

My Kitchen Tap versus My Refrigerator Dispenser?

Dr. John T. O'Connor, PE © 2005 John T. O'Connor

What does a Refrigerator 'Filter Cartridge' do?

Since refrigerators often come in houses and last for decades, it can be a major household event when a brand new unit arrives. In fact, in our 39 years of marriage, this year was only my wife's second opportunity to purchase one of her very own choosing. In addition to dual thermostats, night lights and numerous storage conveniences, our shiny new appliance came with a water *'filter'*, or more properly, an in-line plastic cylinder containing a small quantity of granular activated carbon. To one who has conducted scientific studies of drinking water quality for half a century, the opportunity to compare the water issuing from our new refrigerator dispenser with our local (Columbia, Missouri) tap water was irresistible.



Cutaway view of a replacement refrigerator *'filter'* cartridge and its carbon contents

Water and Ice

Shortly after its arrival (and after the recommended 10 liter purge of water from the dispenser), I began collecting samples of water every few days from my refrigerator's water dispenser as well as from the kitchen tap for comparison. There was little question that the refrigerator water tasted cold and refreshing, especially with crushed ice. To make this comparison still more interesting, I subsequently began collecting ice cubes separately from the refrigerator and hot water, as well as cold, from the kitchen tap. All samples were *'first draw'* samples meaning that neither the dispenser nor the faucet had been used overnight before samples were taken.



Sampling kitchen tap (left) and refrigerator dispensers (right)

Looking for Particles and Microorganisms - Ultraviolet Light Microscopy

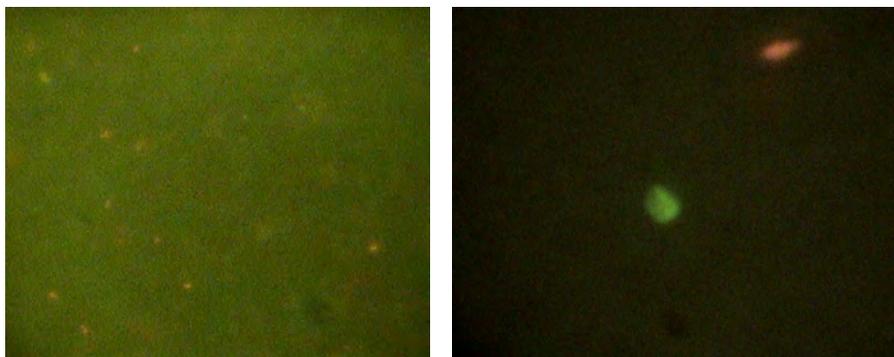
In preparation for microscopic examination, equal volumes of each liquid sample (after melting the ice) were passed through a membrane to retain particles as small as bacteria. A drop of fluorescent dye was then added to stain any organisms on the membrane so that they would fluoresce under ultraviolet light illumination.

Micrographs of typical portions of each membrane were taken using a digital camera.



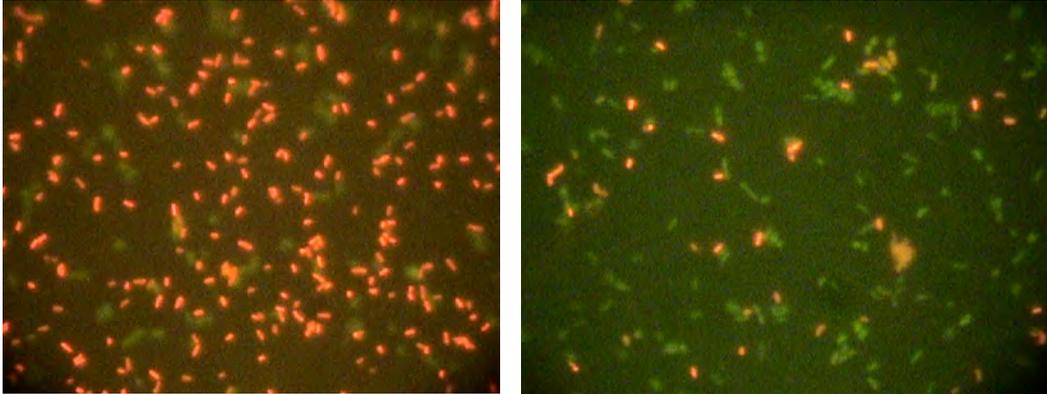
To my surprise, differences in the waters did not develop slowly, but were immediately evident. Even after several weeks of observation, the initial results appeared consistent and reproducible.

