Jurnal
Teknologi

Full Paper

A REVIEW OF REMOVAL IRON AND MANGANESE BY USING CASCADE AERATION SYSTEMS

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Article history
Received
24 April 2015
Received in revised form
4 May 2015
Accepted
9 May 2015

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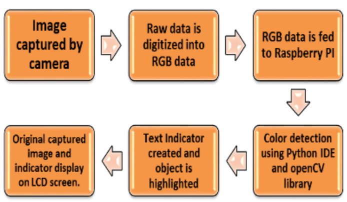
Graphical abstract



Abstract

This review covers the removal of iron (Fe) and manganese (Mn) using aeration system for groundwater. The review focuses on the aeration systems that used by the previous researchers on the system in removing iron and manganese. The important aspects that will be discussed in this paper are the strength and the weaknesses that had been implemented and the success of systems, in the critical review. There are many systems that been used either using the oxidation or filtration. The suitability of the method is depending to study area, soil type and water characteristic. All the systems worked as a tool to remove the iron and manganese, the differences between the systems in removing this metal will 100% or less than 100% removal. In this review, the weaknesses between all the removal systems that would be done will be discuss, to improve other study about this system and the suggestion from the researcher also take as an idea to execute a research in this area. The comparation between the strategies evaluated, pilot study and simulation will be discussed. This paper has highlighted on the appropriate system is used to remove iron and manganese from groundwater, in addition a number of system design are also analyzed for knowing the importance of flexibility of operations with the model produced. The best system will be proposed to remove iron and manganese for further study depending to the weakness, advantages and disadvantages in costing and the best treatment.

Keywords: Iron, manganese, aeration, groundwater, systems

Abstrak

Kajian ini meliputi penyingkiran besi dan mangan yang menggunakan sistem pengudaraan untuk air bawah tanah. Kajian ini memberi tumpuan kepada sistem pengudaraan yang digunakan oleh para penyelidik terdahulu untuk menyingkirkan besi dan mangan. Aspek-aspek penting yang akan dibincangkan dalam kajian ini ialah mengenai sistem yang dilaksanakan dari segi kekuatan dan kelemahan, serta kejayaan sistem dari tinjauan kritikal. Terdapat banyak sistem yang telah digunakan sama ada menggunakan pengoksidaan atau penapisan. Kesesuaian kaedah tersebut bergantung kepada kawasan kajian, ciri-ciri air dan jenis tanah. Kesemua sistem yang digunakan sebagai alat untuk menyingkirkan besi dan mangan, perbezaan di antara sistem-sistem tersebut dikaji, sama ada penyingkiran logam akan menghasilkan 100% atau kurang daripada 100%. Dalam kajian ini, kelemahan antara semua sistem penyingkiran yang dilaksanakan akan dibincangkan, untuk memperbaiki kajian lain tentang sistem ini dan cadangan daripada penyelidik juga diambil sebagai idea untuk melaksanakan penyelidikan di kawasan ini. Kajian ini mengetengahkan sistem yang sesuai yang akan digunakan untuk menyingkirkan besi dan mangan dari air bawah tanah, dalam masa yang sama bilangan rekabentuk yang dianalisis untuk mengetahui kepentingan operasi model yang dibangunkan Perbandingan antara strategi menilai, kajian rintis dan simulasi akan dibincangkan. Sistem terbaik akan dicadangkan untuk menyingkirkan besi dan mangan bagi kajian pada masa akan datang berdasarkan kelemahan, kebaikan dan kekurangan dalam perbelanjaan dan rawatan yang terbaik.

Kata kunci: Besi, mangan, pengudaraan, air bawah tanah, system

1.0 INTRODUCTION

Iron and manganese is minerals that naturally exist in the Earth's crust, where iron is the metal most widely discovered and usually coexist with manganese. The existing iron and mineral in drinking water are not health threatening but this is a problem when bacteria occur in soil, aquifers and some surface waters [1] . According to Rein Munter *et al*. [2], iron behaviour depends on organic types and concentration wheres organic substances (or silica) in water may interfere with the iron removed process, forming the stable complexes with iron, Fe(II) and Fe(III). The concentration of iron (Fe) and manganese (Mn) in well water can be seasonally and vary with the depth and location of the well and the geology of an area where the iron (Fe) and manganese (Mn) naturally occur in groundwater that has little or no oxygen. The bacteria feed on iron (Fe) and manganese (Mn) in water, then these bacteria will form red-brown for iron or black-brown for manganese, this reaction often detected in toilet tanks, pipe systems and clog water system. The presence of iron and manganese in domestic drinking water delivery has become a serius problem because it changes the taste, color and odor to the water. To solve this problem a better technology has to find, make the water quality that used to have a standard quality. The technologies that used should be suitable with the raw water source conditions, social, and economic, to make this water treatment work properly. The removal of iron and manganese from ground water accomplished by oxidation, precipitation and sand filtration for separation the oxidation metal [3].

