

## **A Study on Effectiveness of Sodium Dichloroisocyanurate (NaDCC) as Surface Water Purifier: Aquatab Tablet**

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**Abstract:** Sodium dichloroisocyanurate (NaDCC) is a chemical that can be used to purify water. Purification of water is intended to improve the quality of water that is both harmless and safe for human consumption. Sodium dichloroisocyanurate (NaDCC), which is frequently used in emergencies, is a chlorine alternative that may have some advantages over household-based interventions in developing countries. NaDCC is a white crystalline powder or granular substance that has a faint chlorine odor. A typical effective concentration of free available chlorine (FAC) in drinking water is around 1 mg/L. Assuming a daily water intake of 2L per person, the daily NaDCC intake would be 3 mg. A product that form NaDCC will be Aquatab tablet for treat surface water. The guideline values for water quality were determined using the National Lake Quality Criteria and Standard (NLWQS). The study location was located at G3 lake in the campus of Universiti Tun Hussein Onn Malaysia as many students complained the lake smells rotten and irritating after do water activities. The Aquatab tablet by Medentech product that contain 8mg of NaDCC per packet will be determine the effectiveness as water purifier and identify the active element NaDCC in this studies. The efficiency of Aquatab tablet for sample at G3's lake for total dissolved solids (TDS) 17.58%, turbidity (NTU) 15.07%, pH 13.03%, electrical conductivity (EC) 32.02%, and oxidation reduction potential (ORP) 65.69% amd tested using HANNA multi-parameter.

**Keywords:** Sodium Dichloroisocyanurate, NaDCC, Aquatab, Water Purification, Surface Water, Lake

### **1. Introduction**

Nowadays, application of water purification for water treatment had been develop in many countries. Filtration is among of popular water treatment. However, new design of water treatment had developed to a new way by using purification. Purification treatment was an emergency treatment before the effluent water being used for a critical treatment for human used. Water purification is crucial nowadays as clean water resources getting limited sodium dichloroisocyanurate (NaDCC) that potentially to be used in treating water at household level. NaDCC has currently been approved by the

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United State Environmental protection agency (UESPA) and World Health Organization (WHO) as water purifier. NaDCC that contain both the dihydrate and anhydrous material, as well as cyanuric acid, are well-characterized substances. Physical and chemical properties are described in the Kirk-Othmer Encyclopedia of Chemical Technology [1] in a web-based document on chloroisocyanurates by Occidental Chemical Corporation [2] in a monograph developed by OxyChem [3].

To determine the effectiveness of sodium dichloroisocyanurate (NaDCC) as surface water it should be running few of parameter analysis. Parameter analysis that related with water quality were total dissolved solid (TDS), turbidity (NTU), pH, electrical conductivity and oxidation reduction potential. By this parameter, it can conclude NaDCC has the potential to be used in surface water purification due to the active ingredients and its chemical properties.

## 2. Literature Review

Due to the growth of population and industrial, the availability of water resources was decrease day by day. Various processes of the water purification have been developed by the scientist and researchers in order to overcome this problem of water pollution. There are two main types of water main type of water purification. They are drinking water treatment and the wastewater treatment. Firstly, the drinking water treatment need the water has to be collected from their original sources such as rivers and reservoirs and purify them under the applicable quality standards followed by the environmental protection license. After the purification, water should be healthy for human consumption and free of harmful microorganisms and organic and inorganic pollutants. Secondly, wastewater treatment was from the industrial processes should be collected and purified before releasing it to different environment such as surface waters, lands for irrigation purposes, marine coastal areas and etc.

Surface water is mostly obtained from rainfall and formed of run-off and groundwater. It includes major rivers, ponds, and lakes, and also minor upland streams that may originate as springs and collect run-off from the watershed (World Health Organisation, 2001). For this case study, lake was used for analysis the data. Lake water can be described as an enclosed body of water with preferable size and surrounded by land with no direct access except with a river or stream that feed or drains the lake (Yuk Feng Huang, 2015). Based on the National Lake Quality and Standard, lake water are categorized by categories. Table 1 shows the categories of lakes.

**Table 1: Description of lake categories [4]**

NO	CATEGORIES	DESCRIPTION
1	A	Lakes that are managed in which the water to be used for recreational purpose such as swimming, diving and kayaking [4].
2	B	Lakes used for recreational purposes as secondary body contact such as boating and cruising. Swimming is not allowed in this category of lakes [4].
3	C	The lakes are meant for the preservation of aquatic life and biodiversity [4]
4	D	Lakes managed for the minimum preservation of good aquatic life in the lakes. It applies good management practices of lakes [4]

From Table 1, it shows the overall lakes catergorized into 4 based on National Lake Quality Standard. Lakes under category A normally let the people to swim in that lakes. These category is free from water born disease. Table 2, Table 3, Table 4, and Table 5 shows the minimum required parameter and the value of lakes under category A, B, C and D.

