



Material Methods LLC
Applied Science for Industry TM

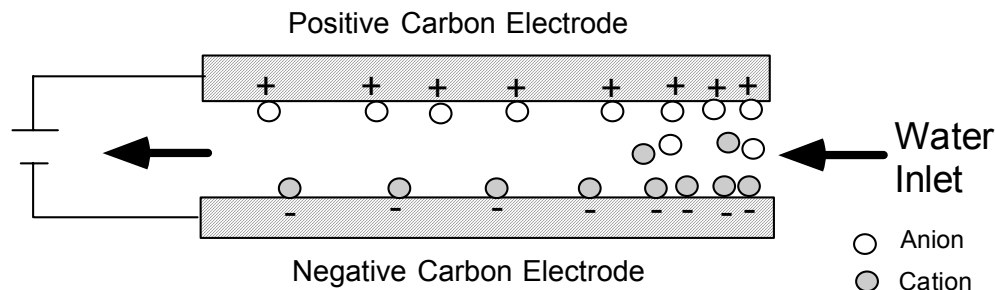
The Flow Through Capacitor

An Efficient, Chemical-Free TDS Reduction System

April, 2003

The Flow Through Capacitor

The flow through capacitor (FTC) is an efficient means of chemical-free TDS reduction using electrically charged plates to remove ions. The FTC delivers high purification, high recovery and long life. It resists scaling, and requires no routine maintenance or chemicals. It also is capable of removing “problem” ions such as arsenic, perchlorate, metals, nitrate, and sulfate. It purifies up to 98% of hardness and salt from tap and brackish feed waters.



The FTC consists mainly of two carbon electrodes and a DC power source. Water flows through the narrow gap of the FTC, and anions as well as cations are removed via adsorption on the electrodes under the influence of an applied electric field. By simply controlling the applied voltage, the ions can be released thereby regenerating the cell. Chemical-free operation, low operating and maintenance costs, long lifetime, high recovery, low pressure drop and the ability to remove harmful impurities distinguish the FTC.

Impurity Removal

In testing of a laboratory-prepared sample of Newport Beach tap water with EPA target spikes, the FTC removed 90% of the hazardous elements and TDS. Table 1 shows the results of this test.

Solution	Spike	PPM	Purification of Solution	Purification of Spike
Newport Beach Tap	Baseline TDS	500	To 98%	N/A
Newport Beach Tap	As	0.6	84%	75%-85%
Newport Beach Tap	ClO ₄ ⁻	0.5	85%	>95%
Newport Beach Tap	NO ₃ -N	100	80%	90%-95%
Newport Beach Tap	NO ₃ ⁻ and SO ₄ ⁻	100 and 150	85%	>90%
Newport Beach Tap	Pb	0.05	85%	80%-90%
CuNO ₃	CuNO ₃	1000	85%	85%

Table 1. Removal of EPA inorganic targets. Non-harmful impurities, such as hardness and salt are present at 500-ppm levels in the tap water. EPA targets were added.

Table 2 shows analytical testing of Newport Beach tap water purified by the FTC. These data show that while removing hardness from municipal water, the FTC also removes health hazards such as copper, sodium, nitrate, and sulfate. Additionally the pH was neutralized and chloride was removed. Removal rates for health hazards and hardness is greater than 90%, while recovery (the fraction of feed-water that was purified) is almost 60%.

Impurity	Unit	Baseline	Purified	% Removal
Calcium	PPM	83.0	1.7	98%
Copper	PPM	0.1	0.0	90%
Magnesium	PPM	14.0	0.4	97%
Potassium	PPM	3.7	0.0	100%
Sodium	PPM	58.0	3.0	95%
Alkalinity as CaCO3	PPM	180.0	7.5	96%
Bicarbonate Alkalinity as CaCO3	PPM	180.0	7.5	96%
Chloride	PPM	53.0	1.6	97%
Hardness (as CaCO3)	PPM	260.0	5.9	98%
Nitrate-N	PPM	1.8	0.0	100%
Sulfate	PPM	110.0	2.3	98%
TDS	PPM	480.0	47.0	90%
pH	--	8.0	6.8	15%
Specific Conductance	mS/cm	760.0	24.0	97%

Table 2. Purification of Newport Beach tap water at 56% recovery. These data show the combined benefits of water softening and removal of health threatening impurities.

A Water Purification Appliance

Figure 1 shows lifetime testing results on artificial, high hardness (1400 PPM hardness) water. After more than 180 days of continuous operation, and despite the extremely high hardness content of the feed water, the FTC consistently purifies at ~95% with no signs of scaling. During this time the FTC required no maintenance or chemical addition. It is truly an appliance.

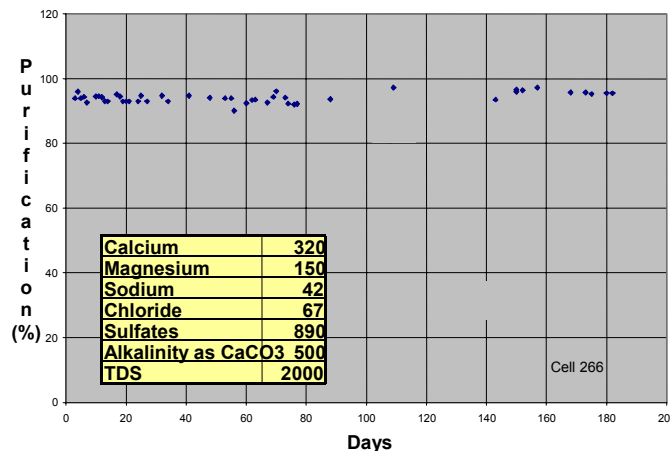


Figure 1. The FTC demonstrates consistent 95% purification of artificially high hardness (1400 PPM hardness) water.

The System

The FTC is compact and efficient. A demonstration unit with external dimensions of 18 x 8 x 20 inches yields a product, which is over 90% purified, with 60% recovery and an average energy usage 60W (see Figure 2). This was done with Newport Beach tap water, at a flow rate of 0.5 GPM of purified product. The external dimensions of the unit can be further reduced depending on customer requirements. (A note should be made here about performance. The variables with any FTC system include flow rate, purification, source TDS, and recovery. The performance values enumerated above are for a specific design point. These variables can be modified to accommodate a wide range of values. As an example, the TDS level of the input stream can go as high as brackish levels for this unit.) Table 3 shows the power required to purify an input stream to 90% purification using this unit.



Figure 2. FTC demonstration unit with side panel removed

Feed TDS (PPM)	Purified Flow Rate	Purification	Recovery	System Pressure Drop	Energy Used by System to Purify
600	0.5 GPM	>90%	>60%	18 PSI	~1 WH/GAL

Table 3. Performance data for Demonstration Unit

An Idea Whose Time Has Come

The FTC is a highly efficient means of reducing the TDS of an input water supply. It can truly be considered an appliance as the unit runs with little or no regular maintenance, requires no chemicals, and does not scale. Lifetime testing has shown the FTC to be a robust and reliable means of TDS reduction, with the ability to remove “problem” contaminants. The potential applications include POE purification such as whole house softening, POU purification such as under counter/sink water, industrial level TDS reduction of water, and any other application that can benefit from efficient chemical-free TDS reduction.