The review focuses on the aeration systems that used by the previous researchers on the system in removing iron and manganese. The important aspects that will be discussed in this paper are the strength and the weaknesses that had been implemented and the success of systems, in the critical review. There are many systems that been used either using the oxidation or filtration. The suitability of the method is depending to study area, soil type and water characteristic. Study area plays an important role in determining the type of system to be used to remove of iron and manganese, which is very economical, secure technique and social community. In removal iron and mangenese, soil types, depending on the texture, land structure, porosity and so on. Soil texture depending on the type of land is clay, sand or silt, while land structure and porosity respectively, based on aggregates (grained single and compound superstructure) and the balance between macro and micro current process aeration occurs. Another thing that is needed to determine the system that will be used for the removal iron (Fe) and manganese (Mn) is water characteristics, such as temperature, pH, turbidity, taste, colour and so on. The temperature used to initialize a factor for aquatic life associated with the life cycles, for pH indicate whether the water acidic or alkaline (pH 1.0-14.0), while turbidity, taste and colour can known by discoloration and taste in water.

This work is different to others because the cascade aerator will be use to treat water from groundwater not from water supply or wastewater. The study from literature will be use to find the ideal of dimentional to redesign the cascade aerator in removing the iron and mangenese.

2.0 IRON AND MANGANESE

Iron (Fe) and manganese (Mn) usually not affect the health but can cause offensive taste, appearance and straining. Testing the water treatment is a method to clean public water channels and private water supplies. Iron (Fe) and manganese (Mn) is a metal that exists in the earth's crust. Sometimes, iron in pipes could cause the appearanced of iron in water supply [4], in deep wells, where oxygen content is low, the iron/manganese bearing water is clean and colorless. This means if the iron and manganese is not exposed to air then changes of taste, appearance and straining won't happen.

When the iron (Fe) and manganese (Mn) expose to oxygen, discoloration will occur, the iron is oxidized into red brown while manganese will change to brownish-black. This can be seen when there is a reddish brown color on laundry, porcelain, dishes, glassware and utensils. There are two tests conducted by researcher to test public water supplies and private water supplies [4]. Testing of public water supplies follows the U.S Environment Protecttion Agency (EPA) fall into two categories: Secondary Standards and Primary Standards. Secondary Standards are based aesthetic factors such as taste, color, appearance, straining and others. Primary Standards are based on health considerations and designed to protect human health. For testing the private water supplies, they needs to do their own tests at laboratory or checked with EPA methods.

There are many types of removing the iron and manganese from the domestic water system. In aeration system, there are a few ways that will be used to remove iron and manganese such as the biological aerated filter, chemical reaction, stepped spillway and cascade aeration. These systems are usually used in the real work in order to remove iron and manganese in water surface, groundwater and wastewater treatment. The use of biofiltration has been studied by [5], where the difference between a small columns that has been injected with indigenous biofilms from Mangan (Mn) filtration plant and filtration columns that has been injected with a liquid suspension of Leptothrix discophora SP-6 was studied from the previous experiments, showed that the removal manganese can be used a larger pH range than the previous researcher studied. In this paper the presenting about dissolved oxygen (DO), the aeration and the system that will be use in removing iron and manganese.

Removal of iron (Fe) and manganese (Mn) from the lake using chlorine dosage has been investigated using ultrafiltration (UF) systems, in this system chlorine were added to remove iron (Fe) and manganese (Mn) from drinking water [6]. In this study, used of the chlorine dose depends on the content of iron (Fe) and manganese (Mn) in the water resources, with the addition of chlorine into the water efficiency of manganese removal will occur rapidly up to 80 % of the chlorine dose of 3 mg/L as Cl2. According to S.Lin *et al*. [7] Palygorskite used in the removal of iron and manganese from aqueous solution, this study was using batch study, roasting temperature, the effect of contact time and acid concentrations, where chemicals and reagent used in the experiment. As a result, both the metal iron and manganese had been exposed well and achieve equilibrium absorption in short period [7].