**Table 2: Parameters of lake water for category A [4]**

Parameter	Unit	Category A
PHYSICAL		
pH	-	6.5 – 8.5
Turbidity	NTU	40
Total Dissolve Solid	mg/L	<100
Dissolve Oxygen	mg/L	6.3 – 7.8

**Table 3: Parameters of lake water for category B [4]**

Parameter	Unit	Category A
PHYSICAL		
pH	-	6.5 – 8.5
Turbidity	NTU	40 - 170
Total Dissolve Solid	mg/L	100 -150
Dissolve Oxygen	mg/L	5.5 -8.7

**Table 4: Parameters of lake water for category C [4]**

Parameter	Unit	Category A
PHYSICAL		
pH	-	6.9 – 9.0
Turbidity	NTU	70
Total Dissolve Solid	mg/L	200
Dissolve Oxygen	mg/L	4.5 – 10.3

**Table 5: Parameters of lake water for category D [4]**

Parameter	Unit	Category A
PHYSICAL		
pH	-	5.5 – 9.0
Turbidity	NTU	250
Total Dissolve Solid	mg/L	> 200
Dissolve Oxygen	mg/L	3.3 – 10.3

To make sure the quality of lake is maintained, the NAHRIM will be review every 3 to 5 years. The reason of this time frame is to collect more information can be used and updated the information on parameter so it will be more accurate with Malaysian standards [4]. Based on previous studies, according to Muhammad Syazwan G3's lake falls under category A. Therefore, all the parameter will be tested and compared to this category.

## 2.1 Sodium Dichloroisocyanurate (NaDCC) as surface water purifier.

Household water treatment with NaDCC has been acknowledged as a cost-effective method of reducing the severe burden of diarrhoea and other waterborne infections, especially among communities without sufficient water supplies. Sodium dichloroisocyanurate (NaDCC), which is frequently used in emergencies, is a chlorine alternative that may have some advantages for household-based interventions in poor economies [5]. NaDCC is a white crystalline powder or granular substance that has a slight chlorine smell. When chlorinated and non-chlorinated isocyanurates are dissolved in water, a series of complex interactions between them and free available chlorine (FAC) in the form of hypochlorous acid are formed (HOCl). HOCl is the active antibacterial agent, effective against a wide variety of bacteria, fungi, algae, viruses, and other microbes, regardless of the source of FAC. When NaDCC is applied to water, it releases FAC and triggers a complex series of isocyanurate equilibrium reactions involving six chlorinated and four non-chlorinated isocyanurates. As an analogy [3], dissolving of NaDCC results in the formation of 1.0 mg/L total active chlorine at a pH of 7.0 [6]. In normal batch-type use of NaDCC, oxidative and microbiocidal demand will consume FAC until all available chlorine has been reduced, leaving only non-chlorinated isocyanurates. But, as long as NaDCC is added to water to maintain a certain level of total available chlorine or FAC, the various cyanurates will be present at levels dependent on the properties of the water.

**Table 6: Table of characteristics NaDCC [6]**

	<b>Anhydrous</b>	<b>Dihydrate</b>
<b>CAS number</b>	2893-78-9	51580-86-0
<b>Chemical formula</b>	NaC <sub>3</sub> N <sub>3</sub> O <sub>3</sub> Cl <sub>2</sub>	NaC <sub>3</sub> N <sub>3</sub> O <sub>3</sub> Cl <sub>2</sub> •2H <sub>2</sub> O
<b>Formula weight</b>	219.95	255.98
<b>Assay (dry basis)</b>	> 98%	> 98%
<b>Available chlorine</b>	>62.0 %	55.0 % - 57.0%
<b>Solubility in water</b>	24g /100g	28g /100g
<b>pH (1% aqueous solution at 25 degree</b>	6.0 – 7.0	6.0 -7.0
<b>Melting Range</b>	240o (decomposes)	loses 1st H <sub>2</sub> O at > 40 o; 2ndH <sub>2</sub> Oat>80o; 240o (decomposes)



**Figure 1: Aquatab by Madnetch**

This product as shown in Figure 1 is manufactured by Madentech in Ireland to custom as a branded solid version of NaDCC for different treatment regimes. Medentech manufacture a 67mg contain NaDCC to treat wastewater. In solution, NaDCC creates HOCl as a disinfectant, but withholds half of the potential free chlorine in a stored, unavailable form until its usage is requested. This is especially beneficial to work around the pH sensitivities inherent in dilute liquid bleach [7]. It is stable in form of Aquatab tablet, easy to handle, longevity, and transit more easier than with liquid bleach. Aquatabs have acidic ingredients that lower pH and boost effective disinfection as well. Aquatabs are hard to create and cost a bit more than concentrated bleach per health impact for all of these material benefits.

