

Magnetized Water and Its Effects on the Reduction of the Microbial Content of Sewage Wastewater

*Sufyan Mohammed Shartooh **Khalid Abbas Rasheed
Ahmed Abdulameer Hadi *Ahmed Jasim Mohammed
*Ahmed Aladeen Abdulmajeed

*Ministry of Science and Technology - Directorate of Waste Treatment and Destruction/ Baghdad – Iraq

**Al-Nahrain University – Biotechnology Research Center / Baghdad – Iraq

*** National Investment Commission / Baghdad – Iraq

****General Secretariat for the Council of Ministers / Baghdad – Iraq

E-mail: dralwaisi@yahoo.com

Abstract

The pathogenic microorganisms in water cause a real parlous on human beings. The various types of sterilizers that used in water purification showed its failure to remove the spores of microbes, however, the computed magnetic densities showed the ability to remove these spores.

This study includes the enumeration of Coliform, Faecal Coliform, Streptococci, Faecal Streptococci bacteria and total bacterial count in sewage wastewater, the experimental tests show the ability of different magnetic flux densities 500, 1000 & 1500 G to reduce all types of bacteria under study with retention time of 10 min. and 20 min. Results showed that the bacterial contents were reduced by increasing the magnetic field densities. The study recommended the effectiveness of this technique and the ability to use it in water purification units.

Key words: Coliform, Streptococci, Magnetic Water treatment and Wastewater.

المياه المعالجة مغناطيسياً وأثرها في خفض المحتوى الميكروبي لمياه الصرف الصحي
*سفيان محمد شرتوح * خالد عباس رشيد ** أحمد عبد الأمير هادي *** أحمد جاسم محمد
* أحمد علاء الدين عبد المجيد

*وزارة العلوم والتكنولوجيا – دائرة معالجة وإتلاف المخلفات / بغداد – العراق

**جامعة النهدين – مركز بحوث التقنيات الإحيائية / بغداد – العراق

***الهيئة الوطنية للاستثمار / بغداد – العراق

****الأمانة العامة لمجلس الوزراء / بغداد – العراق

الخلاصة

تشكل الأحياء المجهرية الممرضة في المياه خطراً كبيراً على صحة الانسان، وتظهر الأنواع المختلفة من المعقمات المستخدمة في تصفية وتعقيم المياه فشلها الواضح في القضاء على الطور السبوري لها. ولكن عند استخدام المجال المغناطيسي وبشدهات محسوبة تبين إمكانية التخلص من هذه السبورات إضافة إلى الطور الخضري. شملت الدراسة الحالية حساب أعداد بكتريا القولون والقولون البرازية وبكتريا المسبقيات والمسبقيات البرازية، كما تم التحري عن العدد الكلي للبكتريا في عينات مياه الصرف الصحي. لوحظ من خلال التجارب المختبرية إمكانية إحداث أكبر خفض ممكن لأعداد البكتريا بشدهات مغناطيسية مختلفة هي 500، 1000، 1500 كاوز وبزمني إستبقاء 10 و 20 دقيقة ولجميع أشكال البكتريا ضمن الدراسة الحالية. بينت النتائج أن أعداد البكتريا تنخفض عند زيادة شدة المجال المغناطيسي بأطول فترة، كما أوضحت الدراسة فاعلية التقنية المغناطيسية وإمكانية استخدامها في وحدات التصفية.

الكلمات المفتاحية: بكتريا القولون، بكتريا المسبقيات، المياه المعالجة مغناطيسياً ومياه الصرف الصحي.

Introduction

Man-made magnetic fields have become a part of our biosystem. Studies of the biological effect of strong magnetic field have been intensified in recent years due to its possible harmful or beneficial effects on many eukaryote organisms, including human beings (Emura *et al.*, 2003; Iwasaka and Ueno, 2003; Schiffer *et al.*, 2003). Magnetic spread on the whole earth prepared to serve human and his benefit, but living organisms have to adapt themselves to this new factor, which can influence some of their biological functions.