In wetland treatment system the removal of iron and manganese are reviewed through rates, processes and implications for management, where the removal of iron successfully done with the installation of passive treatment system, but if the concentration of iron is very low, the biotic removal process will be a priority [8]. According to L.Batty *et al*.[8], manganese can be eliminated using the wetland, but the removal of the iron must be removed before the removal manganese took place, this shows the process of removal of iron and manganese cannot be done simultaneously.

3.0 AERATION

Aeration is important to provide enough DO for aerobics organisms in BOD removal and nitrification in activated sludge plants and retain contaminants suspension biomass [9]. According to E.Alp *et al.* [10], aeration is defined as using atmospheric air as the oxygen source and built oxygenation, this an important process in water and wastewater treatment to transfer oxygen from the gasses to the liquid phase between the atmosphere and water [10, 11]. Aeration brings water and air in close contact, to remove dissolved gases (such as carbon dioxide) and oxidizes dissolved metals such as iron, hydrogen sulfide and volatile organic chemicals (VOCs). Aeration system is widely used for cleansing the pollutant loads from wastewater treatment plant and mixed culture of sewage activated sludge, that supplemental aeration could be an effective approach to improve DO concentration [10, 12, 13]. Aquatic life in the river and stream needs aeration for respiration and continuing their life, the survival of the aquatic life is depending to aeration system. According to A.Baylar *et al*. [14], there are several hyraulic structure used in aeration process such as water jet aeration with circular, water jet aeration with venturi nozzles, pipe aeration with venturi tube, high-head conduit aeration, weir aeration and free-surface conduit aeration. B.O.L. Demar *et al.* [15], studied about the accurate estimation of gas transfer in streams, this study about Doddins model which theory is about interfacial film that assumed to exist in water.

According to S.Moulick *et al.* [11], aeration is a critical process in water and wastewater treatment to transfer the oxygen from the gaseous to the liquid form. Three methods that commonly used for aeration: gravity aeration, mechanical aeration and water diffused aeration [11]. Utilizing a simple weir can makes gravity aeration, an inclined corrugated sheet or stepped cascade. A.Snider *et al.* [16], studied about wastewater aeration tank model with built-in equipment for uniform distribution of atmospheric air, the data analyed using the Mathematical Model of wastewater aeration tank and oxygen concentration transient process in simulink modelling. Mathematical Modelling are analyzed based on Linear stationary models of wastewater aeration, block-diagram for comparative research and block diagram for comparative research of stationary and non-stationary models while for oxygen concentration transient process consist of the development of adaptive self turning virtual models and block-diagram for comparative research of stationary and non-stationary models [16]. The simulation showed the comparison between the simplified stationary model and non-stationary model resulted 50% oxygen transfer differed. H.Chanson [17], has studied on aeration performance of low drop weirs, the analysis found no substantial free-surface aeration took place because of the chute model are too short differ to existing free surface aeration. The main finding of this study is the aeration efficiency, reduced when the discharge increases until the aeration occurred, and the gas efficiency increases with the temperature. The weaknesses of this study are researchers could not demonstrate the relationship because the chute produces a lowest result.

There is a study related to self-aeration in spillway chute, where the study can provide an understanding of the related chute spillway aeration. This study was carried out by [18], to provide recommendations on water drop sizes, where both drop sizes and bubble sizes is required to increase understanding of air water flow mixture. This application will direct regard to water quality and air-water gas transfer at and downstream of hydraulic structures. The comparison between energy of ejected drops and the energy contained in turbulence eddies of the flow shows that energy of ejected drops much greater also studied in [18, 19].

