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# PRODUCTION OF OXYGEN FROM AQUEOUS WATER USING THE PRINCIPLE OF INDUCED CURRENT

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## Abstract

*This is a fundamental research work aimed to investigate an alternative route other than the photosynthesis process where oxygen can be generated naturally and then accumulated in the atmosphere. The authors proposed a magnetosynthesis process for this investigation. This is a very important topic so that the real reason our atmosphere could accumulate sufficient oxygen for life can be reviewed. In addition, oxygen produced in this way may possess different* *properties other than that from photosynthesis. The lifestyle of living could be greatly improved in the case scientist could understand this method adequately. In this work, the authors utilised the advanced water filtration method so that majority of the original dissolved oxygen can be expelled away from tap water to the atmosphere. The water with low oxygen content was able to absorb as generated oxygen as dissolved oxygen in the filtered water. This can bring an indication for measurement once oxygen is generated by the magnetosynthsis process. The authors found that oxygen can be produced as dissolved oxygen when a stream of water flows through a magnetic field. Electrons shall be produced when moving aqueous water molecules flow through the magnetic field according to the principle of induced current. Oxygen shall be forced to free off from aqueous water molecules when they received electrons. A mechanism by which oxygen can be free off from water molecules is proposed in this work. When oxygen is produced, the oxygen shall dissolve in the water system until its solubility limit is achieved. Excessive oxygen exceeding the solubility limit is thought to escape to the atmosphere.*

**Keywords**

Aqueous Water, Dissolved Oxygen, Electron, Magnetic Field, Magnetosynthsis

## 1. Literature Review

The earth is surrounded by a layer of atmosphere that consists of enough oxygen to maintain its equilibrium. However, this amount of oxygen present in the atmosphere is believed to accumulate since the Great Oxygenation Event which was around 2.3 billion years ago during the Paleoproterozoic era (Gumsley et al., 2017). In the onset of the Great Oxygenation Event, cyanobacteria are believed to be the earliest living objects with chloroplast to perform photosynthesis (Schirrmeister, 2015; Rantamäki et al., 2016). Consequently, through this photosynthesis process, oxygen is believed to evolve and accumulate to a similar amount of oxygen as the present atmosphere.

While the photosynthesis process is a plausible and convincing earth oxygenation mechanism, the origin of the cyanobacteria is debatable. The earliest cyanobacterial fossil found is unambiguously 1.84 to 1.89 billion years old (Demoulin et al., 2019) when the Great Oxygenation Event has begun. Furthermore, there are also several studies (Anbar et al. 2007; Duan et al., 2010; Crowe et al., 2013; Planavsky et al., 2014; Tomkins et al., 2016; Ostrander et al., 2019; Hoashi et al., 2009) that point out the existence of an oxygenated atmosphere on the earth before the Great Oxidation Event which is much earlier than the age of the earliest cyanobacterial fossils found. According to these studies, significant amounts of minerals such as oxidized molybdenum (Anbar et al., 2007; Duan et al., 2010), rhenium (Anbar et al., 2007), chromium (Crowe et al., 2013), manganese (Planavsky et al., 2014; Ostrander et al., 2019) and iron (Hoashi et al., 2009) aged older than the Great Oxidation Event are found in the sea. These minerals can only be formed under an oxygen-rich atmosphere and mobilized to the oceans. Even in the upper atmosphere, the amount of oxygen is proposed to be similar to the amount of oxygen in the present day based on a study conducted by Tomkins et al. (2016) where ancient micrometeorites are found to have iron oxide particles embedded inside which are proposed to be oxidized while entering the oxygen-rich upper atmosphere much before the Great Oxidation Event.

Indeed, other oxygenation process or processes other than the photosynthesis by cyanobacteria were present according to the findings discussed in the previous paragraph. In this study, the authors proposed a new oxygenation mechanism to supersede the oxygenation mechanism using photosynthesis because the latter process involves the controversial onset of biological existence. Since this is a new proposal, there are no prior art reviews for the proposed mechanism. In this new mechanism, the authors showed that oxygenation happened primarily on the dissociation of water molecules when it moves through any magnetic field which shall postulate to include the abundance of the earth's magnetic field.