### 3. Methodology

A lake at G3 Universiti Tun Hussein Onn Malaysia (UTHM) is chosen for this case study to determine the effectiveness of NaDCC in Aquatab tablet. The sample location was determined using GPS Coordinate application to get a specific place for next reference, N 1°51'34.56393" E 103°5'9.16291. The area of lakes usually used by the students for water activities such as kayaking, leisure and jogging. Based on the previous case study, G3's lake had high value of pH, TDS, TSS, BOD and others parameter. Others than that, many students were complained about the quality of water at G3's lake. They experience irritation after playing kayaking and the smell of rotten water. Approximately, 5 liters of water was collected and stored in refrigerator at MPRC laboratory.



**Figure 2: The sample water was taken by PTTE bottle.**

All the apparatus were washed thoroughly with distilled water. The weight of Aquatab tablet was 8.5 mg and can be filtered for 1 liter water only. Take 1 tablet and drop into water and stir the water sample immediately. This shows that, flocculation and coagulation occur and will release hypochlorous acid based on Figure 4. The tablet dissolves clear within minutes and disinfects the water within 30 minutes. The measurement was carried out using HANNA multi-parameter instrument and the reading of the water samples taken for 3 times. By using HANNA multi-parameter, it will collect data for TDS, pH, DO, turbidity, ORP and EC to determine the effectiveness of this tablet. From this test, the

characteristics of the lake water were obtained. This test also could be obtained the relationship between TDS, Turbidity and pH for G3's lake.



**Figure 3: Reading the parameter by using HANNA instrument.**



**Figure 4: Stir immediately after from the Aquatab tablet.**

#### 4. Results and Data Analysis

##### 4.1 Aquatab tablet as water purification treatment

Aquatabs are tablets that contain the active component NaDCC and an inert effervescent base constructed of pharmaceutical and food quality excipients. NaDCC is also known as sodium troclosene, sodium dichloro-s-triazine trione (SDIC). It is a chlorine contributor that is organic. When NaDCC is dissolved in water, it produces chlorine and cyanurate, a non-toxic and biodegradable by-product. Based on the Table 7 result obtained from previous research, for every tablet Aquatab per packet it contained 8.5 mg of NaDCC. Aquatab tablets were used to disinfect drinking water or in any other emergency circumstance when human intake was required. 1,3,5 – Triazine – 2,4,6 (1H, 3H, 5H) – trione, 1, 3 – dichloro-, sodium salt is used in the manufacture of NaDCC in Aquatab tablets (sodium dichloroisocyanurate). Aquatab has a white tablet shape and has excessive water solubility.

**Table 7: Composition of ingredients NaDCC in Aquatab tablet [8].**

Ingredient	Weight in Product (% w/w)	CLP Classification
Troclosene Sodium / 1,3,5 – Triazine – 2,4,6 (1H, 3H, 5H) – trione, 1,3 – dichloro-, sodium salt	10 – 65%	Danger Oxidizing Solid – Cat. 2 Eyes irritant – Cat. 2 Harmful if swallowed – Cat. 4 May cause respiratory tract irritation – Cat. 3

#### 4.2 The effectiveness of NaDCC before and after treatment

Physical parameter is a significant parameter that need to know the characteristic of the water.

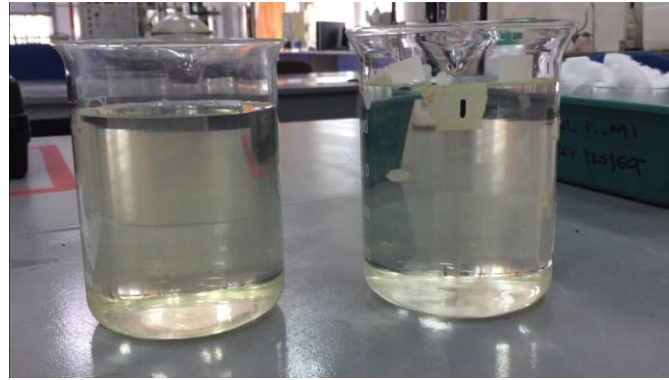
**Table 8: Data analysis water sample before treatment, after treatment and NAHRIM parameter**