Since the municipally-treated tap water drawn from my kitchen faucet is chlorinated, it contains few or no bacterial cells and, indeed, few particles of any kind. However, the hot water from my kitchen tap showed an assortment of small chips and debris, possibly derived from corrosion products formed in my hot water heater. Although heat-loving bacteria often colonize hot water heaters, sometimes causing odors, few bacteria of any kind were evident in my hot water.



Micrographs showing particles in chlorinated tap water: cold (left) and hot (right)

In contrast, from its arrival, my refrigerator dispenser yielded water that consistently exhibited a number of red-fluorescing bacterial cells. At the suggestion of my daughter, I began taking a succession of samples from the water dispenser to see if the flushing of a few glasses of water would significantly reduce the number of bacteria in the water. While seemingly wasteful, her proposed approach seems to work. The micrographs, below, illustrate the relative numbers of bacterial cells observed in two successive glasses of refrigerator dispenser water.



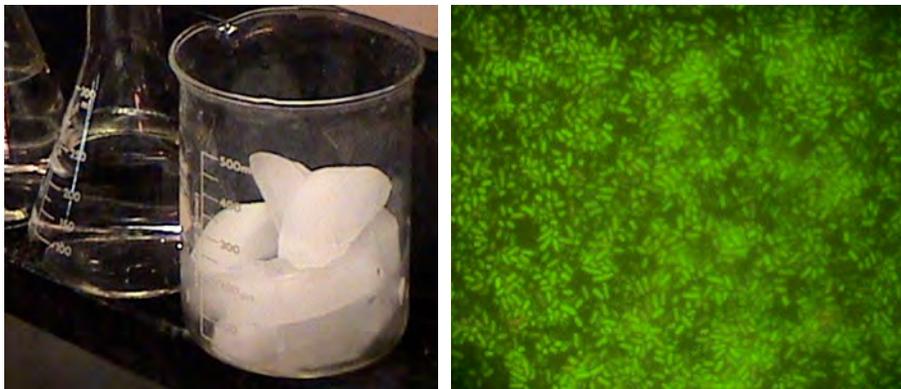
Bacterial cells observed in first (left) and second glasses of water drawn from refrigerator dispenser

What kind of 'Filter' adds particles to Water?

Although the organisms appeared more rapidly than I expected, the presence of bacteria in water from the refrigerator dispenser was predictable. It is well-known that carbon, a reducing agent, readily consumes chlorine. It is this absence of chlorine that consumers cite as their perception that the water quality (taste) has improved. In the absence of a disinfectant residual, bacterial growth will occur. This is particularly true on the surface of activated carbon which adsorbs and concentrates organic matter. For example, activated carbon is used to decolorize rum and sugar. The organic compounds adsorbed on the surface of activated carbon granules then provide a substrate for bacterial growth.

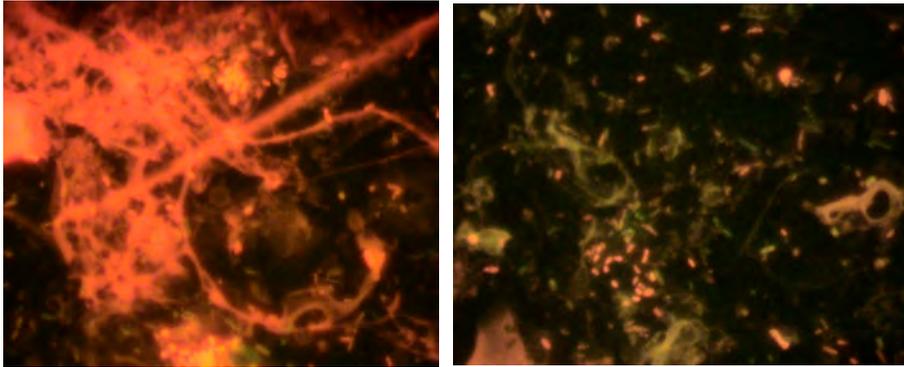
Want Ice in Your Drink?