## 2. Introduction

The authors proposed a magnetosynthesis process to reveal oxygen available in the atmosphere should not only be synthesized from the photosynthesis process. The proposed mechanism in this study is proven able to produce oxygen from aqueous water molecules. The oxygen shall dissolve in the water readily when they are produced by the magnetic treatment according to Henry's law. Nevertheless, the maximum capacity of the water to dissolve oxygen is in the range of 6.5 to 8 ppm depending on the ambient temperature and pressure (Geng & Duan, 2010). It is thought that once the solubility limit of the oxygen in water is achieved, the excessive produced oxygen from the magnetically treated water shall be liberated to the atmosphere. When aqueous water (moisture) is available in the air, when the air and cloud are moving, the magnetosynthsis process is thought to occur to synthesis oxygen. This makes up the present oxygen content in the atmosphere.

## 3. Methodology

This work started with advanced filtration on normal tap water. Once tap water is filtered to drinking water quality and with low dissolved oxygen content, the proposed magnetosynthesis process were carried out. All samples of water; before filtration, after filtration and after the magnetosynthesis process was performed with advanced measurement on pH, conductivity, dissolved oxygen and the oxidative-reductive potential.

**3.1. Preparation of Materials, Apparatus, and Instruments**

In this research, it is vital to prepare magnetic materials with micron or nano sizes. The authors have selected iron oxides which are well known for their soft magnetic behaviour and the oxides are of pigment grade so that their particle size can be small to provide a maximum number of magnetic particles. The authors were used suitable apparatus to contain iron oxides so that magnetic particles can be in-placed to provide fixed sites of magnetic field for water treatment. After the water was treated with the described magnetic field, a few testing instruments were employed to obtain relevant data to support the proposed oxygenation mechanism.

**3.1.1. Materials**

A kind of magnetic material to represent any magnetic source was prepared in this study using micronized iron oxide particles (magnetite powder). The magnetite powder was prepared using the method described in a United States patent (Kin Onn Low, 2008) with the patent number US7347893B2 to provide the magnetic fields for the water treatment. The magnetite powder consists of 80 - 90 % $Fe_3O_4$ and 10 - 20 % carbon with other trace elements such as $SiO_2$, $Al_2O_3$, etc. The powder as described in the patent possessed pigmentation power to many kinds of engineering materials, such power elaborated in the patent has pointed the mean size of the powder to below 1 micrometre.

**3.1.2. Apparatus: Magnetic Treatment Device**

The apparatus to provide the magnetic treatment to the water was prepared by feeding magnetite powder (as prepared from Section 2.1.1) into a cylindrical container (base diameter of 6.5 cm and height of 20 cm) with an internal tubular hollow tube of 1 cm diameter at the centre of the container. The hollow tube was used to accommodate a foreign polyethylene tube with a 6.35 mm internal diameter as illustrated in Figure 1. This container was constructed using stainless steel SS304.

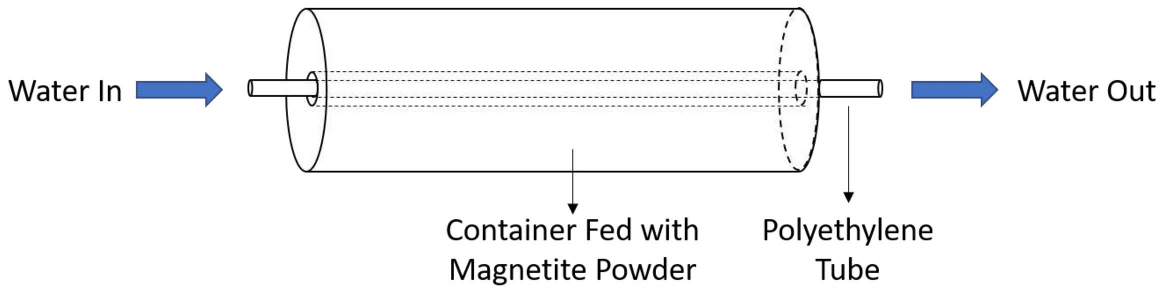



**Figure 1:** *Illustration of water flowing through the container fed with magnetite powder. (Source: Self sketching from the experimental setup.)*

