POTENTIAL OF ORANGE PEEL AS A COAGULANT FOR WATER TREATMENT

Maya Shamira Shaharom[1] and Dyg. Siti Quraisyah Abg. Adenan[2]
[1,2]Department of Civil Engineering and Construction, Faculty of Engineering, Science and Technology, Infrastructure University Kuala Lumpur (IUKL), 43000 Kajang, Selangor, MALAYSIA.
Email: [1]maya.shaharom@gmail.com, [*]dyg_quraisyah@iukl.edu.my

ABSTRACT
The effectiveness of chemicals as coagulants such as alum and ferric chloride is well recognized. However, there are many disadvantages associated with the usage such as high operational costs, detrimental effects on human health, production of large sludge volumes and the fact that it is significantly affect pH of treated water. It is therefore desirable to replace these chemical coagulants with natural-based coagulants such as from fruit peels to counteract the aforementioned drawbacks. Therefore, the aim of this study is to investigate the efficiency of fruits peel as natural coagulants in treating water over the use of alum and optimum dosage of natural coagulant used. In terms of selection of natural coagulants, this study focused on the local waste materials, which is orange peels. These peels were collected from neighbourhood and local stall and market. These peels were prepared by washing, drying, grinding and finally sieving, thus becoming powder of natural coagulants ready to be used. A series of jar test was then performed by using three different water sample which are Taman Metropolitan Kepong Lake, Seri Serdang Lake and Taman Cempaka Lake to determine the effect of individual natural coagulants on the efficiency of turbidity removal and coagulation activity under various operating factors such as pH and coagulant dosage. From the findings, optimum dosage for treating 300 ml individually for those 3 lakes water is 9mg/l, respectively showed turbidity removal of 68 - 80%. The results proved that the use of orange peels as new composite coagulant in water treatment is a feasible option in enhancing the reduction performance of turbidity. Moreover, the usage of this natural coagulant can reduce health risk from long term used of chemical coagulant along with lessen the chemical sludge product to the environment.

Keywords:
Jar test, natural coagulant, optimum dosage, orange peels, pH, turbidity

INTRODUCTION

Water is one of the essential requirements for life. All living things need water for their survival. Water is used for a variety of purposes, including drinking, food preparation, irrigation and manufacturing. Although water covers more than 70% of the Earth's surface, less than 1% of that resource is available as fresh water and this is not evenly distributed throughout the world. Worldwide water demand is increasing day by day due to rapid population and industrial growth, and on the other hand there is continuous decline in ground and surface water levels due to over exploitation (R Subashree et al., 2017). Water contains many impurities which comprise mixture of dissolved solids, suspended solids and colloidal particles. Suspended solids - These may be inorganic in nature or mineral form (sand, silt, clay) or organic in nature including microorganism such as bacteria, virus, algae, etc. these substances are responsible for turbidity and colour of water (M Abdullah et al., 2017). More than one billion people worldwide, mostly in developing countries, lack safe drinking water. Apart from the scarcity of water, there are many other challenges in providing a safe, adequate and reliable water supply in many parts of the world. Many technologies are in practice to treat the wastewater and in the present study, an attempt was made to investigate the

application of natural coagulant from orange peels for the treatment by considering from 3 different sources Numerous of coagulants are widely used in conventional water treatment processes

The popular chemical coagulant is alum. However, the use of these chemical coagulants resulted in many downsides such as harmful voluminous sludge production. Despite the superiority of chemical coagulants in treating turbid water, they are still lacking in terms of green chemistry. In the 1960s, detrimental effects of chemical coagulants on the human health were published (Simate et al., 2012). The fundamental of this study is the potential for the natural coagulant as per used which is orange peels to occupied for water treatment like other conventional coagulant such as alum and other chemical derivative that available. The use of natural coagulant such as orange peel which is used as experimental material in water treatment is more economical instead of to produce treated water with high dosage of pH and highly ecological. These waste peels are low cost, non-hazardous and environment friendly bio-materials which can be used as coagulant in water treatment (Amir Hariz Amran et al., 2018). Coagulants derived from natural sources are usually considered safe for human health. While the commercial coagulants are effectual only at certain pH range and beneficial flocculation not be possible in some water.