More interesting, and still a mystery to me, are the reasons for the large accumulation of fluorescing matter and bacterial cells I found in melted ice. One might have expected the bacterial populations in ice to be similar to those found in the dispenser water. While these large bacterial populations may have been scoured from the brand new ice maker mechanism and might decrease with time, I plan to keep looking so I won't have to guess.



Large numbers of bacterial cells were present in samples of melted ice

At my son's suggestion, I tried partially melting the ice cubes to remove their surface. I compared this initial melt with the melted remainder. I repeated this several times and found that the initial melt contained more debris and bacteria than the subsequent melt. While this procedure may or may not improve the taste, discarding the initial melt water before using the ice may reduce both the amount of entrained particles and the number of bacteria in my drink.



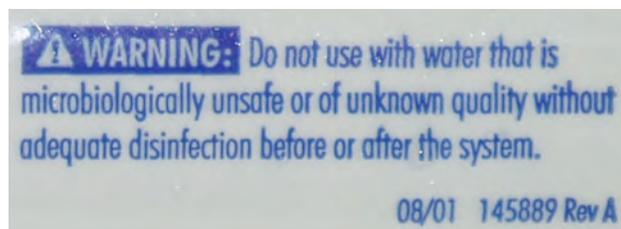
Ice Cubes (surface melt, left; residual melt, right)

Meanwhile, examination of unfrozen water removed directly from the ice maker freezing tray showed bacterial populations comparable to those found in the dispenser water. From this observation, it appears that the ice-making process may result in the progressive concentration and precipitation of solutes in the water that subsequently appear as particulate matter on melting.

Avoiding Drinking Water Quality Deterioration

Since I assume that most of the bacteria observed are not pathogens, I am not fearful of disease from the dispensed organisms. I plan to drink the refrigerator dispenser water and use the ice. However, I will generally discard the first glass of water from the refrigerator water dispenser and possibly rinse the (whole) ice cubes with tap water before using.

However, in a few months, when the activated carbon *dechlorinator/adsorber* cartridge is exhausted (if it isn't already), my experiment is over. I plan to discard the adsorber and, if necessary, install a bypass line to my water dispenser. I can't see any benefit in maintaining a reverse 'filter' that contributes particles and bacteria, even if they are benign, to my drinking water.



Warning on replacement refrigerator icemaker 'filter'

Epilogue - The Refrigerator as In-Home Water Treatment Facility

Five months after purchase, we received a reminder that we should consider replacing the 'water filter' that was built into our refrigerator. Not including taxes, the 'exact filter' replacement needed would cost \$40.00 (actually, only \$39.99). This timely reminder coincided with the refrigerator's built-in, illuminated 'Water Filter Status Display' that counts down 'filter life' from 99%. The little green LED display stood, unblinking, at 6%. Filter 'capacity' is estimated at 'up to 100 gallons...'

Keep your product performing its best

About your refrigerator

Sears sends this notice as a service to our customers. According to the owner's manual, it's time to consider replacing your water filter. And because you purchased your refrigerator at Sears, we know the exact filter you need.



Your refrigerator model #	106.55209*
Water filter part #	9020
Price	\$39.99

FILTERED BY / UTILISE LE FILTRE

ULTIMATE REFRIGERATOR FILTER
FILTRE POUR RÉFRIGÉRATEUR

For replacement filters visit your local SEARS® store or call 1-800-469-4663 or visit www.sears.com/partsdirect in the U.S. or www.sears.ca in Canada.

Obtenez des filtres de rechange au magasin SEARS® le plus près de chez vous en composant le 1-888-473-2772 ou en visitant www.sears.com/partsdirect aux États-Unis et www.sears.ca au Canada.

Part # 9020 / N° de pièce 9020B

ULTIMATE REFRIGERATOR FILTER
Replacement cartridge #T1RFKB1 for Model #T1KB1

Operating Temperature: 100°F (38°C) max
Working Pressure: 120psi (827 k Pa) max
Flow Rate: 0.9 gpm (1.89 Lpm)

This is a mechanical and chemical reduction filter. Filter capacity is up to 100 gallons/379 liters for refrigerators with a PID indicator.