### 3.1.3. Apparatus: Water Filtration System

A system of water filtration was prepared in this study so that a water source of sufficiently clean and low dissolved oxygen content can be obtained. This is essential because relatively clean water can avoid unnecessary disturbance to the final experimental results. Aqueous water with low dissolved oxygen content is necessary for this experiment so that when oxygen frees off from aqueous water molecules, it can be identified easily by further measurements.

This water filtration system was set up by connecting filters in sequence as shown in Figure 2. The functions of each filter are listed in Table 1.

**Table 1:** *Functions of filters*

| Sequence | Types of Filter | Function |
|---|---|---|
| 1 | Pre-carbon | Removal of chlorine, pigments, and heavy metals |
| 2 | Anti-bacteria Silver Carbon | Anti-bacteria and viruses |
| 3 | Alkaline Minerals Enhancer | Supply of cations minerals such as $Ca$, $Mg$, $Na$ and $K$ |
| 4 | Carbon Block | Removal of ethylene, dichloride, bleach, pesticide, and odors |

*(Source: Million Water Sdn Bhd <https://www.millionwater.com/technology/>.)*

In the following discussion, the filters will be labelled according to their sequences in Table 1, i.e. 1 for pre-carbon, 2 for anti-bacteria carbon, 3 for alkaline minerals enhancer, and 4 for carbon block filters. The sequence of filters can be altered according to researchers' requirements.

### 3.1.4. Apparatus: Water Pumping System

The water pumping system was employed to provide flow ability to the intended water. This is essential so that the aqueous water can move from the water source to the destination. This movement is crucial to ensure the aqueous water move through the prepared magnetic field.

The water pumping system in this study was made up of 2 polypropylene bottles, 1 peristaltic pump, and polyethylene tubes with diameters of 6.35 mm. The peristaltic pump was used to pump the aqueous water from one bottle (Bottle A) to another bottle (Bottle B) using an interconnected polyethylene tube. All the fittings were tightened to prevent water from leaking during the pumping process. This water pumping system is illustrated in Figure 2.

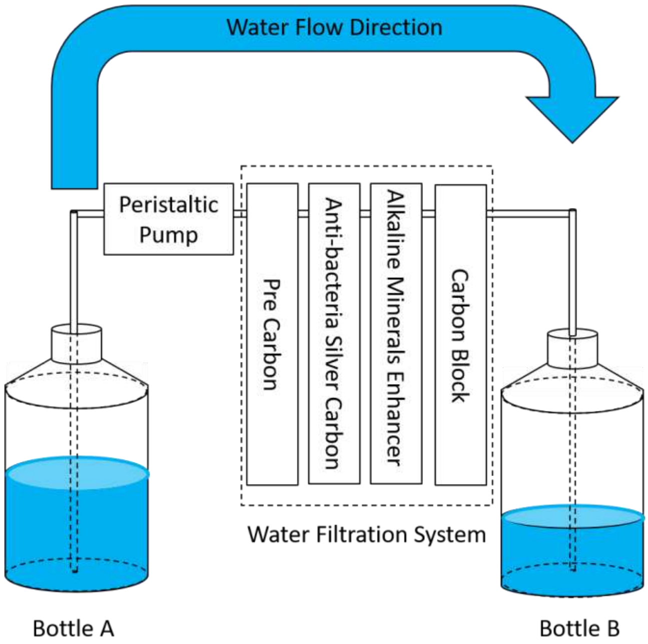



**Figure 2:** *Illustration of the water pumping system with the filtration system (Source: Self sketching from the experimental setup.)*

### 3.2. Experimental Procedures

The experiments can be carried out when all materials and apparatus described in Section 2.1 are ready. The experiment will start by filtering the tap water to desired properties and then follow by magnetic treatment of the filtered water. During the magnetic treatment, the production of oxygen occurs and that produced oxygen can be tested using the proposed instruments.