Many researches concerning this topic have been published in the last 20 years. At first, they were focused on the epidemiology and the question if there is an increased cancer risk in people living or working near power-lines (Pearce *et al.*, 1989; Feychting and Ahlbom, 1993). The results were controversial. Thus, the effects of magnetic fields on smaller biological objects started to be investigated during the last decade. Previous studies found that the strong static magnetic fields had an apparent effect on insect egg hatching which was delayed by the strong static magnetic fields and the delay non-linearly increased with the intensity of the magnetic field (Pan and Liu, 2004). A relatively simple living organisms, bacteria are important research subject in this field too. In a study by Kohno *et al.* (2000) on the effect of static magnetic field on bacteria *Streptococcus mutans*, *Staphylococcus aureus* and *Escherichia coli*. they found that the ferrite magnet caused strength-dependant decreased in the growth rate. Another study by Stansell *et al.* (2001) found that exposure of *E. coli* to static magnetic field significantly increased its antibiotic resistance. The magnetic researches had many studied objects such as; cells (Monti *et al.*, 1991; Scarfi *et al.*, 1997), tissues (Schimmelpfeng and Dertinger, 1993), living organisms (Hones *et al.*, 1998), the viability and proliferation (Davis, 1996), activity of enzymes (Xie

et al., 1997), transport of ions (Galvanoskis and Sandblom, 1998) and gene transcription (Phillips *et al.*, 1992) were investigated. However, a good subject for the study of magnetic field effects can be bacteria (Berg, 1999; Strasak *et al.*, 2002).

In this study, we compare magnetic field effects on four bacterial groups; Coliform, Faecal Coliform, Streptococci and Faecal Streptococci in sewage wastewater, and our choice of this bacteria was supported by the facts that these bacteria are within easy reach and they can be breed at a temperature of 37°C.

Materials and Methods

All experimental methods were achieved following the instructions described in (Abbawi and Hassan, 1990; APHA, 1998).

Samples of sewage wastewater were collected from Al-Rustumia wastewater treatment plant in Baghdad city / Al-Rusafa. The enumeration of Coliform, Faecal Coliform, *Streptococci* and Faecal *Streptococci* was investigated employing the "Most Probable Number" method by the use of MacConkey broth and Sodium azide broth for both Coliform and *Streptococci* bacteria respectively, the bacterial count was reduced by the use of probability tables. Also, the total count of bacteria was investigated using "Pour Plate Count" method, after the well shaking of wastewater samples to ensure the bacterial uniformly distribution. However, the results were read by colony counter within the application of:

$$\text{Total bacterial count} = \text{Number of colonies} \times \text{Dilution inverse}$$

The previous bacteriological tests were taken in triplicates for each sample and the obtained result mean was represented in bacterial count in tested water samples, the bacterial enumeration was described by the bacterial count before and after exposure to the required magnetic densities.

Water samples under study were magnetized by three densities measured

by Gauss-meter, these densities were 500, 1000, 1500 G using fixed magnetics connected to a plastic pipes by passing water samples (not less than 100 ml) through pipes including the required magnetic densities at dual retention time (10 and 20 min.), the reduced bacterial count percentage was calculated after the exposure to magnetic densities within 20 min.

Results and Discussion

It seems clearly that increasing magnetic field density values have significant effects upon the growth ability of all bacterial types under study. But higher reduction ratios of bacteria were occurring at magnetic field density of 1500 Gauss in retention time of 20 min. for all tests.

For Coliform bacteria the microbial growth was found to vary from 240×10^3 cell/100 ml in 500 G of 10 min. retention time to 75×10^3 cell/100 ml in 1500 G of

20 min. retention time (table 1). while for Faecal Coliform bacteria the growth mean values were varied from 150×10^3 cell/100 ml in 500 G of 10 min. retention time to 28×10^3 cell/100 ml in 1500 G of 20 min. retention time in a reduction ratio of 86.7% from the initial bacterial count (210×10^3 cell/100 ml) before exposure to magnetic field (Table 2). In Moreover case of *Streptococci* bacteria, higher reduction ratio was found at a magnetic density of 1500 G for 20 min. retention time which reached 90 % (Table 3). The mean values were varied from 120×10^3 cell/100 ml in 500 G of 10 min. to 15×10^3 cell/100 ml in 1500 G of 20 min. retention time. However, the reduction ratio was increased up to 96 % in case of Faecal *Streptococci* bacteria, and the mean values were varied from 64×10^3 cell/100 ml in 500 G of 10 min. to 3×10^3 cell/100 ml in 1500 G of 20 min. retention time (Table 4).