FILTRATION ULTIMATE POUR RÉFRIGÉRATEUR
Cartridge de rechange n° T1RFKB1 pour le modèle n° T1KB1

Température de service : 100 °F (38 °C) max
Pression de service : 120 psi (827 kPa)
Débit : 0,9 gal/m (1,89 L/m)

Ce filtre a une capacité de réduction mécanique et chimique. Il peut traiter jusqu'à 379 litres d'eau pour les réfrigérateurs munis d'un indicateur PID.

Whirlpool, KitchenAid and PUR recommend changing filter at least every 6 months
Whirlpool, KitchenAid et PUR recommandent de changer le filtre au minimum tous les six mois

NSF International, a nationally recognized not-for-profit agency for the certification of water filters, has tested and certified this product to reduce the following list of contaminants. Products with the NSF mark are certified to pass a series of stringent independent tests.

Tested and certified by NSF International against NSF/ANSI Standard 53 in model number T1KB1 for the reduction of Lead, Cysts, Turbidity, THM, Atrazine, Mercury, Ionophore, MTBE, Aroclor, Lindane, Alachlor, Endrin, Benzene, o-Dichlorobenzene, Tetrachloroethylene, Ethylbenzene, and Monochlorobenzene and Standard 42 for Chlorine Taste and Odor, and Nominal Particulate Reduction Class 1.

The contaminants or other substances removed or reduced by this water filter are not necessarily in all users' water.

Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system. Systems that are certified for cyst reduction may be used on disinfected water that may contain filterable cysts. Individuals requiring water of certain microbiological purity should consult their physician.

NSF International, un organisme à but non lucratif reconnu à l'échelle nationale pour la certification des filtres à eau, a testé et certifié ce produit pour la réduction des polluants énumérés ci-dessous. Les produits portant son sigle ont subi à une série de tests indépendants rigoureux.

Testé et certifié par NSF International conformément à la norme NSF/ANSI n° 53 relative à la réduction de la teneur en plomb, kystes, turbidité, THM, amiant, mercure, ionophore, éther méthyleributylé, atrazine, lindane, alachlor, endrine, benzène, o-dichlorobenzène, tétrachloroéthylène, éthylbenzène et chlorobenzène, et à la norme n° 42 relative à l'élimination du goût et de l'odeur du chlore et à la réduction nominale des particules de classe 1 pour le modèle T1KB1.

Les contaminants ou autres substances éliminés en totalité ou en partie par ce filtre ne sont pas nécessairement présents dans l'eau de tous les utilisateurs.

Ne pas utiliser avec de l'eau insalubre du point de vue microbiologique ou de qualité incertaine, sans prévoir une désinfection efficace avant ou après la filtration. Les systèmes ayant reçu la certification pour la réduction de la présence des kystes peuvent être utilisés avec de l'eau désinfectée pouvant contenir des kystes de taille filtrable. Les personnes qui doivent consommer une eau particulièrement pure sur le plan microbiologique devraient consulter leur médecin.

IMPORTANT NOTICE - Read the manufacturer's performance data sheet.
California Department of Health Services Certification #04-1853 for model T1KB1. For conditions of use, health claim certified by the California Department of Health Services, and replacement parts, see Performance Data Sheet in your refrigerator User & Care Manual.

Made in the U.S.A. Distributed by Sears, Roebuck & Co., Hoffman Estates, IL 60170. Kenmore® is a registered trademark of Sears Brands, LLC. PUR is a registered trademark of The Procter & Gamble Company.

AVIS IMPORTANT - Lire la fiche technique de performance du fabricant.
Nombre de certification du California Department of Health Services 04-1853 pour le modèle T1KB1. Pour connaître les conditions d'utilisation, les informations en matière de santé certifiées par le California Department of Health Services et les pièces de rechange, consultez la fiche technique de performance dans le guide d'utilisation et d'entretien du réfrigérateur.

Fabrique aux États-Unis. Distribué par Sears, Roebuck & Co., Hoffman Estates, IL 60170. Kenmore® est une marque déposée de Sears Brands, LLC. PUR est une marque déposée de The Procter & Gamble Company.

