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Membrane Water Treatment: A Review in Islamic and Science Perspective

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Abstract--- *This paper is about a review on membrane water treatment according to Islamic and science perspectives. Nowadays, water as the most precious human right facing many issues regarding its misuse leading to critical water shortage and contaminated. Various methods have been introduced to tackle this water issue. One of the aspect is by having water treatment or water recycle using process of membrane water treatment. So, the aim of this paper is to explore the concept of water and how the treatment and purification of water in Islam and science views. Next, this paper also suggested the membrane water treatment as the method and process to treat and purify the water whether this water membrane process is comply to Shariah compliance or vice versa. The methodology of this paper is qualitative approach by using document analysis of article papers, fiqhturath books and also related document references. The result reveals the water treated by membrane water treatment process is pure (tahir) according to Islam and science perspectives.*

Keywords--- Membrane, Water treatment, Review.

I. INTRODUCTION

Water is a crutial role in Islam and is recognized by Muslims as a blessing that gives and sustains life and purifies humankind and also the earth. *Al-Ma'* is the Arabic word for water is referenced exactly 63 times throughout the Al-Quran and is a recurring topic in many of the sayings of the Prophet Muhammad (peace be upon him) (Abdul Baqi, 1987). The importance of water for human life has been mentioned clearly in the Al-Quran:

أَوَ لَمۡ يَرَ ٱلَّذِينَ كَفَرُوٓاْ أَنَّ ٱلسَّمَٰوَٰتِ وَٱلۡأَرۡضَ كَانَتَا رَتۡقٗا فَفَتَقۡنَٰهُمَاۖ وَجَعَلۡنَا مِنَ ٱلۡمَآءِ كُلَّ شَيۡءٍ حَيٍّۖ أَفَلَا يُؤۡمِنُونَ

Have those who disbelieved not considered that the heavens and the earth were a joined entity, and We separated them and made from water every living thing? Then will they not believe?

(Al-Qur'an. Al-Anbiya'21:30)

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According to Islam, water is community resource and is a right for all humankind as mention in al-Hadith to teach Muslim about the practice of preserving earth's natural resources particularly water conservation. Prophet Muhammad (SAW) highlights this in the following hadith:

المسلمون شركاء في ثلاث: الماء والكلأ والنار

"Muslims have common share in three things: grass [pasture], water, and fire [fuel]"

(Hadith. IbnuMajah. Volume 3, Number 2473)

II. LITERATURE REVIEW

When called "treated water", it triggers automatically in the minds of general public's imagine the sewage water contained in the sewage tank behind the house is processed into clean water. The dogma of this kind of thinking becomes a habit to our society because of the limited scope of thought and knowledge. In fact, the understanding of "treated water" is broadly defined and the debate about it is still open to the public arguing and throwing ideas. Hence, this study will open the door of the discussion on "water purification" in the perspective of Islam and science as well as breaking the confusion to the community's concerns about the*hukm* and its issues.

Looking at the writings and studies done by previous scholars, researchers found that most of the results were more likely to be scientific studies that discussed chemistry methods or water physics laws which were adapted to the study's title to allow contaminated water to be treated and recycled into clean water to be conserved by life in the world. According to Parent *et al.* (1996), over two decades of research is to illustrate the best method of commercialization in treating contaminated water using the photocatalytic process (light as a catalyst). The goal of this study is to make the sun as a source of light that will contribute to the smooth running of this water treatment process.

While in other writing, an article by Environmental Protection Agency, EPA (2001) deals with more general types of water. Explanation of the types of water divided into three, namely drinking water, distilled water and purified water can provide an overview of any readers on the introduction of treated clean water. This article also briefly discusses the types of water purification processes commonly used by industries such as distillation, deionization, reverse osmosis and carbon filtration. Easily, this article help researcher get a clear picture of the general introduction of types of water and the water treatment methods that are commonly used.

Researcher also refer to the book written by Duncan (1994) that describes in detail the process and implementation used in the treatment of wastewater and clean water through 14 illustrations topics. It's also reveals the common methods used by hot climate states in water treatment and provide an introduction to wastewater and how to treat it. This book also describes the basic types of microbiology commonly found in contaminated and treated water as well as the importance of these microbes. At one glance, the researcher can say that this book help in understanding the water treatment method used in our country today.