#### 3.2.1. Filtration of Tap Water

The water source was supplied as tap water. The tap water is filtered using all 4 filters in Section 2.1.2.2 to serve two purposes. The first purpose is to reduce the dissolved oxygen content, whereas the second purpose is to simulate the naturally available earth rainwater which is composed of $Ca$, $Mg$, $Na$ and $K$ ions (Salve et al., 2008).

**3.2.2. Oxygenation Experiment (using Magnetic Field)**

The magnetic field was provided by the device as described in Section 2.1.2.1. A sample of the original water source was kept as a reference (labelled as 0 in Table 4). The oxygenation experiment was conducted repeatedly from the first cycle to more cycles as shown in Figure 3. In the first cycle, aqueous water from a water source was flown to the magnetic field and collected for analysis. The production of water sources is as described in Section 2.1.2.3. The aqueous water sample from the first cycle was collected for analysis. This was repeated for the subsequent cycles and all collected aqueous water samples were analysed. All results of the analysis were tabulated in Table 4.

Experiments with repeated 10 cycles were conducted in this study. The interval duration between each cycle was less than 10 minutes and all relevant analyses were performed as described in Section 2.3.

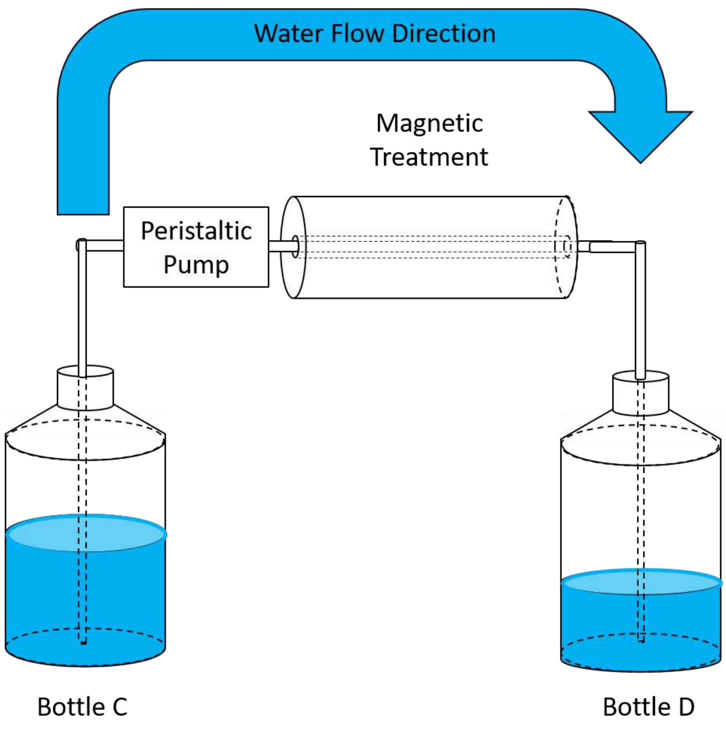



**Figure 3:** *Illustration of the water magnetic treatment*
*(Source: Self sketching from the experimental setup.)*

**3.3. Instrumentation**

The water source as well as all samples collected in Section 2.2.2 were immediately tested for the pH, electrical conductivity (EC), dissolved oxygen level (DO) and oxidation-reduction potential (ORP) using the instrument as listed in Table 2. All measurements were conducted using their standard operating procedures as provided by their respective manufacturers.