EPA EST. No. 070595-CF-001 US Patents pending License #Scoutline n° 2260536
EST. EPA n° 070595-CF-001 Brevets américains en instance 85428889

5

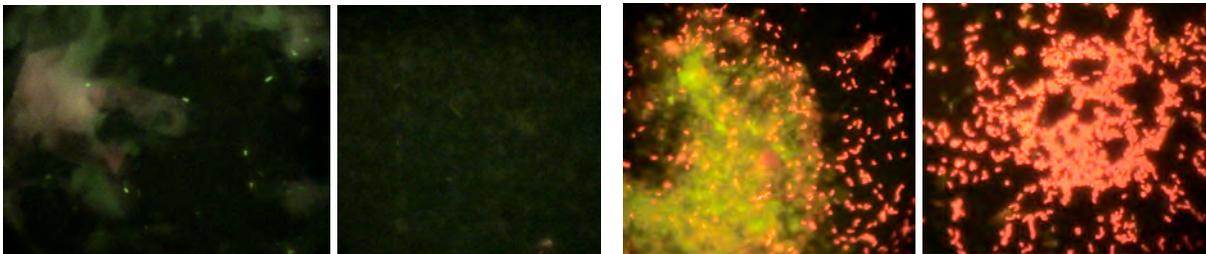
As indicated on its label, this 'ultimate replacement filter' is certified (testing was conducted at 70°F) to *reduce* (not necessarily remove) lead, cysts, turbidity, total trihalomethanes, asbestos, mercury, toxaphene, MTBE (a gasoline additive), atrazine, lindane, alachlor, endrin, benzene, o-dichlorobenzene, tetrachloroethylene, ethylbenzene, monochlorobenzene and tastes-and-odors (most particularly, chlorine). In all fairness, the manufacturer acknowledges that these contaminants "are not necessarily in all user's water" and that "individuals requiring water of certain *microbiological* quality should consult their physician."

If your household water actually contained excessive amounts of any or all of the contaminants listed, unless you planned to draw all of your water for drinking, cooking, bathing and showering from your refrigerator, you might want to consider treating your entire household supply. With a range of volatile organic substances in your water, even singing in your shower could constitute a health hazard.

One Final Check

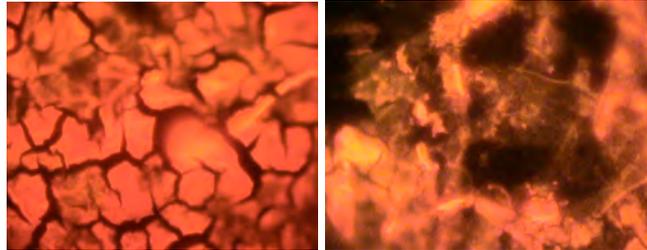
One last time, I took samples of the tap, refrigerator dispenser water and ice to observe the microbial populations at the stage of operation when the 'filter' was nominally exhausted. The micrographs below, appeared much the same as those taken at the start of this microscopic tour.

Although some small, green-fluorescing cells were evident, the City of Columbia tap water was largely free of organisms. Alternately, the refrigerator dispenser water contained substantial numbers of brightly-fluorescing, rod-shaped cells, sometimes colonizing what appeared to be amorphous slime particles.



Columbia, Missouri Tap Water (left) and Refrigerator Dispenser Water (right)

While it also appeared as before, identification of the material from the melted ice still presented a challenge. The heavy layer of debris required that ever smaller volumes of the melt be membrane-filtered before any bacterial cells became evident. However, I am speculating that the mass of material derives from the salts, including calcium carbonate, that precipitate as the ice cube is being formed.



Melted Ice

The 'Ultimate' Solution

Finally, to the refrigerator and cartridge designers' credit, removal of my carbon adsorber did not leave me standing in a pool of water on the kitchen floor. Instead, simply pulling the cartridge out automatically bypassed the refrigerator water directly to its dispenser.

On page 13 of my refrigerator's 76-page *Use and Care Guide*, the owner is advised that "*You can run the dispenser without a filter. Your water will not be filtered.*" (Actually, for most Americans, their water probably is not only filtered, but annually tested for contaminants, particularly, if it is supplied through a water treatment plant.)

Since I have decided to live without a carbon adsorber cartridge, I will not have to consult my physician about the microbial quality of drinking water dispensed from my refrigerator, Sears will not have to send any more reminders, I can allow my green LED to perpetually indicate 0%, and I can devote my semi-annual 'water filter' savings to support my personal research on the improvement of drinking water quality.