In addition, in the book published by Dewan Bahasa and Pustaka (2003) also helps researcher to find information on water and its issues. In this book, readers can understand and know the definition of water from chemist glasses and so on. The researcher interests when the author explains about the factor and cause of water

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odor and discomfort is due to refractory organic compounds such as aromatic hydrocarbon compounds and halogenated hydrocarbons in which both compounds are organic compounds that are not easy to undergo by degradation or decomposition process. It is interesting for researcher as is shows the wisdom in the *Fiqh* method used for the question of why the water used for purification needs must pure and clean water that does not change the smell, color and taste. Hence this encyclopedia indirectly answers the question through science's view.

Hence, the study attempts to see the symbiosis between these two branches of knowledge (science and Islam*)* and try to translate by the researcher by specifying the methods discussed by previous and today scholars in the *Fiqh* books as well. Among the *Fiqh* books that can be used as references to this issue are the book *Mausu'ahAhkamTaharat Al-Najasah 'Ayanuhawa Bayan KayfiyyahTathiruhawa Al-TaharahMinha,* by Sheikh Umar Dibyan Muhammad Al-Dibyan. The author describes the *Fiqhi* method of how the water contained the *najasah* (impurities) can be cleaned. The author states the theory, if the water containing unclean desires to be purified, among the methods that can be used is by adding the soil to it and through several other processes. The author also states some other methods that can be used to purify water through the *Fiqh*method in this book.

Slaughter is a method used to make a *halal* animal eaten, hence the question of making the dirty water *'halal'* to used also requires its own method. If water is rated less than two *qullah,* it can be purified by adding more water to it until it reaches or exceeds the rate of two *qullah*. This method is also mentioned by Al-Syirazi (1996). The same view is also quoted in the book *Al-Mu'tamad fil Fiqh Al-Syafie* by Prof. Dr. Muhammad Mustafa Al-Zuhayliyy in the *Taharah* chapter. This method is better known as *Mu'alajah* method.

On the aspect of *hukm*, there are rules of Fiqh *(qawa'idfiqhiah*) to be referred. Basically, the *Fiqh* books discussed about the *hukm* of used treatment water and how the used water to be purified in the subject of *FiqhIbadah* focused on *Taharah Najasah's* title. Taharah is a concept of purity, sanitation or hygiene that is clean from the *najasahhaqiqi* which is impurity *(khabath)* or *najasahhukmi (hadath).Taharahhaqiqi*is purify the body, clothes and the environment from impurity or *najasah* that can be seen likes urine, stool, blood and wine. *Taharahhukmi* is purify from the uncleanliness that cannot be seen likes breaking of *wudhu*' (ablution) or *ghusl* (bath). The *Fiqhi* methods related to this water treatment issue is *masalihmursalah*and *dhorurah*.

Next, the fatwa issued by the website of the Islamic Affairs and Waqaf Affairs Department of the United Arab Emirates (UAE) mentioned in the fatwa number 1191 dated 18 June 2008 that the *mutanajjis* water becomes purify with the abundant water poured upon it until its *najasah* (impurities) is disappear. If the water is much but there is a little *najasah* in it, so it does not change the condition of the water then it remains purity. This statement is seen as more public and like most of the opinions of the other scholars of the school.

Then, NaifalJuraydan mentions that there is a clear mention of four major schools's views about water and their understanding of it. He also explains in depth the type of water in the *mazhab*of Syafie divided into four parts; the first is pure and purified water (*mutlaq*water). Secondly, pure water can be used only in an emergency or due to lack of water, because the water is too hot (*musyammas*) or too cold, or the water is found from the area that it is imposed the punishment like Lut and Tsamud. Third is the*musta'mal* water and the fourth is the *mutanajjis*water. This division of water is explained by its definition in detail by refer to the books such as *KitabBada'i 'Sana'i, Al-*

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Muhazzab and Al-Majmu'. The writer also explains the stages in the process of waste water treatment which is synchronized with the *Fiqh* method and encloses the fatwa issued by the Council of the Great Kingdom of Saudi Arabia which requires the use of chemical waste water treatment.

The fatwa issued by the Council of Muslim Constitution of the Muslim World (1398) also mentioned the necessity of using treated waste water because it has been removed the *najasah* inside it after undergoing purification processes and then removes the smell, color and taste of the water. The fatwa was issued after a careful study by scientists and scholars to solve the problem of lack of clean water in several countries due to the exceed level of pollution and other factors. The statement quoted on the islamQA.com website also includes the necessity of using these treated waste water for purification purposes and other daily use.