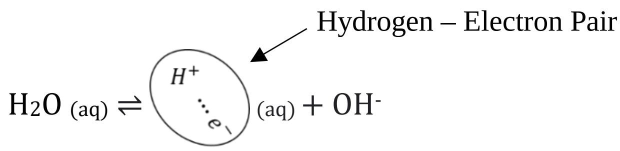
**Table 2:** *Devices for water testing*

| Property | Device | Manufacturer |
|---|---|---|
| pH | pHep®4 pH/Temperature Tester – HI98127 | Hanna Instrument |
| EC | Pocket Pro Low Range Conductivity Tester – 9531400 | Hach |
| DO | ProODO Optical Dissolved Oxygen Meter | YSI |
| ORP | ULTRAPEN™ PT3 ORP Pen | Myron L ® |

*(Source: Devices information.)*

## 4. The Proposed Oxygenation Mechanism

In this oxygenation mechanism, the oxygen is free off from water molecules when they are in the aqueous state. This oxygenation process begins from the generation of electrons when the aqueous water, $H_2O$ molecules move in any magnetic field (Koon, 2016) The generated electrons, $e^-$ are negatively charged particles and thus are affinitive to the positively charged hydrogen ions present in the aqueous state. Once they are successfully paired, the hydrogen, $H^+$ ions are inherently reducing their valency as shown in Eq. 1. When the pairing happens, the ionisation system of water has lost the hydrogen ions. Such losses result in the in-situ increment in the concentration of the hydroxyl, $OH^-$ ions in the original water molecular system.




**Eq. 1**

The previous art (Koon, 2016) indicated in this phenomenon, the pH of the water shall be inherently increased because the concentration of hydroxyl ions increased in the original water molecular system. According to Le Chatelier's principle, once the equilibrium in Eq. 1 is disturbed, the equilibrium shall shift to the left to produce more aqueous water molecules. One may note that when the hydroxyl ions dissociate to form water as shown in Eq. 2, the oxygen, $O_2$ gas shall be the accompanying product.

$$4OH^-_{(aq)} \rightarrow 2H_2O_{(aq)} + O_{2\,(g)} + 4e^-$$

**Eq. 2**

It is clearly identified that the products of hydrogen – electron pairs and the oxygen gas are not part of the water ionization system as in Eq. 3.

$$H_2O_{(aq)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$$

**Eq. 3**

Since these products (hydrogen – electron pairs and the oxygen gas) are not members of the water system, they are "foreign substances" or became new additives to the original water system. The as-produced oxygen gas may dissolve in the water system as dissolved oxygen. According to Henry's law, at a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid. This Henry's law can be mathematically expressed in Eq. 4, where the $C$ is the concentration of the dissolved gas in the liquid, $k$ is Henry's law constant and $P$ is the partial pressure of that gas in equilibrium with that liquid.

$$\mathrm{C} = \mathrm{kP} \qquad \textbf{Eq. 4}$$

Since $k$ of the oxygen in water is a constant which is $1.3 \times 10^{-3}$ M/atm (Sander, 2015), the $C$ is only dependent on the $P$. In the case where the oxygen is produced through the magnetic treatments within the water system, the $P$ of the oxygen is the total of the atmospheric and hydrostatic pressures rather than just the atmospheric pressure solely. Thus, a higher $C$ of the oxygen is expected and the oxygen shall readily dissolve into the water rather than releasing to the atmosphere. However, when the dissolved oxygen concentration achieves a maximum $C - value$, the water is said to be saturated with dissolved oxygen. Therefore, the as generated oxygen gas shall escape to the environment. This is likely to be an infinite source of oxygen gas input to the atmosphere in the case that the flow of aqueous water within the magnetic field is continuous. Such oxygen gas may evolve from the water system until the present grand equilibrium composition of oxygen in the atmosphere which is around 21% in the air. When the grand equilibrium is achieved, the production of two accompanying products may be ceased, so that the entire eco equilibrium system can be maintained. However, such a study shall be the author's next work objective.

## 5. Results and Discussion

All data collected in this work were obtained in a satisfactory manner in respect to the proposed magnetosynthesis process. All results in this work showed perfect matching to the discussion necessary in the proposed magnetosynthesis process (oxygenation process). It was surprising to find that the value of ORP from the proposed oxygenation process is higher than the normal water with about the same dissolved oxygen value. This showed that the properties of the oxygen produced from the magnetosynthesis process shall be different from the normal oxygen commonly available in the atmosphere. However, this finding was not presented in this paper to avoid confusion of readers.