Parameter	Before treatment	After treatment	Efficiency (%)	Parameter based on NLWQS (2015)
Total Dissolve Solid (TDS)	273 mg/L	225 mg/L	17.58	300
pH	5.45	4.74	13.03	6.5 – 8.5
Dissolved Oxygen (DO)	5.36 mg/L	5.49 mg/L	2.43	6.3 – 7.8
Turbidity	6.77 NTU	5.75 NTU	15.07	40
Oxidation Reduction Potential (ORP)	85.2 mV	141.17 mV	65.69	-
Electric Conductivity (EC)	625.67 uS/cm	425.33uS/cm	32.02	< 1000

Table 8 shows that TDS value before treatment was 273 mg/L and after treatment 225 mg/l. The value was decrease after the treatment with Aquatab tablet. According to WHO, TDS concentrations in natural sources range from less than 30 mg/litre to as much as 6000 mg/litre, depending on the solubility of minerals in various geological regions [9]. Consumers generally accept water with TDS concentrations less than 1000 mg/litre, although acceptance varies according to circumstance [9]. However, if the value indicates that the water contains a high concentration of TDS as a result of possible taste and excessive scaling in water pipes, heaters, boilers, and residential appliances. Water with pretty low TDS concentrations may also be unpleasant to consumers due to its bland, insipid flavour; it is frequently also damaging to water supply systems.

Moreover, the data for DO was increase from 5.36 mg/l to 5.49 mg/l respectively (Table 8) before and after treatment. The oxygen concentration in lakes varies according to their depth. In deep lakes with less wind, oxygen levels decrease as we go deeper. Oxygen levels are generally low at the bottom of all lakes, where the water meets the lake sediment or mud. This is because the sediment contains numerous bacteria and animals that live and breathe. These bacteria and animals consume oxygen as they decompose dead material that sinks to the bottom. Elsewhere, Tennessee's listing method says that if the low DO level is triggered by a natural condition such as groundwater sources, a spring, or a wetland, the low DO concentration is designated a natural condition, not pollution [10].

Turbidity levels greater than 1–2 NTU lead to low levels of chlorination by increase chlorine demand and perhaps sheltering bacteria from inactivation. [11]. As it shows on Table 8 the value before treatment for turbidity was 6.77 NTU and slightly drop to 5.75 NTU after the treatment with Aquatab. Keegan state that, while there is data that disinfection can occur at increasing turbidity, chlorine concentrations or contact duration must be increased to obtain a sufficient Cts1 [12].



**Figure 5: Prove that the sample after treatment (right) have lower turbidity more than the before (left).**

Next, ORP testing provides several benefits for “real-time” monitoring and recording of water purification potential as an important parameter of water quality. Based on Table 8, 85.3 mV was the value before treatment and improve after treatment to 141.7 mV. Even so, Trevor found that an ORP should be above 650Mv and anything that greater than 800mv is excellent [13].

Surface water considered to be an ideal insulator rather than a conductor of electric current. Electrical conductivity is often determined by the quantity of dissolved particles in water [14]. G3's lake was tested for EC and the value was decreased (Table 8) from 625.67 to 425.33 after treatment. EC really determines the ionic mechanism through which a solution transmits current. According to WHO guidelines, the EC value for drinking water should not exceed 400 S/cm. [15].

## **5. Conclusion**

The main objective of the study was to identify the active element sodium dichloroisocyanurate (NaDCC) on Aquatab tablet. Based on the results obtained from previous research, for every tablet Aquatab per packet it contained 8.5 mg of NaDCC. Aquatab tablets were used to disinfect drinking water or in any other emergency circumstance when human intake was required. 1,3,5 – Triazine – 2,4,6 (1H, 3H, 5H) – trione, 1, 3 – dichloro-, sodium salt is used in the manufacture of NaDCC in Aquatab tablets (sodium dichloroisocyanurate). Aquatab has a white tablet shape and has excessive water solubility. The second objective was to determine the effectiveness of NaDCC as a water purifier. Based on the result and data analysis, the G3's lake water sample was testing by using HANNA parameter and only three (3) parameters out of six (6) parameters that reach NAHRIM quality standard for category A in lakes.

It is recommended that to improve the treatments, during collecting sample water and should take a sample from different points to get more data accuracy. The physical parameter such as temperature, BOD, COD, TDS, and any other important physical parameters should be checked to understand the quality and characteristics of G3's lake. HANNA multi-parameter instrument should be maintained per 2 years so, the water sample can be tested and the data will be more accuracy. Lastly, try to do some research on NaDCC other products brand to get more effective and accurate data.

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