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Research Article
Improve Kinetic Degradation Fluxion Filter Performance for Sterilization of Drinking Water by Magnetic Technique

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Abstract

Background and Objective: Water contamination is a common problem to all over the world. These may be geological or anthropogenic (man-made), so higher levels of contaminants in drinking water are seldom to cause acute health effects. The aim of this research is includes linking a magnetic system with a filter to enhancing the effect of Kinetic Degradation Fluxion (KDF) as sterilizing the effectiveness of this filter in the elimination of pathogenic organisms form drinking water. **Materials and Methods:** Used polluted laboratory water by using *E. coli* with counts (1.5×10^8 CFU mL^{-1}) showed physicist activity with property magnetic effect which effectively reducing the impact of some of these objects by 25% by using density of magnetic 3000, 6000 and 9000 gauss, as well as for the chemical activity of KDF, redox, oxidation and reduction also have an effect on the oxidation of organic ingredients in the water and reduce the impact by using 3 columns with length (7, 9 and 12 cm) and flow rate (0.2, 0.4 and 0.8 L h^{-1}). **Results:** When expose bacterial cell to only magnetic field with magnetic density 6000 gauss, the output of bacterial cell is 44 CFU mL^{-1} and when expose bacterial cell to only KDF with column length 7 cm, the output of bacterial cell after exposed is 8 CFU mL^{-1}, but the best treatment showed when it mixed both techniques with output bacterial cell become 2 CFU mL^{-1}. **Conclusion:** The results showed a very high efficiency of such filters with magnetic system to remove the number of bacterial cells and reduce risks to drinking waters to obtain sterilized water at range of 90%.

Key words: Kinetic degradation fluxion, water disinfection, magnetic field, water treatment, radox, oxidation, reduction

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The contamination of drinking water by bacteria is one of the problems facing consumers for drinking water. The only way to verify the existence or absence of water samples from bacteria is by examining the water samples in the specialized laboratories and ensuring that they conform to the specifications of drinking water set by international organizations such as the World Health Organization (WHO) and the Environmental Protection Agency (EPA), the presence of all types of bacteria is not considered to be a dangerous place, but focuses only on pathogenic bacteria, especially intestinal, which is an indicator of the presence of other pathogens that cause many diseases such as gastrointestinal infections, dysentery, hepatitis, typhoid fever and cholera[1].

Now sterilization is different which includes chemical and physical methods to kill bacteria and other pathogenic microorganisms that may be present in water that infect humans in several diseases, most sterilization processes are accompanied by the emergence of other compounds as a result of Disinfection by Products (DBPs) in water sources and from these substances, compounds called triglyceride halo methane. The chlorine is known as the main chemical sterilizer used in sterilization of drinking water since 1908. It has been used as an effective sterilizer and has so far helped to reduce the transmission of epidemics and diseases that are major cause of the water where the spread exceeded penicillin and antibiotics other in the preservation of the lives of people[2].

Kinetic Degradation Fluxion (KDF), which is a key product of many filtration systems can be used together with other products to provide highly efficient filtration. This technique can be incorporated with carbon filters for control of bacteria. This technique with magnetic systems become the magnetic field and changes the properties of water, which prepares the water before entering the filter KDF[3]. The KDF is characterized by high purity material including Copper and Zinc alloy (50% Cu, 50% Zn). It is used in a water treatment unit where a process known as the process of oxidation and reduction. Reduction process is a reaction of transfer the electrons between molecules in some cases, such as free chlorine and in this transport are benign substances such as chloride, which passes through the filter [4] as in Fig. 1. The field of oxidation is a deadly environment for some microorganisms. It creates free radicals; hydrogen peroxide (H_2O_2) and hydroxyl (OH-) affect the ability of organisms to work[5]. The general shape of the KDF used in the rest of research by using X-ray for analysis of KDF which have been carried in the laboratory of the Department of Chemistry and Materials Physics. The chemical and physical properties of Kinetic Degradation Fluxion (KDF) is Zn and CU 50%. Particle size range (0.149-2.00 mm), apparent density (2.4-2.9 g cc^{-1}) and physical form is granular[6]. Many researchers studied the effect of magnetized water and the magnetic field on microorganisms. The effect of magnetic field strength on properties was studied. Also, the exposure of *Serratia marcescens* to the magnetic field was strongly observed at the range of 20-80 gauss inhibiting the growth of bacteria[7]. It was also found that the exposure of *Salmonella typi* to a magnetic field 10-20 gauss inhibited the growth of bacteria[8].

The KDF has made achieved progress in water treatment technology, which works according to the basic process known as oxidation and reduction. It is a new and unique method in water treatment. Many water treatment systems such as; RO and deionization water are the most widely used systems. When using a KDF filter with these systems, it improves the performance of these systems. These systems work better and provide protection for the membranes and ion exchange that occurs when water is produced (ANSI/NSF Standard 42)[9].

