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SPECIAL ARTICLE

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WATER CONTAMINATED $CaCO_3$ AND ITS OPTICAL PROCESS OF AGGREGATION

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ABSTRACT

This paper reports an intensive study of water contaminated $CaCO_3$ and its optical process of aggregation by using an integrated simple electronic and optical devices system focusing on a simple integrated electronic system of time versus temperature and optical parameters measurements of transmittance, linear absorption coefficient and refractive index simultaneously. Our findings show the contaminated well water located about few kilometers from the beach area of Batu Merah Dalam, Ambon, Indonesia with a complex environmental problems of floods area has interesting physical properties in terms of its $CaCO_3$ aggregation process and bubbles formation during the heating temperature process from 35 to 100 ^{0}C. The process of aggregation formation increases as the temperature of the well water increases. While the refractive index of the system is mainly due to the bubble formation associated with a strong interaction of $CaCO_3$ aggregation process and the water molecules. This study contributes to an explanation of a strong scattering from microbubbles bahavior in the physical liquid system.

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INTRODUCTION

The main problem in human life is the water quality particularly related with its content quality which is consisting of chemical substances and its water size. On the other hand, the air pollutions due to CO and CO_2 as well as C-F gases may have widely influenced the whole earth atmosphere in which ${}_6C^{12}$ atom here is the most active element which is very light and can move faster when there is action of the same particle or another atomic particles close to it **[1-14]**. The chemical substances in contaminated well water here could be a contaminated substance from external environment such as in small attractive islands areas of Maluku, Indonesia consisted of about 400 islands in its north part and about 1340 islands in the center and south east parts with the number of small islands in Aru area alone is ~59 % or ~800/1340 islands. The main chemical substance such as $CaCO_3$ has the main contribution in this unique province of Indonesia of ~1740 small islands sourced from many different types of a long natural process of various types of coral reefs and ocean animal shells. On the other hand, current advanced soft-drink technology have been widely accepted in modern society via the injection or the cooperation of another useful and healthy chemical substances into pure water. In this postmodern society in which advanced nanotechnology has been widely spread, the water molecule from tape water named as normal H_2O aggregated molecules can be reduced about 5-8 times smaller in order to move it much faster and easier into human body when they drink water so that this kind of water molecules can function as a healer in human body moving in the whole body. In this paper, one tries to introduce a simple method to study unusual optical behavior of water contaminated $CaCO_3$ taken from a well of water located in a few kilometers distance from the sea area in a complex human housing in Batu Merah Dalam, Ambon, Indonesia. Time-temperature dependence of such water was characterized using a built up thermal sensor connected to a laptop via its USB port. While the optical properties of the water contaminated $CaCO_3$ was investigated under the influence of temperature linked to $CaCO_3$ aggregation process. By measuring the refractive index of each aggregation condition, we obtain that the optical behavior of this water contaminated $CaCO_3$ was mainly due to bubbles formation that covered each aggregation size in various different temperature. These findings suggest that such unusual optical properties might contribute to human advanced knowledge especially in water quality research and its various applications.

METHODS

Well water contaminated by $CaCO_3$ sample was taken from the area of Batu Merah Dalam, Ambon, Indonesia and then investigated using both simple experimental technique by incorporating an integration between a time measurement system sourced from computer device and temperature measurement system connected to a temperature sensor with the capability up to 100 ^{0}C, and an integrated microcontroller controlled using a software with a USB connector to laptop, and a separated optical measurement system linked with a USB microscope and a simple built up refractive index measurement system briefly depicted in **Fig. 1**.

