared via NSF filtered tap water containing a 358.091ng/ml base Iron level. This phenomena only occurs in low dissolved solids solutions! For example, when 300ng/ml of Iron is added to synthetic seawater,

630.282ng/ml total Iron results as the spike concentration. The same (2) 12Pks (used) sorbed all the soluble Iron within 14 minutes and 16 seconds of filtration (53.44 gallons total volume). The (2) used 12/Pks reduced the Iron to the 358.091ng/ml Iron base level.

groundwater. Under current federal regulations 100ng/ml or 100µg/L or 0.100mg/L (weighted average) is the current action level or allowable limit. Due to the nature of the regulation, and the weighted average term, levels can be found considerably higher than the 100ng/ml Chloroform ceiling. The

weighted average is done over four quarters with each week's testing

averaged into a month, which is again averaged and further averaged. Chloroform is a known cancer causing agent -- not a suspected agent.

Testing:

We attempted to filter a Chloroform solution under pressure at our regular test-flow rates (3.78 gpm); however, due to Chloroform's volatile nature, much of the Chloroform vaporized during the filtration process. In order to perform proper filtration, Dr. Abdel-Rahman, Director of UMDNJ's Toxicology Department and Laboratory devised a method for filtration.

Spike Solution:

Spectrograde Chloroform (highest grade) (68 microliters) was added to 100ml volumetric flask to make 1mg/ml Chloroform concentration in ethanol. This was further diluted until 30.28ml of 100µg/ml Chloroform was added to 7.57 Liters of .243µS/cm conductivity (sterile, pyrogen-free) water.

This formed our Chloroform spike solution containing 347.01 ng/ml Chloroform. We added sufficient sodium hydroxide (electronics grade) to the water to raise the 6.53 pH to 8.00 pH. Very high grade water gives a false or nonreadable pH value.

Our Chloroform spike solution was 347.01ng/ml Chloroform concentration. We poured this solution through our PMA-1 Assembly filled with only one (1) 12/Pk at maximum gravity

flow rate and produced 90.71ng/ml filtrate. Next, we poured the initial filtrate (90.71ng/ml) through another PMA-1 Assembly filled with (1) 12/Pk at maximum gravity flow rate and produced 66.39ng/ml Chloroform concentration filtrate. We estimate the flow rate @ 3.785L/minute.

This filter (1) 12/Pk sorbed 73.85% or 256.30ng/ml Chloroform on a single pass. Under Federal Regulations, for Drinking Water, the spike solution after

passing through (1) 12/Pk was now safe for drinking.

Formation of a Synergistic Solution Comprising Three Metals Copper, Iron, and Zinc in a Synthetic Seawater Solution.

The three metals Copper, Iron, and Zinc had been tested in potable water and synthetic seawater for reductions during previous filtration tests. In addition, we tested chelated Copper (Mardel's Copper Safe) adsorption/absorption under both high and low concentration. We decided to see if Copper or Iron would act as Lead had done during our previous synergistic tests.

The Copper Ion was Aldrich Chemical Co. AA/ICP calibration/check standard, pure dissolved Copper, concentration 1010µg/ml. Lot No. 05224CN.

The Iron Ion was Aldrich Chemical Co. AA/ICP calibration/check standard, pure dissolved Iron, concentration 1010µg/ml. Lot No. 05212BP.

The Zinc Ion was Aldrich Chemical Co. AA/ICP calibration/check standard, pure dissolved Zinc, concentration 990µg/ml Lot No. 05313DF.

Note: For information purposes, we should add that the Nalgene tank was washed with a 10% nitric Acid solution which was flushed through the entire test apparatus/system. Next, the system was flushed with D.I. Water (.243µSiemens/cm conductivity. The Nalgene tank was then flushed with a 10% HCl solution which ran through the entire system to discharge. Finally, ultra pure water (0.56µSiemens/cm) was run through the entire system. This was done after each major metals test — to remove residual contamination. The system was ready for the synthetic seawater solution which was prepared as follows: highly filtered tap water (125µSiemens/cm) was added to the Nalgene tank (37.85L), we added Instant Ocean Salt as per the manufacturer's literature and stirred with a large acid-washed glass rod for 15 minutes. Specific gravity was checked via certified hydrometer calibrated at 60°F. When the specific gravity was between 1.023-1.025, we checked the solution's pH. We found freshly hydrated Instant Ocean normally produced 8.17-8.20 pH on our calibrated daily Orion Research digital ion analyzer with the probe maintained in standard solution (7.000 pH) between measurements.

Iron Controls:	450ng/ml detected as 444.06ng/ml 1020ng/ml detected as 1031.40ng/ml
Analysis Method:	Atomic Absorption EPA Method 7380

We prepared 10 gallons (37.85 Liters) of NSF Filtered tap water. The Newark city water contained: 125µSiemens/cm, 00.00 Zinc, and 6.11 pH. We added 2ml (NaOH2.5N) as a buffer along with the pure Zinc in solution (HCl acid) This produced 242.12ng/ml Zinc spike at a 7.09 pH. We took (2) 12/Pks (dry) and pumped (open system) the solution for 34 seconds, which resulted in 200.62ng/ml filtrate or 17.14% Zinc reduction. The buffer depleted to 6.34 pH. Next, we took the (2) 12/Pks (used) and pumped the remaining 8.10 gallons for 14 minutes and 16 seconds of recirculation filtration (53.44 gallons total volume). This produced 150.63ng/ml filtrate or a 37.78 Zinc reduction. The filtrate further acidified to 6.16 pH.