LITERATURE REVIEW

In the treatment of water, coagulation is essential step for removing odor, colour and suspended particles. The utilization of plant and fruit peels materials as selected coagulants for treatment of waste water has number of research exercises are going on. Coagulation process in raw water treatment is the procedure of charge balance of colloidal particles utilizing the addition of a chemical reagent or the formation toward conditioning suspended solids particles to promote their agglomeration thus produces bigger particles that can be more promptly evacuated in consequent treatment processes (AWWA et al., 1990). Flocculation is the procedure by which the destabilized particles agglomerate and shape flocculants particles, or "floc."(Crittenden et al., 2005).

Previous researchers mostly used Jar Test as their laboratory work to study the coagulation and flocculation of water treatment where it is a common experimental approach for the research. As for the materials, predominantly coagulant used of natural based was Moringa Oleifera with high percentage of turbidity removal while usual conventional coagulant used was Aluminium Sulphate. *Moringa Oleifera* is the most widely cultivated species of the genus moringa, which is the only genus in the family *moringaceae.* Crushed moringa seeds clarify and purify water to suit domestic use and lower the bacterial concentration in the water making it safe for drinking. It can be used as a quick and simple method for cleaning dirty river water. It also acts as an anti-bacterial agent removing 90-99% bacteria content in water (Nagarajan et al., 2018).

Utilizing some locally accessible natural coagulants, for instance banana strip and lemon strip significant improvement in removing turbidity and BOD from engineered raw water was found. Most extreme turbidity decrease was found for very turbid waters. After dosing, water-solvent Concentrate of banana strip and lemon strip diminished turbidity from 38 to 5.2 NTU after dosing and filtration. It was likewise discovered that these natural coagulants decreased about 89– 96% BOD. Among the regular coagulants utilized in this investigation for turbidity decrease, lemon strip was discovered most effective. It decreased up to 95.89% turbidity from the raw turbid water (R. Subashree et al., 2017).

According to Anju S et al (2016), Dairy wastewater was used for coagulation studies with orange peel powder as coagulant. Main object of coagulation studies is to explore effectiveness of orange peel coagulant for reducing wastewater characteristics parameter such as turbidity and measuring the pH, total solids through removal of organic colloidal suspensions. Five orange peel coagulant doses in range of 0.2 to 1g/l were applied to wastewater. The turbidity was found to be reduced from 260NTU to 8NTU with the dosage of 0.2g, 0.4g, 0.6g, 0.8g, 1g.

METHODOLOGY

The methodology for this case study will be on intervention that is also known as experimental action research. The subject of this examination is to study the use of Orange Peel as a trademark coagulant for the refinement and illustration of raw turbid water and waste water from different sources.