One of the other study have been done by Md Yunus *et al* (2004) about the status of using NEWater as drinking water and also for domestic use. This treatment water also is used for ritual purpose such as *gusl* and *wudhu'*. Hence, this study revealed the *hukm* of using NEWater is *harus* or permitted because this water is pure and can be purified *(mutlaq* water). Next, other study on water treatment from the ablution usage to be reused for domestic use by (Misbahul *et al.*, 2014) after having a treatment process. This study also revealed the permitting of the reused water after having the treatment process.

Hence, previous studies resulted the water treatment usage either by one perspective only; science or Islam. So, this paper will combine both Islamic and also scientific view toward the usage of treated water for various purposes.

III. METHODOLOGY / MATERIALS

Methodology of this study is using qualitative method as this research is based on sosial science's field. Qualitative research is primarily exploratory research. It is used to gain an understanding of underlying reasons, opinions and motivations. It provides insight into the problem or helps to develop ideas or hypotheses for potential quantitative research. It is also used to uncover trends in thought and opinions and dive deeper into the problem. Qualitative research is designed to reveal a target audience's range of behaviour and the perceptions that drive it with reference to specific topics or issues. It uses in-depth studies of small groups of people to guide and support the construction of hypotheses (Susan, 2011).

The qualitative method in this study includes content analysis approach by using two source of data which are primer and secondary data. For gain more data in this study related to the water treatment and purification process, researcher use the related documents as the instruments to know about *fuqaha'* opinions toward water treatment and purification process by referring to the *kitab* (books) *Fiqhthurath,* article papers and also documents related to the research topic. These books and documents are accested by using computer and library research.

Further, the researcher will explore the findings of previous study, then analyse the data and come out with the finding of water treatment and purification. The sources of secondary data are also gained either from internal or external data sources. These numerous data will be collected, analysed and discussed to obtain sufficient understanding towards the research conducted.

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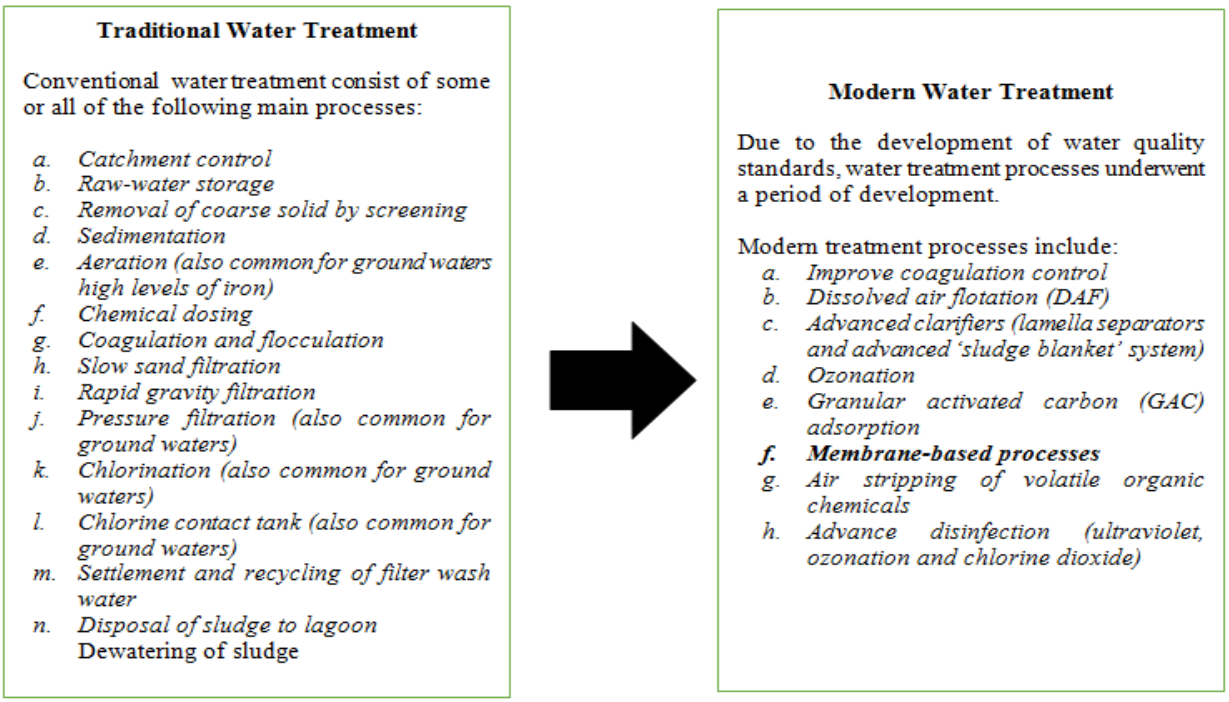
IV. MEMBRANE WATER TREATMENT: ISLAMIC AND SCIENCE PERSPECTIVES