Note: It was noted during additional testing in synthetic seawater that Zinc, a very reactive metal, prefers to combine and form complexes. When we formed 140.72ng/ml Zinc spike as part of a synergistic solution of Copper, Iron, and Zinc, the Zinc was well sorbed 21.57ng/ml Zinc filtrate (84.7% within 60 seconds) even in a very high TDS situation (33,000µS/cm). Previously, no Zinc absorption (390.09ng/ml spike solution) had occurred during a 14 minute and 16 seconds of recirculated synthetic seawater filtration (386.60ng/ml filtrate)

Zinc Controls:	330ng/ml detected as 337.60ng/ml 600ng/ml detected as 648.56ng/ml
EPA Method 7950:	150ng/ml detected as 179.02ng/ml 300ng/ml detected as 319.45ng/ml
Atomic Absorption:	

Volatile Organic Chemicals (VOC's) Background:

For this type of testing, due to the nature of VOC's, one volatile organic chemical has been picked as a surrogate due to its ubiquitous nature. That chemical is the trihalomethane Chloroform (CHCL3). Chloroform naturally forms through the chlorination of organic matter (specifically tannins and humic acids) the common color agents found in

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all legitimate prices!

The synthetic seawater contained the following backgrounds: 31.700ng/ml Copper, 306.098ng/ml Iron, and 7.65ng/ml Zinc.

The synergistic spike solution consisted of 200ng/ml Copper, 200ng/ml Iron, 200ng/ml Zinc which was added to the 37.85 Liters of synthetic seawater, stirred with the glass rod for five minutes, until the system's pump was started and run for five minutes of flow. After the recirculation, the 37.85 Liters pH was retested -- it indicated 8.00 pH. This drop was natural and due to the acid content of the synergistic spike. The spiked solution read as follows: 211.730ng/ml Copper, 418.424ng/ml Iron, 140.0ng/ml Zinc, was stirred with a glass rod for five minutes, until the system's pump was started for five minutes of recirculation. For the filtration test, we installed (2) PMA-1 12/Pks, without a base particulate filter, started the system (open discharge) and discharged into a collection container for disposal. The system ran for 60 seconds @ 3.87 gpm (14.30 Liters per minute) prior to sample collection. The sample showed 80.80ng/ml (61.8% reduction) Copper, 356.02ng/ml (14.9% reduction) Iron, 21.57ng/ml (84.7% reduction) Zinc. The filtrate's pH had increased from 8.00 pH to 8.06 pH after 60 seconds.

For the next test, the same (2) PMA 12/Pks remained installed and the unused portion of the 37.85 Liters (37.85 - 14.30 = 23.55L) was recirculated for 14 minutes and 16 seconds. The sample demonstrated

72.62ng/ml (65.7% reduction) Copper, 281.136 (106.8% reduction) Iron, 0.00 (100% reduction) Zinc. The most interesting aspect of this test was the ability of the filter media to sorb Zinc in synthetic seawater. A previous test had shown (2) PMA 12/Pks only sorbed 386.60ng/ml (0.8% reduction) of 390.09ng/ml Zinc spike after 14 minutes and 16 seconds of recirculation/filtration.

Zinc is not normally sorbed out of synthetic sea water under normal conditions. However, if Copper and Iron are added to the mixture, a synergistic solution forms which the Zinc can be completely sorbed quantitatively. Another interesting observation, Iron which does not sorb below the synthetic salt mix's base Iron level, can be forced to do so upon the addition of Copper and Zinc. It should be noted that the levels of Copper and Zinc required to start the reaction would be toxic to most, or all, marine specimens. Therefore, concerns over trace element depletion should be obviated since Zinc normally occurs in a concentration of 7.65ng/ml¹ to 9.60ng/ml² in synthetic seawater mixes.

¹ Detected during our Zinc testing.
² ASTM D1141 Spec. for Substitute Ocean Water. A further disclosure about trace metal depletion is as follows: "Some metals, such as uranium and iron, form anionic complexes in the presence of sulfate and chloride ions and can be absorbed by using anion exchange resins" ref. Rohm and Haas pages 27-28 pub., if

you use water. We confirmed this during several test procedures where we compared Poly-Filter performance against other commercial products. During Zinc testing in synthetic seawater, the following occurred: 500ml of Purigen adsorbed 17.55% of 390.09ng/ml Zinc or 68.49ng/ml (and dropped the filtrate to 7.34 pH) during the 14 minutes and 16 seconds filtration. The Poly-Filter (2) PMA-1 12/Pks running 14 minutes and 16 seconds sorbed raised the spike solutions' 7.97 pH up to 8.37 pH. Obviously, an anionic complex didn't form during the (2) PMA-1 12/Pks 14 minutes and 16 seconds of filtration. Unfortunately, the Purigen dropped the spike solution's 7.97 pH down to 7.34 pH. This demonstrates the formation of anionic complex and the absorption of hydroxide ions. The Test Methods EPA 7950 (Atomic Absorption — flame emission). During Iron testing, Kent Marine's expert series organic resin sorbed the following: 10 gallons of Synthetic Seawater base Iron level 358.091ng/ml + spike (5.4ml of 1010µg/ml concentrate) = 630.282ng/ml total detectable Iron. The 10 gallons of prepared Iron-spike solution was split into (2) equal (5 gal.) volumes. Filtration for 14 minutes and 16 seconds through 500ml of Kent's anion resin produced (100% removal) or 358.091ng/ml Iron (filtrate). Again, as predicted by Rohm and Haas in their technical literature. The Test Method: EPA 7380 Atomic Absorption-FE. Our Poly-Filter cut into (2) PMA-1 12/Pks produced the exact same results 630.282ng/ml spike sorbed down after 14 minutes and 16 seconds to the base Iron level 358.091ng/ml. In the case of Iron in synthetic seawater, both the Kent Marine product and the Poly-Filter (2) PMA-1 12/Pks functioned the same as Iron formed anionic complex through reactions with chloride and sulfate ions.

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