Water Sampling

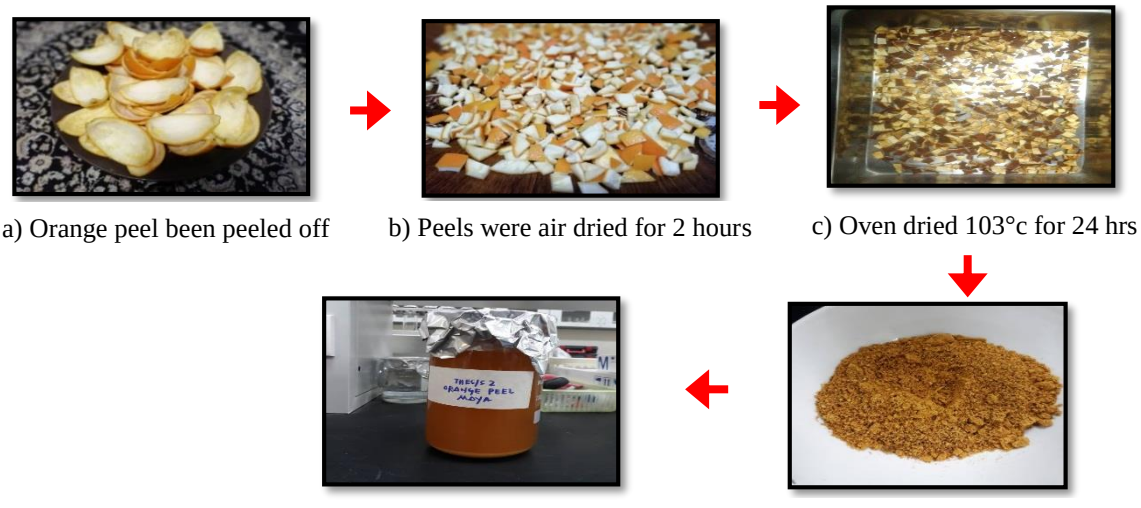
Collection of water samples were derived from 3 different sources. The water samples were taken as raw water of 4 litres amount per place in sterilized bottle. The crude water was basically from lake based which were obtain from Taman Metropolitan Kepong Lake, Seri Serdang Lake and last but not least Taman Cempaka Lake. The water samples then been taken to the laboratory for several test in order to get initial condition before proceed to jar test.

Preparation of Chemical Coagulant (Alum Solution)

Alum solution was prepared by dissolving 1 gm of powder alum into 1000ml or 1 litre of distilled water and stir vigorously to produce a 1 % solution strength. Thus, 1 ml of this (stock solution) is equivalent to 10 mg of alum (or 10 mg/l dose when add to a 1-l raw water sample) (Al-Saati et al., 2016).

Preparation of Natural Coagulant (Orange Peel)

Orange peel was collected from nearby market and wash a few times with tape water to evacuate the adhering dirt. Further the peels were air dried for 2 hours and cleaved by manual cutters into little pieces. Later on squashed to acquire small particle measure powder. Later the fresh peels were spread on trays and oven dried at 103 - 110 °C for 24 hours. The dried peels were blended into powder and sieved using mesh size of 600µm. The powdered peel was stored in an airtight container. Then 10 gram of powdered peels were taken and mixed with 1000ml (1 litre) of distilled water to produce orange peel stock solution. Figure 1 shows the process of preparing an orange peel stock solution as natural coagulant.



a) Orange peel been peeled off b) Peels were air dried for 2 hours c) Oven dried 103°c for 24 hrs

e) Orange peel powder mixed with 1000ml of distilled water d) Orange peel powder been sieved

Figure 1: Process of preparing an orange peel stock solution

Experimental Procedure

Coagulation experiments were performed using jar test apparatus. Water samples were poured in 500 ml of 12 beakers with a volume of 300 ml each and varying doses alum were added in different 6 beakers containing 3ml, 6ml, 9ml, 12ml, 15ml and 18ml while of Orange Peel were added in different 6 beakers containing of 9ml, 18ml, 27ml, 36ml, 45ml, and 54ml. Initial pH and turbidity of the water samples was measured using pH meter and turbidity machine respectively. Samples were stirred at 100 rpm for 2 minute and slowly mixed at 40 rpm for 20 minutes followed by settlement of 30 minutes. Effectiveness of was evaluated by measuring removal of turbidity at various pH and coagulant doses, and river water. Turbidity of the settled samples was measured using turbidity meter. All the samples were tested three times and mean values are reported. The jar test experiment set up is shown in Figure 2.