This section will discuss about membrane water treatment according to Islamic and also science perspectives.

4.1. Membrane Water Treatment

Pure water is never found in nature and it is rare to encounter a source of water that requires no treatment before being used for portable water supply. There are two phases in introducing water treatment; traditional and modern (Chris Binnie *et al*, 2002).



One of the modern water treatment is membrane based-processes. Membrane is a porous thin layered material that allows water molecules to pass through it but at simultaneously restricts the passage of bacteria, viruses, salts and metals. Membranes use either in pressure-driven forces or electrical technologies. Pressure driven membrane technology is a perfect method for water purification to any desired quality (Kumar *et al.*, 2014). Membrane separation processes are advanced methods for the treatment of water and wastewater and it separate substances depending on pore and molecule size. It is a reliable and automated process for wastewater treatment (Gehrke *et al.*, 2015). The challenge of membrane technology is the inherent trade- off between membrane selectivity and permeability. This technique requires high-energy consumption due to the pressure-driven process. Fouling of membranes makes the process very complex and also reduces the life time of membranes and membrane modules (Qu *et al.*, 2013). The performance of the membrane system depends on the type of membrane material. There are three fundamental different categories of membrane materials as follows (Peyravi *et al.*, 2012):

i. Organic (polymeric)

   Either cellulose based or composed of modified organic polymers.

ii. Inorganic (ceramic)

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Such as ceramic and metal

iii. Biological

Bio membrane is selective barrier within or around a cell in living organism

In fact, the water treatment process is basically used organic membrane or polymeric-based as a result of their facile processing into viable membrane structures and the diverse polymers available, as well as the capability to synthesise novel polymer structures (Peyravi *et al.*, 2012).

4.2. Types of Membranes

There are several types of membranes for water treatment processes including microfiltration (MF), ultrafiltration (UF), reverse osmosis (RO), and nanofiltration (NF) membranes. Microfiltration membranes have the largest pore size and typically reject large particles and various microorganisms. While ultrafiltration membranes have smaller pores than microfiltration membranes. Therefore, in addition to large particles and microorganisms, they can reject bacteria and soluble macromolecules such as proteins. Reverse osmosis membranes are effectively non-porous. Therefore, exclude particles and even many low molar mass species such as salt ions, organics and so on. Nanofiltration membranes are latest and sometimes called "loose" reverse osmosis membranes. They are porous membranes but since the pores are on the order of ten angstroms or less, they exhibit performance between reverse osmosis and ultrafiltration membranes. Ultrafiltration is usually associated with the separation and concentration of macromolecules, using membranes with micropores of the order of 1–100 nm.

The membrane technology has played an important role in developing more efficient and selective production with a reduced consumption of raw materials, energy and water and the minimization of wastewater and solid waste. Membrane processes have been introduced in industrial operations in order to treat the water, recycle process water and for the potential reuse and recovery of by-products (Bernardes *et al.*, 2014). But in this paper, the membrane process focusing on water treatment and recycle water process only. Membrane separation processes is vary and are used in the treatment of water, sewer and industrial wastewater. Commercial membrane processes present different characteristics. Among the membrane processes, pressure driven membranes which are microfiltration, ultrafiltration, nanofiltration and reverse osmosis are the ones applied to water and wastewater treatment.