4.0 GROUNDWATER

Groundwater is water that flows or collects beneath the Earth's surface and originates from rain and from melting snow and ice. It sinks into the ground, filling the small empty spaces in soil, sediment, and porous rocks. Aquifers, springs, and wells are supplied by the flow of groundwater [3, 20, 2, 21]. M.J.CAJ Appelo *et al*. [22], conducted a study on removal iron and manganese from groundwater by using in situ modelling, where the modelling used a volume of oxygenated water and a large of volume groundwater, a result from the experiment shows the concentration of oxidant in injected water have insignificant effect due to changes in the ferrous iron is low. The problem of researchers is how the DO injected the water and reached the reductant in groundwater. SPSS analysis software is used to show the concentration of dissolved water in removal iron and manganese [20]. D.Ellis *et al*. [3], Focus on the microfiltration (MF) of iron and manganese in variables such as tangential flow rate, pressure and metal feed concentrations, where the artificial and natural groundwater shows a similar behaviour. In Morocco, ferrous iron in groundwater was studied by [23], this studied found that the mixing reactor was justified and the iron oxidation based on aeration in 63 L split rectangular airlift reactor.

A pilot plant studies at groundwater of nortern Croatia was studied by [24], the studies is about removing of ammonia, iron and manganese from the groundwater, where the nitrification only detected at the middle part of biofilter, however the removing of iron, ammonia and manganese are dissapeared completely. Comparison of full-scale trickling filters that have been done on Oasen water treatment plant Lekkerkerk show some difference in the removal of manganese and there are some problems with the combination of nitrification, where the nitrification will encourage competition between phosphate or essential trace substrates in biological processes, this was due to incomplete removal of manganese [25]. P.Berbenni *et al*. [26], The laboratory test proved that the biological process and autocatalysis make a role of the manganese removal in liquid phase and suggested the whole process are depended on the parameter such as redox potential, temperature and sludge age.

5.0 BIOLOGICAL AERATED FILTER

They're having lots of related research that have been done from other researcher in cascade aeration and remover iron and manganese from water. Biological aerated filter (BAF) was used to treat low-temperature groundwater containing iron and high concentrations of manganese and ammonia nitrogen, the use of raw water in this study because, the implementation of the process of loading high and influent concentration of pollutans 2.52-4.22 mg/l, 1.22-3.97 mg/l and 1.24-3.92 mg/l each. The results showed that the biological oxidation of iron and manganese has achived steady state, while nitrification process is affected by hydraulic loading, and that iron, manganese and ammonia nitrogen could removed simultaneously under the hydraulic loading, when the iron inlet concentration is low [27].

Moreover, according to F.Piao *et al.* [28], the groundwater was treated with the process as aeration and contact oxidation filtration for pollutants to influence removal iron and manganese from groundwater, the removal rate of organic material and ammonia nitrogen from water polluted was low. The simultaneous biological also be practiced to remove of iron, manganese and ammonia from simulated contaminated groundwater was studied by biological aerated filter using dual layer as reinforcement stuff in the laboratory, the influence of variable flow rate of simultaneous removal of manganese, iron and ammonia nitrogen was studied [29, 30]. While a stepped spillway is a common figure for energy dissipation purpose, aeration cascade is used for inflow reaeration, in water treatment plants enhance the gentle wind-water transfer at atmospheric gases (e.g. oxygen, nitrogen) and for the removal of volatile organic components (VOC) such as methane and chlorine [19].

Nowadays, biological treatment process is most commonly used than chemical treatment process, cause there are no need for extra chemical addition, low cost maintenance and high filtration rate. According to L.Bradley *et al*. [31], BAF offers the advantages in singking media which perform well of a suspended solids (SS), COD and ammonia removal. Better mixing and longer contact time of the air and wastewater or water makes good oxygen transfer in the filter, BAF also a flexible system in a different zones or section can be achieved [32]. Used a zeolite was the suitable filter media in the BAF, but a cost of using zeolite very high and not economic, another alternative that will be use such as plastic media and polystere pellet is a better options which can be used.

5.1 Biological Aerated Filter (BAF) Experiment

Pilot scale BAF consisting of plexiglass, 3m height and 185 cm external diameter, where the operations of BAF column will run for several months and when the material turns to black this means manganese oxidation has occurred. Raw water in the head tank flow across a flowmeter and drop onto the biofilter layer through the perforated pipe at the top of the filter, and then flow directly to the bottom of the filter that was perforated by pump. According to X.Ma *et al*. [27], filter media is made up of two layers, the layer on (0.8 m) which is coated by material diameter (3.2-5.0 mm) and diameter (1.6-3.2 mm) at the bottom (0.8 m). This material combination provides advantages to produce more effective dissolved oxygen at the top of the water.