### 5.1. Oxygenation Experiment

The pH, EC, DO and ORP of the tap water, filtered water, and magnetically treated water are measured and tabulated in Table 3.

**Table 3:** *Properties of water under various treatments*

| Property | Tap Water | Filtered Water Using Filters 1, 2, 3 and 4 | Magnetically Treated Water (1st Treatment) | Filtered Water after Exposed to Air for 10 Minutes Without Magnetic Treatment |
|---|---|---|---|---|
| pH | 8.5 | 9.6 | 9.6 | 9.6 |
| EC / $\mu Scm^{-1}$ | 106 | 155 | 156 | 155 |
| ORP / mV | 588 | 39 | 62 | 40 |
| DO / % | 99 | 32 | 48 | 33 |
| Oxygen content/ppm | 8.18 | 2.64 | 3.97 | 2.73 |

*(Source: Data collected from experiments.)*

It is clearly shown that the starting tap water was saturated with oxygen with 99% equivalent to 8.18 ppm of oxygen as tabulated in Table 3. Tap water is usually produced to this standard so that consumers can maintain a healthy diet. By using filtration technology as mentioned in Section 2.1.2.2, the authors had successfully suppressed the dissolved oxygen to a sufficiently low value, so that subsequent oxygenation experiments can be conducted effectively. The oxygen content in the water has reduced by two folds to 2.64 ppm from the starting 8.18 ppm in the tap water because the carbon compounds in Filter 1, 2, and 4 can absorb oxygen (Delavar & Nabian, 2015; Purnamasari et al., 2019). When the water with 2.64 ppm oxygen content was treated with the magnetic device, its oxygen content increased drastically to 3.97 ppm. Such increment by approximately 50 % was a significant record. This phenomenon was discussed in Section 3.0; it indicated clearly that oxygenation by magnetic field in the water flowing system took place. This oxygenation process is not coincident, and the authors observed that no other possible leaking part in the water flowing system can cause possible external oxygen from dissolving into it. The original filtered water did not perform a drastic increase in dissolved oxygen value as compared to the magnetically treated water. The increment was just 1% even after exposing to air for 10 minutes. Hence, it is concluded that the drastic increase in dissolved oxygen during the oxygenation experiment was not caused by external air exposure rather it is pointed to the success in oxygenation when the water flows through the magnetic field. The authors are of interest to discuss oxygen content and its dissolved oxygen values in this experiment while other results that required extra discussions in Table 3 will not be presented.

#### 5.1.1. Repeatability Test of Oxygenation Experiment

Magnetic treatment of filtered water was subsequently repeated 9 times as reported in Section 4.1 to verify the repeatability of the oxygenation experiment. The results are tabulated in Table 4 and plotted in Figure 4. Inevitably, the dissolved oxygen values increased significantly each time when the water was magnetically treated. The oxygen content increased from 2.64 to 7.44 ppm in the entire 10 cycles with an average 1 ppm increment each time when the water was treated magnetically. This shows that the production of oxygen in water using a magnetic field is effective and the proposed oxygenation mechanism is working well.

**Table 4:** *Results of the DO and ORP of the repeated oxygenation experiment cycles*

| Number of Magnetic Treatment | pH | EC / μScm$^{-1}$ | ORP / mV | DO / % | Oxygen Content/ppm |
|---|---|---|---|---|---|
| 0 | 9.6 | 155 | 39 | 32 | 2.64 |
| 1 | 9.6 | 156 | 62 | 48 | 3.97 |
| 2 | 9.6 | 155 | 92 | 58 | 4.79 |
| 3 | 9.5 | 156 | 96 | 69 | 5.70 |
| 4 | 9.5 | 155 | 110 | 74 | 6.11 |
| 5 | 9.4 | 156 | 106 | 79 | 6.53 |
| 6 | 9.4 | 157 | 116 | 82 | 6.78 |
| 7 | 9.4 | 155 | 128 | 84 | 6.94 |
| 8 | 9.5 | 155 | 142 | 85 | 7.02 |
| 9 | 9.5 | 155 | 153 | 88 | 7.27 |
| 10 | 9.6 | 156 | 167 | 90 | 7.44 |