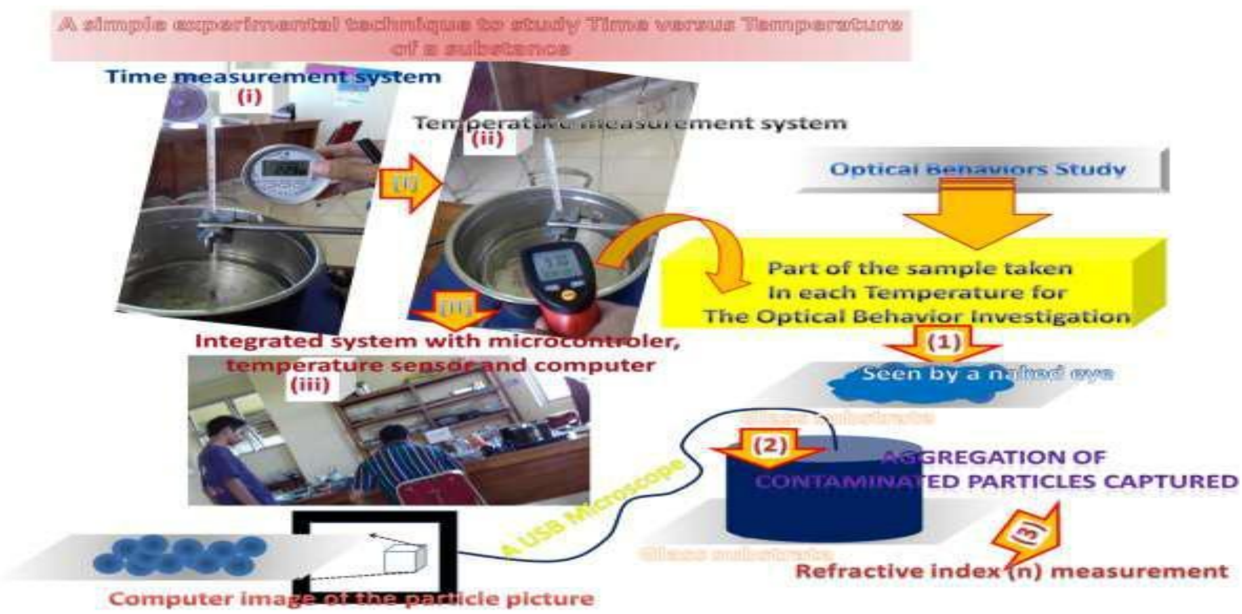

Figure 1. Three steps treatment to record an accurate data of time (*t*) versus temperature (T) in a substance: (**i**) Time measurement system, (**ii**) Temperature measurement system and (**iii**) Integrated system with microcontroller, temperature sensor and computer. While the optical behaviors measurement was also conducted simultaneously with at least 3 steps as follows: (**1**) Part of heated sample collected in different temperature, (**2**) a mobile USB microscope used to take the particle picture, and (**3**) Refractive index measurement was carried out to check the inner property of the substance.

In **Fig. 1**, one uses a double check measurement system in order to make sure the accuracy of this study. For example, the temperature measurement of the boiled well water contaminated by a main substance of $CaCO_3$ was measured not only by using one temperature sensor connected to an integrated electronic system, but also by direct measurement using an infrared thermometer.

RESULTS

Figure 2 shows a typical character of well water contaminated by $CaCO_3$ substance. The time versus temperature behavior of the contaminated water indicates that as the temperature increases, the time of aggregation of $CaCO_3$ substance inside it increases as well. It is interesting to point out that when the temperature reaches ~86 ^{0}C, the $CaCO_3$ aggregation got saturation about 66 s, and then as the external T increased until reaching 100 ^{o}C, there was a sudden decreased of temperature about 10 ^{0}C just in 8 s.

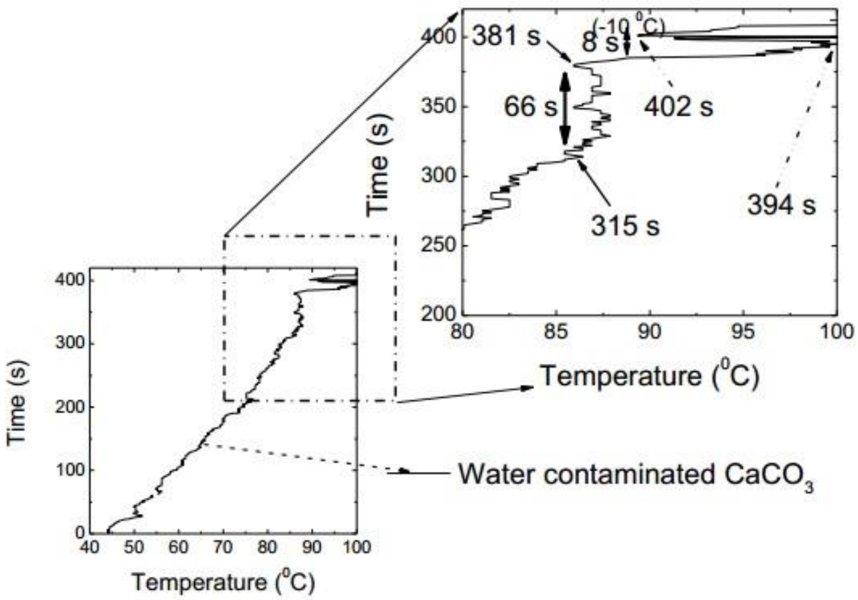

Figure 2. Character of time (*t*) versus temperature (T) of a well water (H_2O) contaminated with $CaCO_3$. The inset is the enlargement of a particular behavior of the sample.