Table (1) The Coliform Count Number of Different Magnetic Densities at Dual Retention Time

Magnetic field density (Gauss)	Bacterial initial count before exposure	Retention time 10 min.	Retention time 20 min.	Reduction percentage
500	460×10^3 cell/100 ml	240×10^3 cell/100 ml	150×10^3 cell/100 ml	67.4 %
1000	460×10^3 cell/100 ml	150×10^3 cell/100 ml	93×10^3 cell/100 ml	79.8 %
1500	460×10^3 cell/100 ml	120×10^3 cell/100 ml	75×10^3 cell/100 ml	83.7 %

Table (2) The Faecal Coliform Count Number of Different Magnetic Densities at Dual Retention Time

Magnetic field density (Gauss)	Bacterial initial count before exposure	Retention time 10 min.	Retention time 20 min.	Reduction percentage
500	210×10^3 cell/100 ml	150×10^3 cell/100 ml	93×10^3 cell/100 ml	55.7 %
1000	210×10^3 cell/100 ml	120×10^3 cell/100 ml	75×10^3 cell/100 ml	64.3 %
1500	210×10^3 cell/100 ml	48×10^3 cell/100 ml	28×10^3 cell/100 ml	86.7 %

Table (3) The Streptococci Count Number of Different Magnetic Densities at Dual Retention Time

Magnetic field density (Gauss)	Bacterial initial count before exposure	Retention time 10 min.	Retention time 20 min.	Reduction percentage
500	150×10^3 cell/100 ml	120×10^3 cell/100 ml	93×10^3 cell/100 ml	38 %
1000	150×10^3 cell/100 ml	64×10^3 cell/100 ml	39×10^3 cell/100 ml	74 %
1500	150×10^3 cell/100 ml	23×10^3 cell/100 ml	15×10^3 cell/100 ml	90 %

Table (4) The Faecal Streptococci Count Number of Different Magnetic Densities at Dual Retention Time

Magnetic field density (Gauss)	Bacterial initial count before exposure	Retention time 10 min.	Retention time 20 min.	Reduction percentage
500	75×10^3 cell/100 ml	64×10^3 cell/100 ml	48×10^3 cell/100 ml	36 %
1000	75×10^3 cell/100 ml	28×10^3 cell/100 ml	15×10^3 cell/100 ml	80 %
1500	75×10^3 cell/100 ml	9×10^3 cell/100 ml	3×10^3 cell/100 ml	96 %

Table (5) The Total Bacterial Count of Different Magnetic Densities at Dual Retention Time

Magnetic field density (Gauss)	Bacterial initial count before exposure	Retention time 10 min.	Retention time 20 min.	Reduction percentage
500	500×10^3 cell/ ml	350×10^3 cell/ ml	270×10^3 cell/ ml	46 %
1000	500×10^3 cell/ ml	270×10^3 cell/ ml	200×10^3 cell/ ml	60 %
1500	500×10^3 cell/ ml	180×10^3 cell/ ml	110×10^3 cell/ ml	78 %

Regarding total bacterial count, magnetic field density of 1500 G was found to show the highest reduction ratio ability of bacteria that reaches 78 % in 20 min. retention time. Thus, we found that the number of Colony Forming Unit (CFU) decreases with the time of exposure, and the mean values of these counts were ranged from 350×10^3 cell/ml in 500 G of 10 min. to 110×10^3 cell/ml in 1500 G of 20 min. retention time (Table 5).

Our work has collected the results of magnetic field effects on the bacterial types under study, and we have compared the changes in the bacterial growth or (CFU) numbers after the magnetic field exposure as a function of the duration of the exposure time and the magnetic field induction. The data were compared with the control numbers of bacteria as it seen in the previous tables which shows that all the bacterial types under study react to the magnetic field in the same way.

From the previous results it seems obviously the direct effect of magnetic field on the bacterial cell, where the water forms the essential item of the bacterial cell structure (Atlas, 2005), as the magnetism densities may lead to the analysis and dissociation of the ionic contents of the cellular structure which have a direct impact on the microbial biological systems (Gaafar *et al.*, 2006), which can explains the clear reduction in bacterial numbers or (CFU) with increasing of magnetic intensity. However, the extreme increase in the

magnetic intensities does not mean necessarily an increase in the reduction of bacterial numbers especially when use changeable magnetic coils, because the thermal effect is greater than the magnetic effect which reduced the bacterial enumeration (Ma Haile *et al.*, 2003).

The question of how the magnetic field can kill bacteria is not solved by our experiments. The main theories that try to explain the biological effects of magnetic fields are based on the possible effect of electromagnetic field on the permeability of the ionic channels located in the cell membrane. This can affect the ion transport into the cells and it can result in biological changes of the organism. The other possible effect is the formation of free radicals due to magnetic field exposure (Strasak *et al.*, 1998). The results obtained from the present study are in agreement with other studies such as (Fojt *et al.*, 2004; Gao *et al.*, 2005) on the effect of magnetic fields on the bacterial growth.

From the above findings it can clearly show the effectiveness of using the magnetic field technique to make a direct impact on the bacterial cell through the effect on the Ionic contents and the osmotic regulation of the microbial cell, which may lead to break down the cells. Therefore, it is possible to adopt this technique in the elimination of bacterial contamination in drinking water purification units.

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