Oxidation and electrochemical absorption reduce or eliminate many undesirable pollutants from water. The KDF fluid treatment's are unique combination of Copper and Zinc creates an electro-chemical reaction. During this reaction, electrons are transferred between molecules and new elements are created. Some harmful contaminants are changed into harmless components. Free chlorine for instance is changed into benign, water-soluble chloride, which is then carried harmlessly through the water supply as a multi-functional medium with superior ability to remove chlorine from drinking water and reduces heavy metals and bacteria from water treatment units[10].

The effectiveness of this substance is influenced by the design factors of the candidate such as; the flow rate and surface area of the substance itself and the thickness through which the time of detention or traffic is determined[11].

This material is considered as environment friendly, it can be washed in reverse back wash to reactivate and reuse for other purposes and the operating life is longer than the rest of the medium used in multilayer filters.

Fig. 1: Kinetic Degradation Fluxion (KDF) material using in filter

The Environment Protection Agency (EPA) has considered KDF as one of the materials, which are used in elimination of biogenic pollutants (algae, fungi and bacteria)[12].

This study aims to improve the quality of filters and reduce environmental pollutants to protect human health and save the environment, hence a layer of a chemically active material called Kinetic Degradation Fluxion (KDF) was added to work with magnetic system. This filter is a combination of Copper and Zinc granules at a certain rate and high purity and it helps increasing filters' effectiveness in the elimination of soluble pollutants with magnetic field. In addition, the study aims to determine biological organisms in water.

MATERIALS AND METHODS

The study was carried out at Chemical and Microbiology Laboratory, Water and Environment Directory in Ministry of Science and Technology of Iraq from January-November, 2019. The lab tested and disinfection system consists of a (20 L) container, a pump, magnetic system and KDF filter as shown in Fig. 2(a, b). The system used in the experiments is a 20 L plastic tank that was connected to a 6 mm plastic pipe. In order to transfer the water to the rest of the system, a Diaphragm electric pump was used with an 1.2 L m^{-1} flow rate to pull water out of the tank. The flow rate is controlled by connecting the valve at the start of water discharge from the pump (0.2, 0.4 and 0.8 L h^{-1}). It is then passed by a tissue filter to reduce the impurities and then the magnetic system.

The magnetic system is a set of upper and lower magnets that pass through the water. The lower magnets are stationary and the upper is mobile to control the magnetic field. Three intensities (3000, 6000 and 9000 gauss) are used. After the water is flow out of the system, it passes to the KDF filter, which is used for 3 depths (7, 9 and 12 cm).

The water used in this experiment was prepared in a laboratory where it was polluted by bacteria type (*Esherichia coli*). In the experiment, different flow rates were tested to show the effect of the filter and the magnetic system on bacterial removal.

Escherichia coli was isolated according to standard method 9260-F APHA[9] of the final discharge water of the Baghdad Educational Hospital discharged to the Tigris river. A bacterial decomposition was performed to measure the bacterial density. The bacterial suspension tube was compared with the 0.5 no. of McFarland solution tubes containing 108×1.5 CFU mL^{-1}, which gave a spectra of 0.1 wavelength of 450 nm when measured with a spectroscopy device[13]. In addition, bacterial suspension to 20 L of sterilized distilled water used and mixed It is good to serve as a dedicated drinking water after it has been tested (Q = total number of bacteria). Total plate count for the number of repeaters which was 45, 38 and 59 cells mL^{-1}, respectively, according to the Iraq standard for drinking water for the year 2011, which states that the total number of aerobic bacteria[9] by 100 cells mL^{-1}. The data is analyzed by using Analysis of Variance (ANOVA).

