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Low-Frequency Electromagnetic Field Pipe

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Abstract: *An increase of pathogenic bacteria (E. coli) in river water is a concern as it is the main precursor to health hazard disinfection in conventional drinking water treatment systems. To date, many treatment methods for the removal of E. coli have been introduced in treatment plants and proved effective for bacteria removal. However, there is no information about non-ionising radiation applications in water treatment plants in Malaysia. Therefore, this study develop the new technique to remove Escherichia coli (E. coli), and reduce the concentration with low-frequency electromagnetic fields (LF-EMF) as a component of the non-ionising radiations in the river water. This prototype design and construct a LF-EMF device on horizontal coiled pipe that were capable of producing uniform magnetic fields in the frequency range of 50 Hz. A magnetic field density was varied at 2, 4, 6, 8, and 10 mT. The diameter of pipe was 50 mm, which underwent 6 hours of LF-EMF exposure at 50 mL/min of water flowrates. The maximum removal efficiency of E. coli in was 100% at 6, 8, and 10 mT of magnetic field exposure. These results indicated that the E. coli in the sample of water that was exposed to the LF-EMF was statistically significantly decreased. The magnetic intensity of the LF-EMF changed the characteristic responses for E. coli bacteria.*

Keywords: electromagnetic field, low-frequency, E. coli, river water

1. Introduction

Clean and safe water is one of the most pressing global health-affecting and environmental issues. Generally, in Malaysia, surface water is exposed to organic, inorganic, and microbial pathogen contamination due to poor management of septic tanks, wastewater, and agricultural runoff and earthwork products. According to the Department of Environment (DOE) Malaysia's annual report, 48% of the 473 rivers monitored in 2014 have been contaminated by these sources. This poses more challenges to the authorities in delivering and providing safe drinking water via the conventional treatment system because of the low surface water level, and high pollutant loads. Therefore, to ensure a stable and safe drinking water supply, alternative methods for water management are necessary especially during extreme weather conditions. This product has been developed with an efficient method that capable to remove the E. coli using new application techniques.

Chlorine, chlorine dioxide, ozone, and chloramines are, so far, the most common bacterial and chemical disinfection agents in the drinking water process. These chemicals are powerful oxidants that oxidise the organic matter naturally present in water, and kill harmful microorganisms effectively. However, chemical disinfection processes may pose a potential risk to consumers, and also produce disinfection by-products that are residually present in the

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finished drinking water. Based on previous studies, improvement techniques and systems can be produced by using low-frequency electromagnetic fields (LF-EMF) for the treatment of water to make it free from photogenic microorganisms.

LF-EMF are a component of the non-ionising radiations used to treat and control the effective growth of E. coli bacteria. Application of the LF-EMF on the E. coli bacteria has shown that exposure to non-ionising, electromagnetic radiation can induce numerous and quite varied removal effects. Due to the capability of LF-EMF to remove the E. coli bacteria, this application was introduced as an alternative technique of E. coli removal in drinking water treatment. Therefore, evaluating this LF-EMF product effects on the river water is important to determine its effectiveness for the removal of E. coli in drinking water supply. The ability of LF-EMF to remove and decrease the concentration of E. coli in the river water samples was successfully demonstrated using this product.

The low-frequency electromagnetic field pipe (LF-EMFP) was developed using ANSYS Maxwell software to generate and analyse the magnetic field. Design and simulation of the LF-EMFP visualised the magnetic field flux for the removal of E. coli. Based on the results, LF-EMFs were able to kill a part of the E. coli, and decreased the concentration by magnetic field exposure. This LF-EMFP product proved its capability to remove and control the growth of E. coli with magnetic field exposure. The effect of the magnetic field in the removal of E. coli by using an LF-EMFP was validated with experimental results. The experiments were carried out to study the removal of E. coli in coiled pipe. The optimal percentage of E. coli removal at 6 hours exposure 100%, respectively. This result indicates that the application of this product is able to remove 100% of E. coli. Thus, this product provided better technique to control the growth of E. coli in the water and improve surface water quality.

2. Objective

This product had been developed and apply a low-frequency electromagnetic field for E. coli removal in the water. Hence, the aims of this product is:

1) To determine the removal rate of E. coli using LF-EMFP.
2) To evaluate the optimal LF-EMF contact time and magnetic field intensity parameters for the removal of E-coli.

3. Novelty

LF-EMFP is a new technique to remove pathogenic bacteria such as E. coli in water using LF-EMF. It’s also non-chemical and non-ionising technique to increase the quality of water.

4. Usefullness

This Product provides the enhancement of technique in the water treatment using non-destructive disinfection systems. LF-EMFP also introduced an alternative technique of E. coli removal in the water and proposed LF-EMF effectiveness for the removal of E. coli in drinking water supply.

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5. Conclusion

An increase of pathogenic bacteria (E. coli) in river water is a concern as it is the main precursor to health hazard disinfection in conventional drinking water treatment systems. LF-EMFP is a new method that introduce non-chemical techniques and natural treatments in Malaysia. It's also a new technique and practical in water treatments for bacteria removal to ensure the safety of drinking water.

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