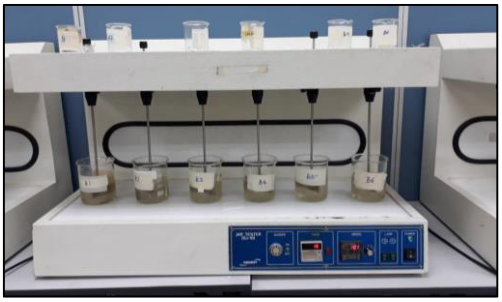


Figure 2: Jar Test Method for both coagulants alum and natural in IUKL Laboratory

RESULT AND DISCUSSION

Combination Results of pH and Turbidity for Sample 1, 2 And 3 by Using Alum

The initial and residual value of pH and Turbidity for sample 1, 2 and 3 is shown as reference in Table 1. The results of pH and Turbidity (NTU) after the treatment is being done and the graph pattern for pH vs alum stock solution (ml) and turbidity vs alum stock solution (ml) are shown in Figure 3 and 4, where it clearly states that the highest residual pH level for sample 1, 2 and 3 with 8.04, 7.72 and 7.04 respectively using 3ml of alum stock solution and the lowest pH level is7.48, 7.33 and 6.51 individually with 18ml alum of stock solution added. According to Suleyman A. Muyibi et al., 2004, pH level which is in the range of 6.5 – 8 is acceptable as following to National Water Quality Index Standards for Malaysia (NWQS) (S. Suratman et.al. 2015).

Next, in the matter of turbidity, the initial value of turbidity removal for sample 1 and 3 was 45.43 NTU and 43.00 NTU where it is in the state of low turbidity (<50 NTU) while initial reading for sample 3 was 62.27 (50 < turbidity < 100) where it is in the state of moderate turbidity (Suleyman A. Muyibi et al., 2004). Once the treatment is carried out, the lowest residual turbidity removal for sample 1, 2 and 3 is 4.01NTU, 13.70 NTU and 13.53 NTU respectively with 3ml of alum stock solution added and the highest residual turbidity removal for sample 1 is 0.42 NTU with 9ml, 2.14 NTU with 18ml for sample 2 and 1.51 NTU with 15ml for sample 3. This corresponding to efficiency percentage removal of 99%, 96% and 95% individually for sample 1, 2 and 3. World Health Organization (WHO) has set the guideline value for the residual turbidity in drinking water at

5 Nephelometric Turbidity Units (NTU) where alum satisfied the criteria with turbidity removal less than 5 NTU (Eman N. Ali et.al 2010).

Combination Results of pH and Turbidity for Sample 1, 2 And 3 by Using Orange Peel

In reference to Table 1, it shows the results of pH after the treatment is being done, it stipulates that the highest residual pH level for sample 1, 2 and 3 is 8.09, 7.18 and 7.12 respectively with 9ml of orange peel stock solution and the lowest pH level is 7.31, 6.66 and 6.64 individually with 54ml of orange peel stock solution added. The graph pattern for pH vs orange peel stock solution (ml) and turbidity vs orange peel stock solution (ml) can be observed referring to Figure 5 and 6. Therefore, pH value for sample 1, 2 and 3 is classified as neutral which follows the standards as prescribed by World Health Organization (WHO) (Nagarajan et.al, 2018). Volume of dosage plays an important role where the higher the dosage of orange peel stock solution added the lower the pH value.

Other than that, in respect of turbidity, (<50 NTU) is categorized as low turbidity, (50 < turbidity < 100 NTU) is known as moderate turbidity and last but not least (> 100 NTU) is in the class of high turbidity (Suleyman A. Muyibi., 2004). The initial value of turbidity removal for sample 1 was 45.43 NTU, 62.27 NTU for sample 2 and 43.00 NTU for sample 3. In regards to Table 1, it shows the results of turbidity removal once the treatment is done, the lowest turbidity removal for sample 1, 2 and 3 is 21.77 NTU, 30.53 NTU and 28.23 NTU accordingly with 54ml of orange peel stock solution. The highest turbidity removal is 9.16 NTU, 13.87 NTU and 13.93 NTU consequently with 9 ml of orange peel stock solution which adequate to efficiency turbidity removal percentage of 80%, 78% and 68% respectively. As for natural coagulant, less concentrated solution which refers to lower dosage of coagulant will act effectively in turbidity removal where it produced less colloidal solution. This is the reason that the result in turbidity removal is increasing as dosage of orange peel stock solution increasing. Accordingly, 9 ml of orange peel stock solution is satisfactory as an optimum dosage of those 3 water samples which it reduces the most colloids from the solution compared to the highest dosage which is 54ml in resulting to low turbidity removal.