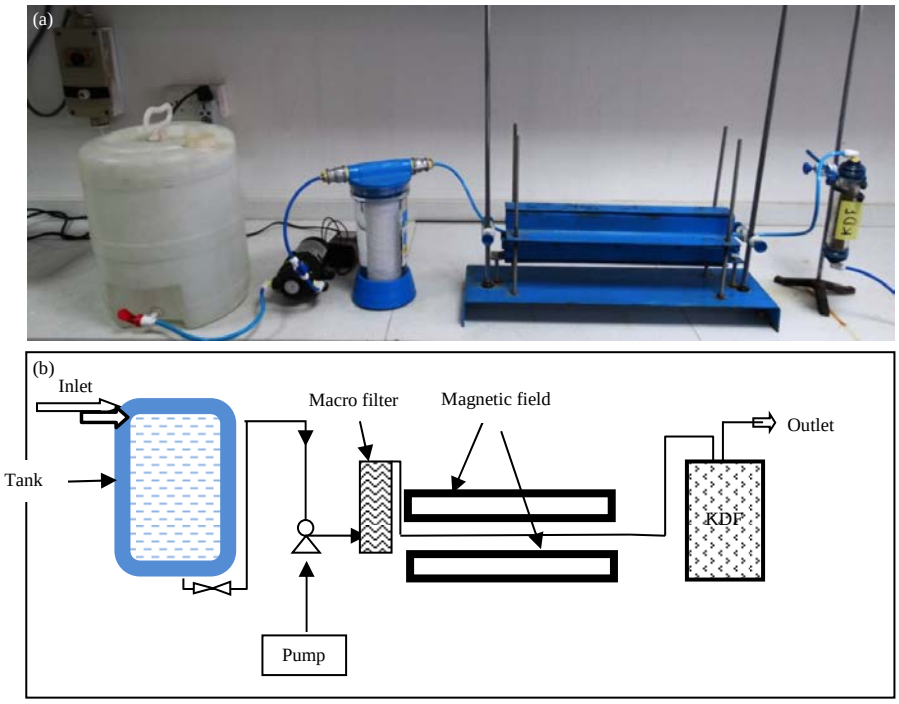

Fig. 2(a-b): (a) Magnetic field system with the KDF filter and (b) Diagram of magnetic field and KDF filter

RESULTS AND DISCUSSION

Distilled, sterilized water (20 L) was used and added bacterial contamination at a concentration of 59 CFU mL^{-1} for distilled water. In the first experiment, it was emitted through a magnetic system consisting of three magnetic fields. In the second experiment it passes on the KDF filter. Table 1 shows that the combination of the two techniques get best results. However, magnetic field in water treatment is a simple physical treatment. It is conducted by flowing water through magnetic fields by Baker and Judd[14]. They suggested that the magnetic fields able to change the electron configuration and coordination of the water ions. Besides, they also summarized that magnetic fields can also affect in zeta potential and dissolution. Many researchers such as; Baker and Judd[14] and Gehr *et al.*[15] claimed that due to the characteristic of magnetic fields, it can change the physicochemical properties of the particles that exposed to it. According to Beruto and Giordani[16], the magnetic fields able to redistribute the surface charge of the particles or molecules when it passing through the magnetic fields. Therefore, this phenomenon will enhance the coagulation and precipitation of the particles[17].

In Fig. 3, the magnetic intensity used in this experiment was 6000 gauss the length of the filter column was clearly seen as 7 cm. Figure 4 represents a relationship between the number of bacterial cells and the flow. They were used 3 magnetic intensities in the form of gauss in Fig. 4a (9000 gauss), Fig. 4b was 6000 gauss, in Fig. 4c the intensity was 3000 gauss and the filter column KDF was constant in these cases at a height of 7 cm.

Figure 5 shows the relationship between the number of bacterial colonies with three values for the depth of the KDF column in the filter.

Experiments were carried out on water prepared *in vitro* using a filter containing KDF in the presence of magnetic field to sterilize water. Creating a large voltage in the bacterial environment, as this effort will overwhelm the natural efforts that are mainly in the center of these small cells, affecting the flow of ions through the cell wall and loss of control[18]. The passage of ions through the cell wall is associated with many important cellular processes. This results in poor performance of the bacterial cell when it loses the ability to regulation

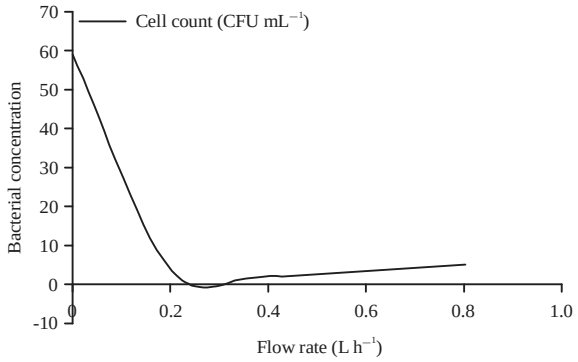

Fig. 3: Relationship between flow rate and bacterial concentration by using 2 technique, KDF at height 7 cm and magnetic field with intensity 6000 gauss

