

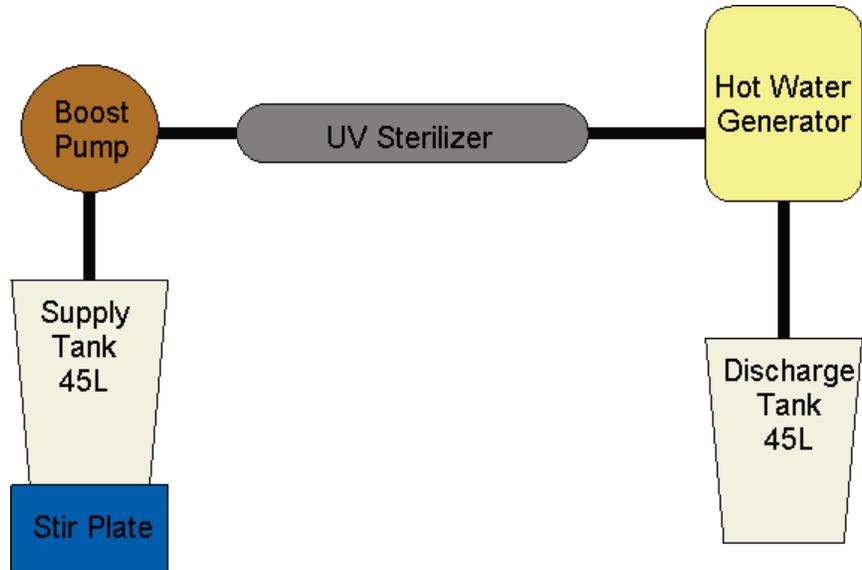
# Breakthrough Technology



**University of South Florida - Center for Biological Defense**  
**Eco-4 Project - Anti-Microbial Effect of UV/Far InfraRed Water Treatment System on E. coli K-12**

**MATERIALS:**

**UV/FIR Water Treatment System 4 gallons/min (15.14 L/min) Hot Water Generator (HWG) – modified to use 120V 15 gallon/min (56.78L/min)**  
**UV Sterilizer 20 L/min Hot Water Boost Pump Intake and Connections**  
**- 5/8" ID Clear Vinyl Tubing Discharge - 0.375" ID Silicone Tubing**



**Set-up:**

Supply tank, boost pump, UV Sterilizer, and Hot Water Generator connected by 5/8" ID Clear Vinyl Tubing. Discharge tubing connecting HWG to discharge tank is 0.375" ID silicone tubing.

Flow Rate: 5238 mL/min

Transit time (Supply intake to discharge): 30 sec

Temperature increase: 12 oF (6.6°C)

Temperature Range: 71oF (21.7°C) to 83°F (28.3°C)

**Methods:**

E coli K-12 was grown in Tryptic Soy Broth overnight at 35°C resulting in an OD600 of 0.5 to 0.6 and a final concentration of approximately 3.5x 10<sup>9</sup> CFU/ mL.

Eight to 80 mL of overnight bacterial culture were added to 40 Liters of de-ionized water in the supply tank with constant stirring.

Pump primed and placed into supply tank. UV/FIR Water Treatment System 4 gallons/min (15.14 L/min) Hot Water Generator (HWG) – modified to use 120V 15 gallon/min (56.78L/min) UV Sterilizer 20 L/min Hot Water Boost Pump Intake and Connections  
- 5/8" ID Clear Vinyl Tubing Discharge - 0.375" ID Silicone Tubing

Assay conducted as follows:

T=0 min	Start	Start Pump	
T=1 min	Control sample		Collect -UV/-FIR sample, start UV
T=2 min	UV only sample		Collect +UV/-FIR sample, start HWG
T=3 min	UV + FIR sample		Collect +UV/+FIR sample, turn off UV
T=6 min	FIR only sample		Collect -UV/+FIR sample, turn off HWG
Decon system			



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## Water Quality Testing

Water was analyzed by standard EPA water testing methods, SM 9222 B - Membrane Filter Method for the Enumeration of Total Coliforms. In brief, serial dilutions of each sample were filtered through 0.22 micron filters and the filters were incubated on m-Endo agar, overnight at 35 °C. Plates from each dilution were counted and the mean CFU/mL determined.

Results:

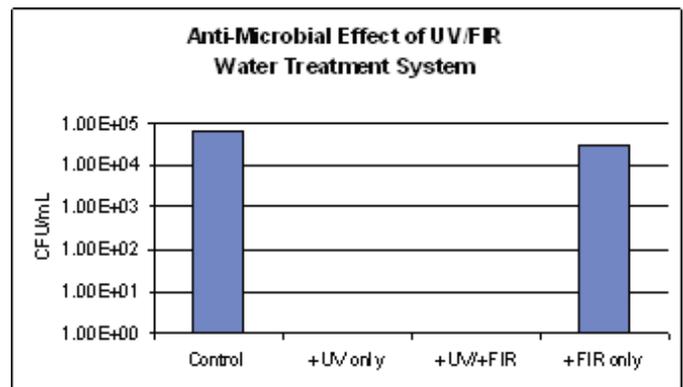
Colony Forming Units per Milliliter (CFU/mL)

	Control	+UV only	+UV+FIR	+FIR only
Mean	$6.29 \times 10^4$	1.08	0.206	$2.88 \times 10^4$
Std Dev	$1.57 \times 10^3$	0.935	0.185	$1.08 \times 10^4$