According to the Malaysian Department of Environment-Water Quality Index (DOE-WQI), the orange peel results closely suitable for class IIA and IIB. Class IIA refers to Water Supply II – Conventional treatment and Fishery II – Sensitive aquatic species. While for Class IIB relates to Recreational use body contact (S. Sutratman et.al. 2015). As a whole of view, residual pH for those 3 lakes indicates a decrease in level which it neutralized the water sample in between the range of 6.5 to 8.0 as shown in Table 1 as equivalent to the range recruited by the standards where for both class IIA and IIB pH value should be in the series of 6.0 to 9.0.While in the matter of turbidity, The Malaysian Department of Environment-Water Quality Index (DOE-WQI) has resolute that for class IIA and IIB, the turbidity value shall be 50 NTU (S. Suratman et.al. 2015). This point out that the residual turbidity obtained from the analysis is satisfactory which less than 50 NTU. In this manner, orange peel as a natural coagulant has a potential in water treatment process precisely in colloids removal.

Table 1: Initial and Residual Reading of pH and Turbidity (NTU) for sample 1, 2 and 3

INITIAL READING							
WATER SAMPLE		**pH**		**Turbidity (NTU)**			
Sample 1 (Taman Metropolitan Kepong Lake)		7.90		45.43			
Sample 2 (Seri Serdang Lake)		7.78		62.67			
Sample 3 (Taman Cempaka Lake)		7.89		43.00			
RESIDUAL READING							
Coagulant	**Dosage (ml)**	**Sample 1 (Taman Metropolitan Kepong Lake)**		**Sample 2 (Seri Serdang Lake)**		**Sample 3 (Taman Cempaka Lake)**	
		Residual pH	**Residual Turbidity (NTU)**	**Residual pH**	**Residual Turbidity (NTU)**	**Residual pH**	**Residual Turbidity (NTU)**
Alum	3	8.04	4.01	7.72	13.70	7.04	13.53
	6	7.85	0.98	7.50	8.58	6.86	6.15
	9	7.66	0.42	7.43	6.53	6.83	2.64
	12	7.61	0.85	7.27	3.38	6.68	2.17
	15	7.59	0.64	7.40	3.73	6.60	1.51
	18	7.48	0.48	7.33	2.14	6.51	2.02
Orange Peel	9	8.09	9.16	7.18	13.87	7.12	13.93
	18	7.80	12.83	7.20	17.93	7.04	16.70
	27	7.76	19.07	6.91	21.40	6.90	21.23
	36	7.63	19.63	7.29	25.47	6.81	22.43
	45	7.53	20.23	6.68	28.40	6.73	24.40
	54	7.31	21.77	6.66	30.53	6.64	28.23