6.0 BIOSAND FILTER

A biosand filter (BSF) is a very slow traditional filter and has been widely used by the community drinking water treatment. A research of BSF has studied by [33], to remove the virus by using iron oxide amended biosand filter. This research is the laboratories and field studies, source of iron will be included at the top of the filter to increase the contact time between viruses and iron oxides. As a result, this study showed that iron must be added to produce the uniform flow even in small amounts, which could not be identified from origional BSF (without iron) and from the results of the study also suggest that the effective period of the transfer of viruses by filtering biosand iron-varied depending on the situation of water resources, the quantity and composition of iron added.

The biosand filter is an innovation on traditional slow sand water filters, specifically designed for household use, it can be produced locally anywhere it is built using materials that are readily available. It is simply a concrete container that encloses layers of sand and gravel. The sand and gravel trap and eliminate sediments, pathogens and other impurities from the water. The effectiveness of Biosand filter is a slow sand filters have been proven to almost entirely remove the disease-causing organisms found in water and has proven as effective as traditional slow sand filters, in both laboratory and field tests. The advantages of the biosand filter are it removes over 98.5% bacteria, 100% parasites, turbidity, some iron, manganese and arsenic. It also no on going costs because of any replacesable parts and easy to maintain the filter. The limitations of the Biosand Filter are the biological layer takes 3 weeks to develop to maturity and this filter cannot remove colour and dissolved compounds.

6.1 Biosand Filter Experiment

Biosand filter experiment contained 4 layer system, where each filter contains 5 cm of gravel under drain (6.25-12.5 mm), 5 cm of medium sized support gravel (3.125-6.25 mm) to isolate a layer of drainage from the filtering sand and 40 cm of filter media (size 0.4 mm) with 5 cm of the top layer of fire sand (size 0.1 mm) [33]. A filter has been changed using iron by adding light steel nails 5.54 kg (40 mm long, diameter 2 mm, ' bright ' finish) mixed thoughout the 20 cm of the filter media and this does not include the coating of sand [33].

7.0 FREEZE/THAW CYCLE

Freeze/thraw cycle (FTCs) is important environmental factors that can make the Cd and Zn forms transformation. According to C.Wang *et al.* [32], five soils sample were collected and tested with parameters that as indicated, pH, clay and organic matter. From the experiment that have done, Cd can transformed with residual form and to the iron-manganese oxide binding with increasing of FTCs, but for the Zn transformation cannot be done due to having the high contents in soil and have a special chemical characteristic.

8.0 CASCADE AERATOR

A problem that often results from iron and manganese in water is iron and manganese bacteria, these (not health threatening) bacteria occur in soil, shallow aquifers, and some surface waters [1]. The bacteria feed on iron and manganese in water, these bacteria will form red-brown (iron) or black-brown (manganese) slime, often detected in toilet tanks, and clog water systems.

To remove iron and manganese from groundwater, cascade aerator is the method to be use. According to V.Rathinakumar *et al.* [1], the outcome of the study affirms that when the flow through cascade increases from the threshold value, the performance of cascade decrease since the time of exposure decrease. Hence, the aeration efficiency in the preparation of the cascade is different water quality and used at the same flow rate. The upshot of the studied parameters on the aeration strongly differs according to the current regime. Also, three different sets of coefficients were optimized for each flow regime in order to consider the psysic of the aeration prediction [34]. According to V.Rathinakumar [1], stepped cascade are very versatile in recent years because it very low cost and speedy construction better than other aeration system. Cascade aerator also can be used to oxidize iron, manganese and to partially reduce dissolved gases. Ahmet Baylar *et al.* [35], stepped cascades were very efficient structure in oxygen transfer because strong turbulent mixing happen with air bubble entrainment and this advantages makes the nappe flow regime where the oxygen transfer on each step of cascade.

Analysis of all studies, the idea of using cascade aerator to remove iron and manganese from pumping well are not done yet. This idea is useful because it's environmental friend without using a chemical to remove iron and manganese. The aeration efficiency in stepped cascade aerators was modeled by using the Adaptive Network Based Fuzzy Inference System (ANFIS). Test results showed that ANFIS could be used to estimate the aeration efficiency in stepped cascade aerators. In this study, ANFIS model was applied in the estimation of the aeration efficiency of steps cascade aerator. There was a secure correspondence between the measured aeration efficiencies and the values computed from ANFIS model [36]. Besides using cascade aerator to remove iron and manganese, the result that obtained will analysis by using Computational Fluid Dynamics (CFD). The CFD software is used to perform the calculation required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. In other words, with high-speed supercomputers and better solutions can be achieved, its also improves the accuracy and speed of complex simulation scenario such as transonic or turbulent flows. The CFD software were used in simulated air removal from gas-existed water supply pipe-bridge, from this simulation hydraulic jump and sloping pipe were determined, and positive linear relationship had been found by representing turbulence kinematic energy [37].