In membrane separation processes driven by pressure, a pressure difference is applied across a membrane that can be of a microfiltration, ultrafiltration, nanofiltration and reverse osmosis nature. The membrane acts as a semi-permeable barrier and may have different selectivities for different compounds. For example, microfiltration is typically used for the removal of suspended solids or bacteria, using membranes with pore diameters ranging between 0.1 and 10 l, molecules with a radius greater ensure the removal of viruses and bacteria from drinking water, or as a pre-treatment in reverse osmosis systems. While reverse osmosis is used to separate salts and small organic molecules from liquid streams, using membranes with dense active layers. Due to the high density of the active layer, operating pressures have to be much higher than those used in microfiltration and ultrafiltration. The nanofiltration process is an intermediate separation process between reverse osmosis and ultrafiltration, commonly used in the separation of organic solutes with low molecular weight (200–1000 Da) and in the partial demineralization (essentially polyvalent salts) of liquid streams.

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The transport mechanisms that operate in these types of membranes are diffusion (as in reverse osmosis) and molecular exclusion (as in ultrafiltration), but electrostatic interactions are also detected, which lead to selective removal of polyvalent ions (Bernardes *et al.*, 2014).

Hence, the membrane field has advanced immensely with being economical, environmentally friendly, versatile and easy to use. Membranes are a leading choice for water purification applications and should continue to be for future.

4.3. Water Purification in Islamic View

Method of treatment and purification of water in Islam are discussed by *ulama'* and *fuqaha*' in *taharah* title in many *Fiqh* books. So, it is important to know about *taharah* first. Musthofa Al-Khin*et al* (2008) in his book *al-Fiqh Al-Manhaji* defined *taharah* as the free from all impurities whether in *hissi* (real) or *ma'nawi* forms. Water is the one of the medium for *taharah* in Islam.

According to Islam, water purification method is debated in *fiqh* books by previous and today *fuqaha'* (scholars). This method is also based on *ijtihad* and *fatwa* of *ulama'* and *fuqaha'* because there is no specific *nas* (script) about it either from Al-Quran or Al-Sunnah. The *ijtihad* mentions how its condition when *mutannajis* water (mutated water) turns into *mutlaq* water (pure water) by stating the theory as follows (Al-Syirazi, 1996):

1st Theory	**The water conditions change on its own naturally (changing of time, sun and wind)**
2nd Theory	The condition of water when added the pure water to clean up and the *najis* is disappear from the water
3rd Theory	The condition where the dirty water is washed by soil

These theories are based on observation of scholars and *fuqaha* to the people around them and according to the situation of that time. According to Shafi' e*mazhab*, the water quantity for two (2) *qullah* is equivalent to 270L of water. If the *musta'mal* water is collected and more than two (2) *qullah*, the water turns into *mutlaq* water (pure water).

After a detailed study, in consultation with scientists and engineers, the Council of Leading Islamic Scholars (CLIS) in Saudi Arabia concluded in a special *fatwa* in 1978 that treated wastewater can theoretically be used even for *wudu'* and drinking, provided that it presents no health risk (Council of Leading Islamic Scholars (CLIS), 1978). The fatwa had issued by Saudi House of Fatwa (Council of Leading Islamic Scholars (CLIS), 1978).regarding wastewater treatment as follows:

According to the report set by the experts in this regard, a large amount of water would be deemed pure from any impurity if the impurity is removed, if more water is added to it, or if the impurity is eliminated by the passing of time, the sun, the wind, or any other cause that would remove it.Impure water can be purified by using modern filtering techniques that are the best and most efficient methods for purifying water. Many additives are put in impure water to remove impurities, as attested to by water treatment experts.

Therefore, the council believes that such water would be completely pure and it may be used for ritual purification and drinking as long as there are no negative consequences on people's health. If it is recommended

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that water not be drunken, it would be due to reasons of public health and safety and not Islamic law.The council recommends avoiding using treated water for drinking purposes to avoid health problems and also in consideration of the negative public sentiment about this water. However, using this water for the irrigation of crops or park areas is permissible.

On the basis of the 1978 fatwa, ablution water at the two holy mosques in Mecca and Medina is recycled for toilet flushing, thus conserving expensive desalinized sea-water (Naser *et al.*, 2001). In fact, with the advancement of water treatment technology nowadays, used water also can be drink or potable to use after having water membrane process. This situation is proven by NEWater technology in Singapore.

4.4. Water Treatment in Science View

The method of purifying water is not a new method for obtaining clean water sources. In a book published in 1948 by the American Water Works Association titled "The Quest for Pure Water: The History of Water Purification from the Earliest Records to the Twentieth Century", the author M.N. Baker and Michael Taras speculates that the pursuit of pure drinking water begins in prehistoric times. However, the earliest documentation on water treatment methods has been found in Sanskrit and inscription in ancient Egyptian tombs. Many water treatment methods are mentioned in Sanskrit medical books known as Sus'ruta Samhita, which began in about 2000 BC.