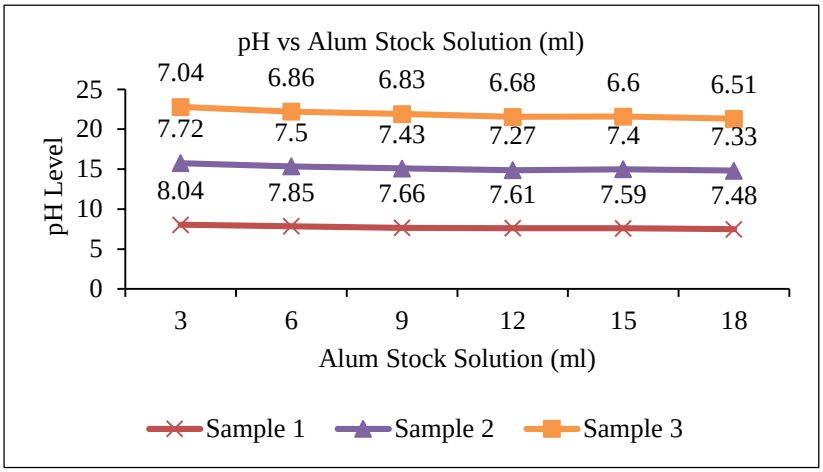


Figure 3: pH versus Alum stock solution (ml) for water sample 1, 2 and 3

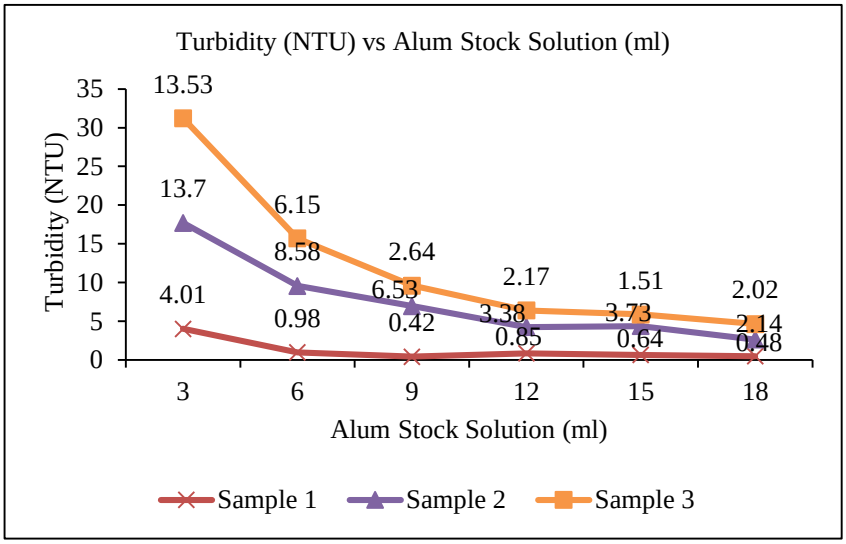


Figure 4: Turbidity (NTU) versus Alum stock solution (ml) for water sample 1, 2 and 3