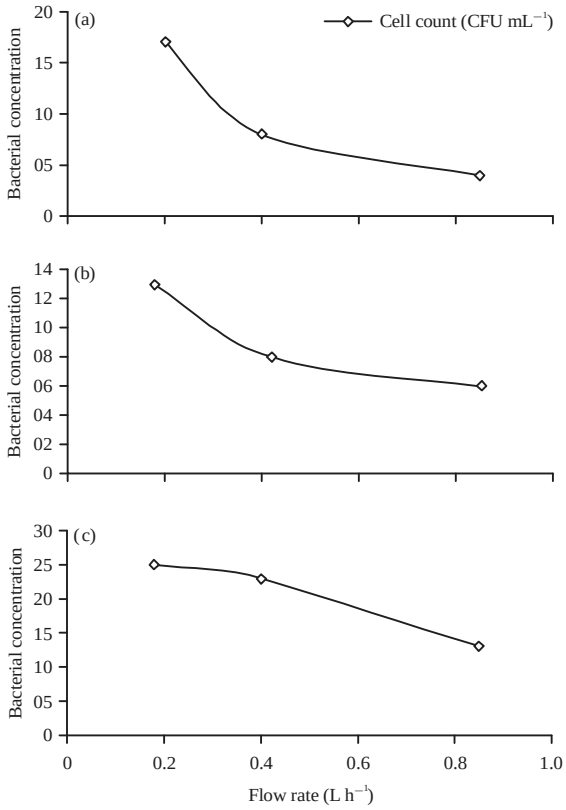

Fig. 4(a-c): Relationship between the numbers of bacterial colonies with the flow rate of 3 magnetic intensities (a) 9000 gauss, (b) 6000 gauss and (c) 3000 gauss

Table 1: Number of bacterial cells using magnetic therapy and KDF

Bacterial cell (CFU mL^{-1})	Flow rate 0.2 L h^{-1}	Flow rate 0.4 L h^{-1}	Flow rate 0.8 L h^{-1}
Magnetic field (6000 gauss)	50	48	44
KDF (7 cm)	20	8	10
Magnetic field (6000 gauss) and KDF (7 cm)	4	2	5

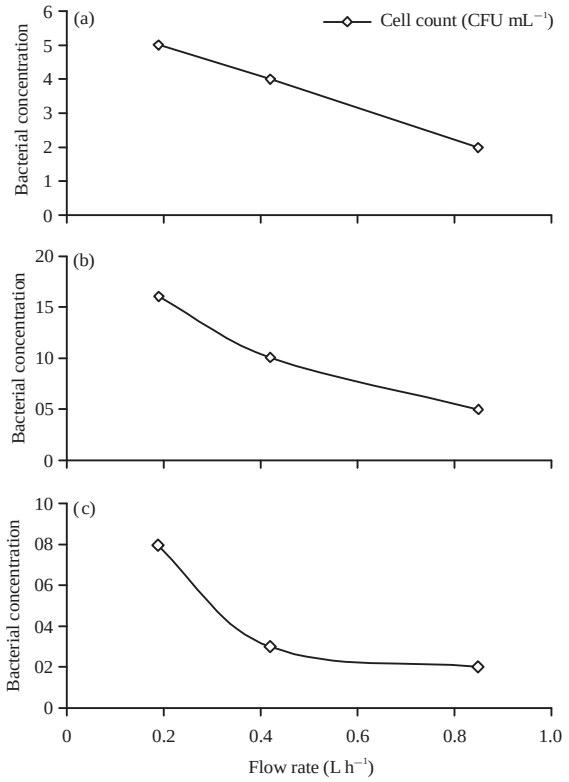

Fig. 5: Relationship between the numbers of bacterial colonies with (a) 7 cm, (b) 9 cm and (c) 12 cm for the height of the KDF column in the filter

flow during the bacterial cell wall and also loses the ability to extrusion. This is one of the main causes of bacterial cell weakness[19]. The concentration of the hydrogen ion is increased and therefore it is unable to release the ions into the outer medium. Therefore, the pH will decrease inside the cell. This will lead to poor performance and when it decreases, it will lead to its death. This is caused by *E. coli*, which is exposed to the magnetic field (1200-3000 gauss). The decline in the number of colonies[20]. The effectiveness of the KDF filter is that the electrons are exchanged with the pollutant i.e., process of giving and taking.

In the KDF filter, the transmission of the electron is impaired, causing damage to the cells. The bacteria are killed by direct electrochemical contact and form flashes of hydroxyl and hydrogen oxide roots, both of which interfere with the ability of the organisms. Also, when the flow rate is increased, sterilization is better as the particles of water inside the magnetic field are bombarded at a higher speed, so some of the physical properties affecting the sterilization process are better changed[21].

CONCLUSION

The high strength of the magnetic field gave the best results of the treatment of a few stresses with KDF filter and high flow rate. This technique has been able to affect bacteria in contaminated water, so it is recommended using magnetic technology with KDF filters and conducting various experiments using multiple magnetic systems to reach the best results.

SIGNIFICANCE STATEMENT

This study discovers the possible synergistic effect of KDF filter and magnetic field system combination that can be beneficial for sterilization drinking water from bacterial contamination. This study will help the researcher to uncover the critical area of two techniques together to reduce pollution by bacteria (*Esherichia coli*) from water that many researchers were not able to explore. Thus, a new theory on these sterilization drinking water and possibly other combinations, may be arrived at.

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