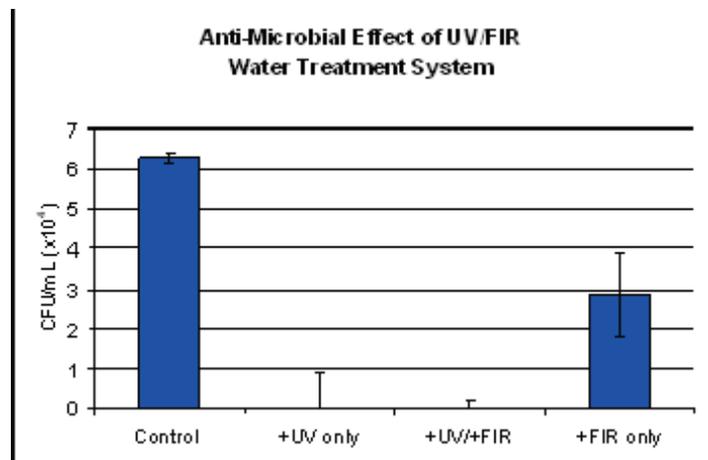
*This assay was repeated three times to produce the data within this report. All three results were similar.*



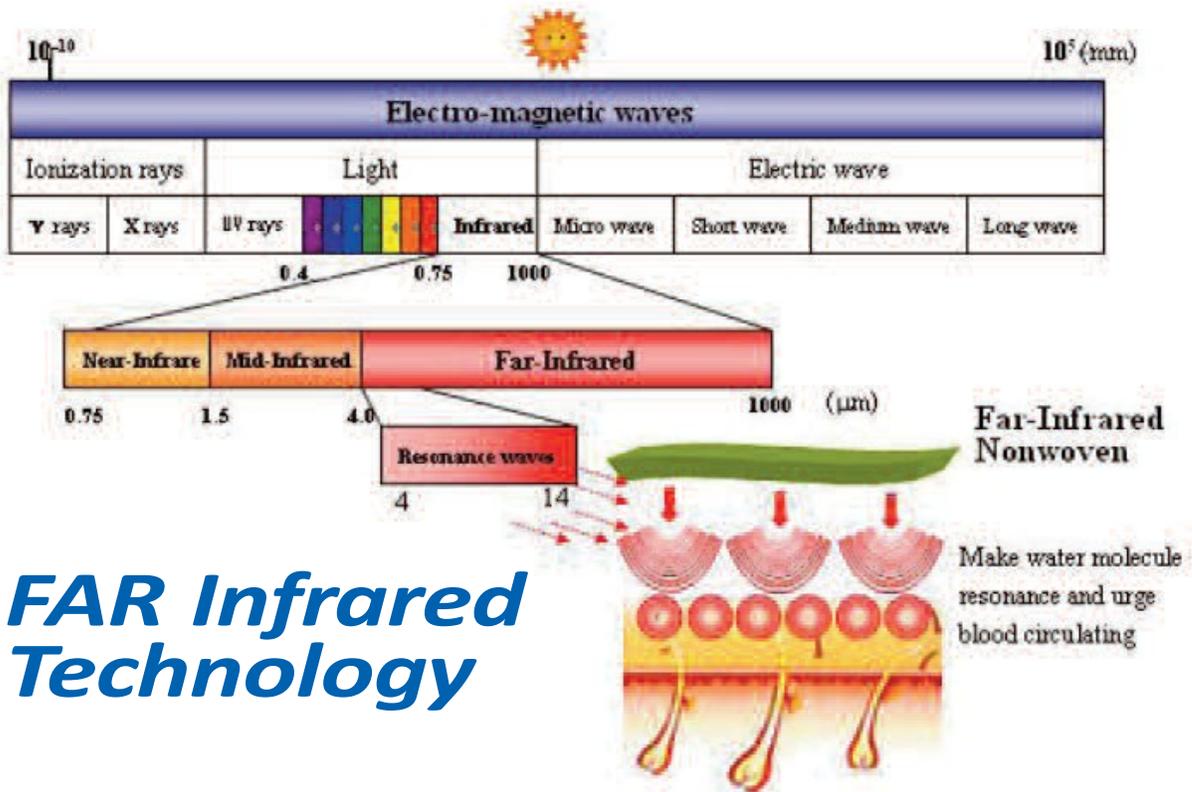
*These results indicate that both the UV sterilizer and the UV/FIR combination treatment consistently result in a significant log reduction of viable CFUs. The UV treatment alone resulted in a 4.5 log reduction from control levels and the combination UV+FIR had more than a five log reduction. The effect of the FIR alone is much less than that of the UV however it may be of significance. Looking at the results more closely in the 10<sup>4</sup> range does show a consistent, albeit small, 0.2 to 0.3 log reduction in CFUs from the FIR alone.*



*This taken in conjunction with one log increase in anti-microbial effect observed when the UV and FIR are used in conjunction leads me to believe that the FIR may well have an independent anti-microbial effect. Whether this is due strictly due to the increase in temperature is unknown at this time, however since the maximum water temperature measured during these assays was 83°F (28.3°C) it is possible that the effect is more than simply a 12 °F (6.6°C) rise in water temperature. To be certain a direct comparison of HWG vs. Standard water heating would need to be tested.*



# Is Far Infrared Safe?



## FAR Infrared Technology

### What is the effect of Far Infrared Rays?

**FIR cause resonance with water molecules. It ionizes and activates water molecules in our cells and blood thus, improving our blood circulation and health condition. The human body contains more than 70% water by weight.**