*(Source: Data collected from experiments.)*

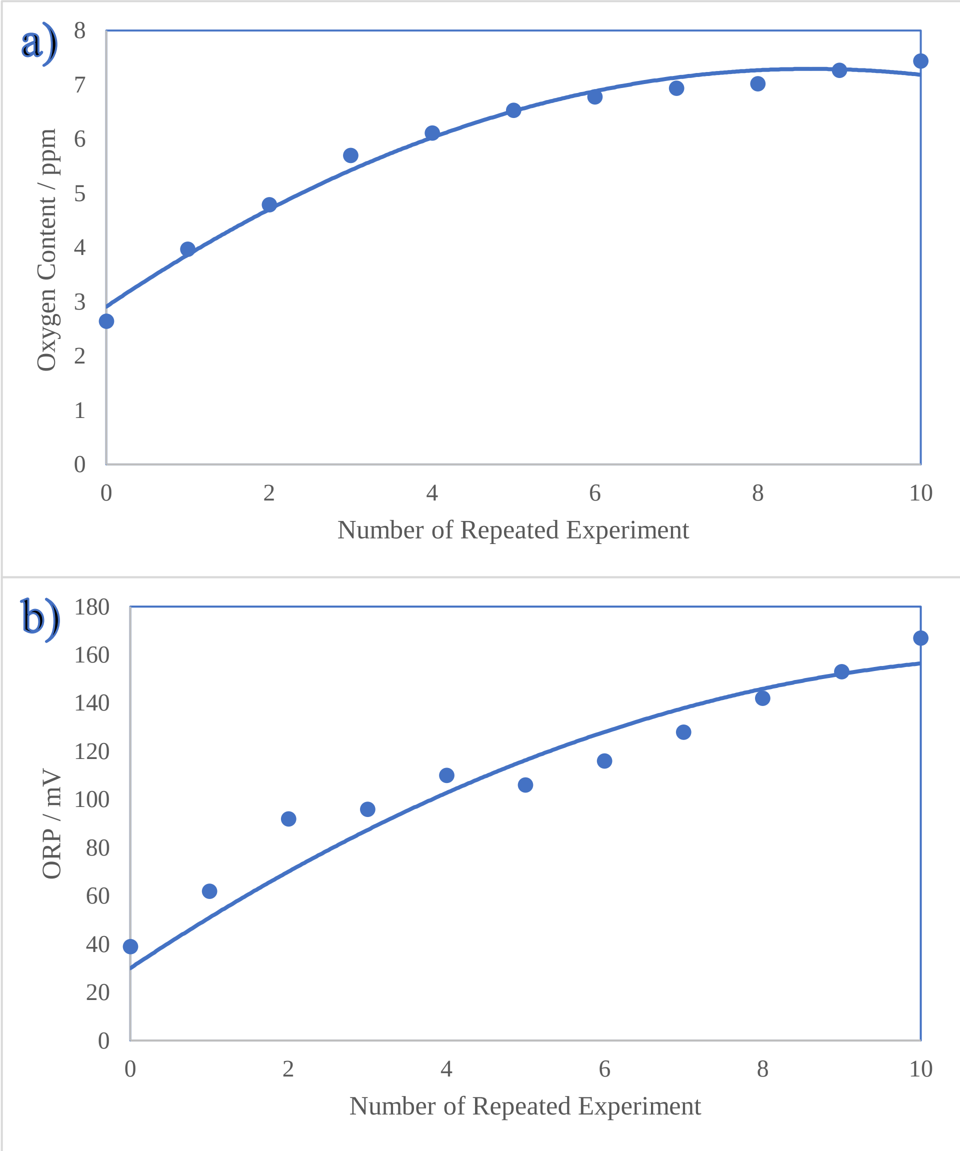



**Figure 4:** *Relationship of (a) DO and (b) ORP of the water in repeated oxygenation experiments*

*(Source: Self sketching from data collected from experiments.)*

Figure 4 (a) shows that the oxygen content increased relatively more rapidly in the initial cycles, but the rate of increment reduces over the number of repeated cycles. The gradient of the curve is the gained number of oxygen molecules dissolved into the molecular water structure. When the experiment is repeated, the gradient is descending, which shows that the power of water molecules to absorb as produced oxygen molecules reduce. Molecules of generated oxygen could be absorbed or desorbed to the water; the gradient is the difference between these two factors. The larger the gradient, the higher the absorption but with lower desorption. The tendency of oxygen to stay in the water or to release to the atmosphere lies on the magnitude of this gradient. So, the larger the gradient, the more likely the oxygen to be absorbed, adversely, the smaller the gradient, the more likely the produced oxygen to be released to the atmosphere.

Figure 4 (b) indicated the ORP increased with the number of repeated experiments in a similar relationship to Figure 4 (a) because ORP measured the oxidative power of the oxygen molecules which are available in the water. Obviously, the higher the oxygen content, the higher the ORP value.

## 6. Conclusion

The prior literature studies revealed that the occurrence of oxygen in the atmosphere can be dragged far older than the Great Oxygenation Event which is about 2.3 billion years ago. However, the mechanism other than photosynthesis for oxygenation is not known but literature studies revealed that they shall be existed but are not known to humans today. The authors had proposed and proved in the experiment that the proposed oxygenation mechanism is working to produce oxygen. In the experiments, the authors had successfully suppressed the initial values of dissolved oxygen and oxidation-reduction potential in the source water to sufficiently low, so that any changes of these values in response to the oxygenation experiment can be observed effectively. In the oxygenation experiment, when water is flowing through the magnetic field, the production of oxygen shall occur. Once the oxygen is produced, it is readily dissolved in aqueous water and was to be reported as dissolved oxygen using the DO