Studied on parameters of aeration and turbulent flow regime or mixing water is the most important thing for cascade aeration, in supported by [1, 34, 38]. From their studies, new geometric and dimension cascade aeration has been built to improve oxygenation and self- purification process such as to determine the total of steps, slope of the entired cascade and hydraulic loading rate where the production of aeration efficiency occur as a maximum [1, 11, 39]. [18, 40] has been studied on turbulent flow and influence of step surface roughness which their research to obtain detailed air bubble entrainment in free-surface turbulent flow and present evidence of multiphase flow dynamics, the result of this studied an important to explain the reoxygenation in stepped cascade which used for stream reaeration and for plant or water treatment. That studied supported by [41], who have made observations on the time exposure, dissolved oxygen, assesment of reaeration constant and oxygenation capacity using Modified Winkler's method as per standard methods. The analysis of cascade aerator also built in United Kingdom [42], the analyzed concluded investigates of removal efficiency such BOD, COD, SS, FC and nutrients include the oxygen supply in reaeration process. A.Baylar *et al.* [43], Investigated on the application of electro-coagulation and ozonation technology in partial depuration of ferrous solution, as a result bubbling ozone produce a reduction in total phenols, the discoloration on the solution shows a reduction in COD and without removing of iron ions.

The stepped cascades basically consist a series of steps over which the water is allowed to run as flimsy celluloid. Gas exchange takes place between the gentle wind in these bubbles and the water and the schematic presented in Figure 1.

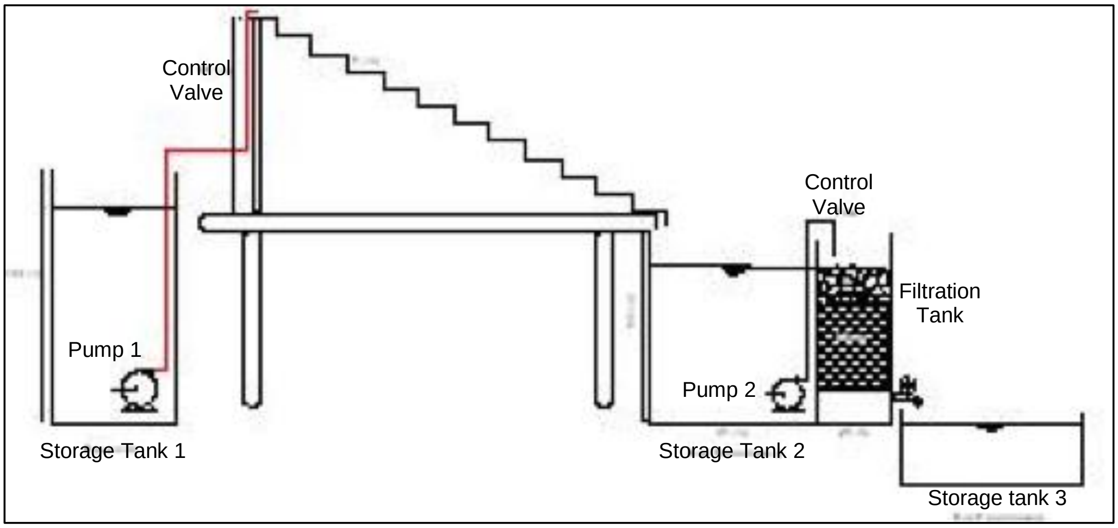


Figure 1 Schematic diagram of cascade aerator [44]

Water flow in cascade aerator is related to hydrodynamic regime, such as having an important impact in the transfer of oxygen. In a stepped cascade, there are three main flow regime: nappe regimes: transition regime and a skimming regime [19]. Flow regime show at Figure 2, nappe flow regime has is a series of small consecutive falls, skimming regime is a recirculation zones with horizontals axes take place between steps outer edge and transition regime is intermediate regime between nappe and skimming.