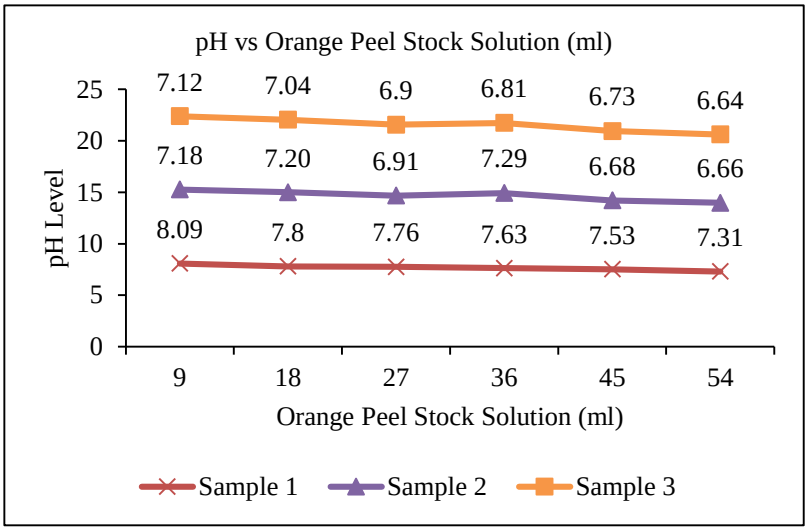


Figure 5: pH versus Orange Peel stock solution (ml) for water sample 1, 2 and 3

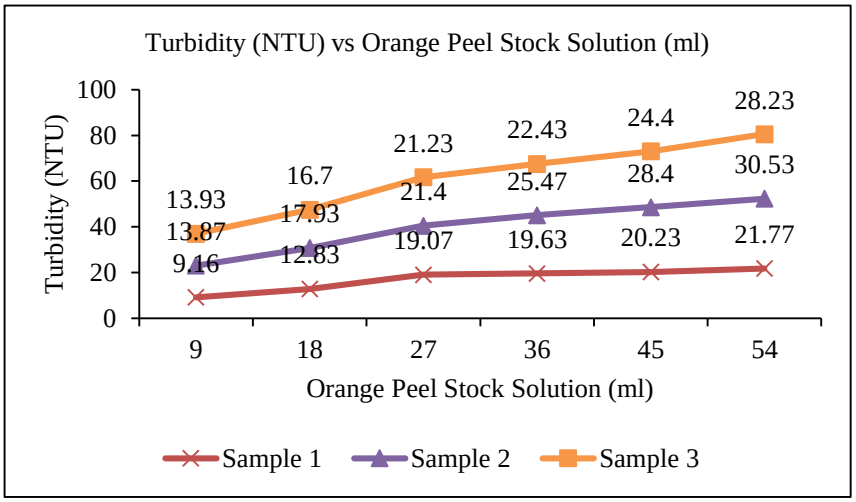


Figure 6: Turbidity (NTU) versus Orange Peel stock solution (ml) for water sample 1, 2 and 3

CONCLUSION

This chapter broadly explains on the whole perspective specifically in coagulation process in water treatment with the used of conventional and natural coagulant which is alum and orange peel respectively by taking results as reference in order to satisfy the objectives stated as follows.

Objective 1: To determine pH and turbidity of orange peel and alum by comparing the results of 3 different sources by using Jar Test.

The results shown includes the initial and residual reading in the aspect of pH and turbidity of the water sample of 3 different lakes which are Taman Metropolitan Kepong Lake, Seri Serdang Lake and Taman Cempaka Lake. Different lake has different properties and characteristics, therefore, the first objective is utmost important in order to determine its features precisely. Appertaining to the previous statement, those 3 water samples indicates pH level within the range of 6-8 which it is classified as natural state after the treatment is carried out. Next in the matter of turbidity, alum as a conventional coagulant shows greater results in turbidity removal up to 99% compared to orange peel as natural coagulant up to 80%.

Objective 2: To determine the optimum dosage of the Orange Peel by using Jar Test.

For the Jar Test process, various dosages of orange peel stock solution were used in order to observe maximum reduction of colloids in the water sample. Therefore, optimum dosage is a vital element in order to examine the turbidity removal at higher proportion. From the results, stated that 9ml of orange peel stock solution was defined to be the optimum dosage in the treatment process for those 3 lakes. This is because 9ml dosage was applicable and utilizable which shows a great turbidity reduction compared to the highest dosage used which is 54ml.

Objective 3: To compare the effectiveness of alum with Orange Peel as a natural coagulant.

Both coagulant used which are alum (conventional) and orange peel (natural) presents an effective results in turbidity removal and pH balance. Alums demonstrated tremendous outcomes which resulting of 69% to 99% of turbidity removal. However, as mentioned in statement of problem, it proves that by using chemical based of coagulant will leads to many downsides such as detrimental effects on the human health (Simate et al., 2012). Even though, orange peel does not presents the results of turbidity removal as high as alum, but it still effective and well worked in turbidity reduction resulting greater than 50% which it removes 69% to 80% of colloids throughout the treatment. Therefore, a prominent solution by using orange peel (natural-based) as coagulant is accepted while not leading to adverse impact to the consumers where it is safe and environmental friendly.

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