Methods mentioned in the previous time are fire boiling water methods, water heating under the sun, dipping the heated iron into water, filtration through gravel and sand and also the use of Nirmali seed (PotatorumStrychnos) and a stone called "Gomedaka".

While on the walls of the tombs of the Egyptian kings such as Amenophis II and Rameses II who reigned in the 15th and 13th before centuries, it was said that there are carvings or apparatus pictures were used for water purification (Baker and Michael, 1948).

Subsequently in the 9th and 8th before centuries, the development of water purification method with the creation of more systematic technologies by the Romans and Greeks such as Hippocrates, Diophanes and Paxamus and also the leading Islamic chemist in the 8th century, Jabir Ibn Hayyan or better known as Geber in the western world that suggested the use of the siphons axis as a method of purification of water.

Exploring the progress of civilization progress, more modern method in water purification process was first seen officially inaugurated in 1804 when Paisley town in Scotland introduced the world's first water purification plant municipality. The plant uses a gravel and concentric sand filter to treat water and then the treated water is distributed to residents using horses and strollers. Hence, the water treatment process development can be summarised as below:

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Phase	Application
Prehistoric Time (ca. 3200 – 1000 BC)	Homo sapient was the human that dwelled on this earth and they survived as hunter-gatherer (Vuorinen et al., 2007). The first human communities were scattered over the wide area on earth and waste produced by them was decomposed using natural cycles by land (Lofrano and Brown, 2010). Nomadic lifestyle by early communities causes to limited disposal problems because they moved when existing conditions became unlivable (Andreas *et al.,* 2018). So, there are no demand for water treatment at that time.
Historical Time (ca. 1000 BC – 330 AD)	The human communities during this period was establishment of permanent settlements and the disposal of human excreta was managed either on the surface of the ground or in holes dug in the ground covered after use. Next, the evolution of collection systems for both wastewater and also stormwater. The first indications of the utilization of wastewater for irrigation and fertilization of agricultural land was in Bronze Age civilizations when human developed advanced sewerage systems to dispose of wastewater to rivers, sea and also to agricultural land for irrigation and fertilization purposes (Andreas *et al.,* 2018). At this time, demanded for water treatment started.
Early and Mid-modern Times (ca. 1400 – 1900 AD)	This period shows the sanitation practiced emerged as the great epidemics in several regions of the world. This situation led to development of effluent disposal and reuse practices. Engineered land application systems evolved and also separation of feces and urine was practiced. Next, the intensive methods of treatment before discharging the treated effluent to land and freshwater bodies by using variety of methods treatment likes large septic tanks, contact beds and trickling filters and also intermittent sand filters were also used (Andreas *et al.,* 2018). The water treatment demand is more at this phase as sanitation problem started to be an issue.
Contemporary Times (1900 AD – present)	Various water treatment methods and process has developed nowadays likes screening, filtration, microfiltration, ultrafiltration, crystallization, sedimentation, gravity separation, flotation, precipitation, coagulation, oxidation, solvent extraction, evaporation, distillation, reverse osmosis, ion exchange, electro dialysis, electrolysis, adsorption, setting-out, centrifugal and membrane separation, fluidization, neutralization and remineralization, reduction and oxidation and so on (Ali, 2012). These water treatment methods can be combined depending on the types of contaminated water and prospective purposes (Stackelberg *et al.,* 2004). The water treatment technology highly demanded nowadays.

Hence, this study shows that the membrane water treatment is comply with Islamic perspective from the material and also process aspects.

V. CONCLUSION

Using of treatment water is one of the way to conserve the nature. But, to ensure the cleanliness and purifies of treatment water is also important as this water not only used for the external uses such as bathing, watering and so

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on but also for internal uses like drinking and cooking that need the clean water to consume for our body healthy. Next, the uses of treatment water for *ibadah* also important to make its purity to ensure the *ibadah* is accepted by Allah. This study proved that the water treated by membrane water treatment process is pure (tahir) according to Islam and science perspectives.

Hence, the method of membrane water treatment and purification process is needed to be promoted for people used and give the right information to Muslim in order to cater the bad perceptions toward treated water.

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