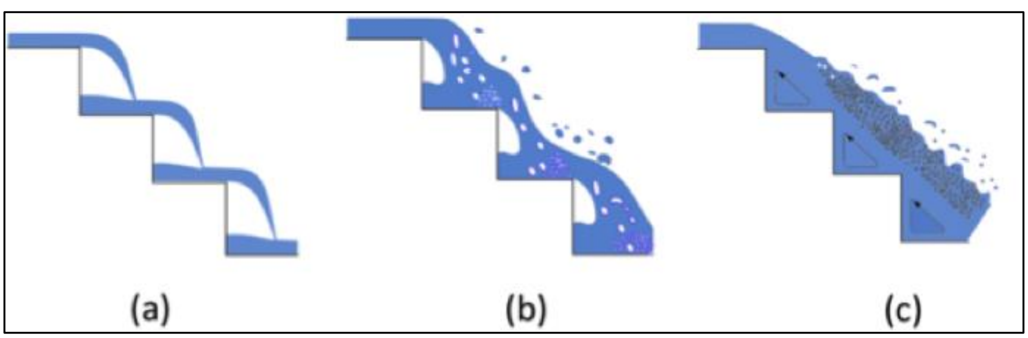


Figure 2 Flow regime over stepped cascade: (a) nappe flow, (b) transition flow, (c) skimming flow [34]

8.1 Cascade Aerator Experiment

Study on cascade aerator carried out by an experiment, in which rectangular cascade consists of a step which is made from galvanized iron (G.I) with height: 0.214, 0.25, 0.30, 0.375 and 0.5 m [11]. Aeration experiment was carried out by using step which different height (h) and hydraulic loading rates (qw). The test water storage tank that had deoxygenated has carried out five sets of experiment, and then the water flowed out from the inlet tank and drop on cascade step through the rectangular weir, but all the researchers have a dimension that used in terms of length, width, height and angle a cascade built. This method is used to estimate DO content in a convenient way.

9.0 FURTHER STUDY

Normally the use of cascade aerator whether in Malaysia or other countries focused on the water treatment and wastewater treatment. While the methods commonly used for the treatment in the groundwater usually use bioaerated filter and biosand filter, where groundwater will pump into the filter to remove volatile organic components from the water. The uses of cascade aerator to treat water from groundwater have not been introduced yet in Malaysia. This system will be an indication of increasing use of groundwater and diversity in the quality of water in Malaysia. However, no study has been attempted in arriving at optimal design criterion of a stepped cascade unit to be used as a pre or post-aeration unit in potable or wastewater [11]. This development will hopefully establish the benefit of improved water quality by using cascade aerator to treat a groundwater as a water supply. The task is important to the communities that use pumping well as a resource of water for daily used. According to A.Baylar *et al*. [35], future studies should continue to study the impact of high-head and free-surface flow systems to reduce taste and odour resulting from the dissolved gasses in the water as well as the removal of iron, manganese and volatile organic compound (VOC) in the water.

10.0 CONCLUSION

Groundwater is very useful and often used as a source that is not needed or ignored. Studies show groundwater is much safer to use because it is the best solution to address the water crisis and reduce water treatment costs in the long term as well as solutions to states, which had experienced a water crisis, such as Selangor, Melaka and Sarawak. The use of groundwater as a source of water supply in Malaysia is not as popular and groundwater treatment using cascade aerator makes it one of the purposes of the study would be reviewed. Based on the studies that have been done by previous researchers, cascade aerator is a simple method that is used for oxidation process occurs. Where the bubble formed from splashing water and combines with oxygen occurs when water through step in cascade aerator, thus the process of oxidation occur between iron and manganese in the water. According to A.Baylar *et al*. [35], future studies should continue to study the impact of high-head and free-surface flow systems to reduce taste and odour resulting from the dissolved gasses in the water as well as the removal of iron, manganese and volatile organic compound (VOC) in the water. This paper has highlighted on the appropriate system is used to remove iron and manganese from groundwater, in addition a number of system design are also analyzed for knowing the importance of flexibility of operations with the model produced. Cascade aerators were choosed because this system is very low cost and low maintanence and also very environmental friendly where no chemical reagen will use in removing the iron (Fe) and manganese (Mn).

Acknowledgement

We are grateful for the Ministry of Education Malaysia for providing LRGS grant No.203/PKT/6726001 dan USM.

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