meter. The amount of dissolved oxygen shall continue to increase when the number of treatments increases; however, it will reach saturation. At the saturation, the amount of dissolved oxygen shall begin to exceed the solubility limit in aqueous water ad excessive treatment or excessive oxygen, more than the solubility limit will cause the oxygen to release to the atmosphere. Such release of oxygen to the atmosphere causes the content of the air in the atmosphere to increase in oxygen. The authors are of the opinion that this is the mechanism of oxygen generation that causes oxygen to present in the atmosphere before the Great Oxygenation Event.

### 6.1. Scope of Future Research

In these experiments, the authors had discovered an alternative method where the earth can accumulate oxygen into its atmosphere suitable for the life of all living objects on the earth. However, the properties of the oxygen produced by this new mechanism may be different from that of photosynthesis. The authors propose to repeat the experiments and to perform more analysis so that the properties of the oxygen can be studied. The authors had indeed observed that the oxidative power of the oxygen produced by this new mechanism has higher oxidative power than that normally available in the atmosphere; perhaps the oxidative power of oxygen that is produced from photosynthesis is lower. More research work shall be reported soon.

### 6.2. Research Limitation

This research works on a new branch of science where oxygen can be produced naturally when any moving stream carrying aqueous water flows across a magnetic field. The effect from this research findings could be great where it shall affect or benefit the entire ecosystem inclusive of human beings. This is because the properties of the oxygen produced from aqueous water may be different from that of photosynthesis. The benefits outlined in present findings and thoughts, although great but it could be even greater and sophisticated to the benefit of the entire ecosystem. Such a great project should require participation from many parties, including but not limited to; government bodies' attention, funding, and support; a large number of researcher's participation across countries; a large number of cross-disciplinary research participation, and so on. At present time, there is a limitation on the above factors where the benefit grown from this branch of science could not be delivered in pave yet.

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