The aggregation process of $CaCO_3$ in the well water captured by a mobile USB microscope connected to a laptop is shown in **Fig. 3**. According to the observation data, one can see that as the temperature of the well water increases, more $CaCO_3$ aggregation is obtained. Furthermore, te size of the aggregation formation inside the water is enlarged. This picture significantly indicates that the power of temperature increment can directly move a very small $CaCO_3$ substance inside the well water one another, and then they interact each other to form bigger aggregation. Therefore, the use of this simple technique is applicable to study an aggregation process of a sample in liquid sample just like the contaminated well water. It is interesting to note that at 65 ^{0}C, there are a lot of $CaCO_3$ aggregation is formed separately in different positions inside the water. Moreover, as the heating temperature is increased, these kinds of small size of $CaCO_3$ aggregations attach one another in their close interactions and then form a few bigger aggregation starting from75 ^{0}C to 100 ^{0}C.

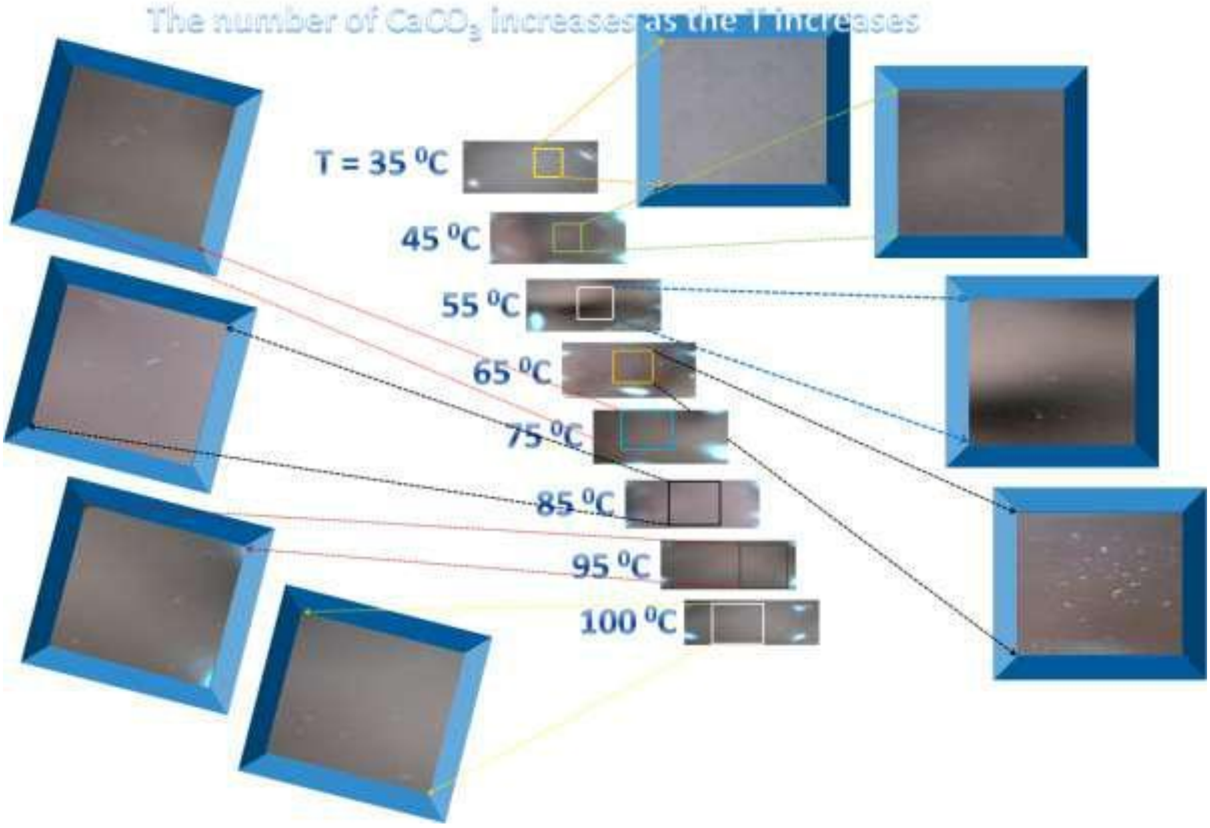

Figure 3. Aggregation behavior of $CaCO_3$ inside the contaminated well water as the temperature of the water increased up to 100 ^{0}C.

Table 1 depicts the important optical parameters data of contaminated by $CaCO_3$ which are under the influence of heating temperature such as transmittance (*T*), linear absorption coefficient (*α*), and refractive index (*n*) measured with two different wavelengths of 532 and 650 nm, respectively.

Table 1. Measurement of optical parameters of water contaminated by $CaCO_3$ in various temperature ranging from 35 to 100 ^{0}C.

T (^{0}C)	Wavelengths (nm)	*T* (100%)	*α* (cm^{-1})	*n*
35	**532**	55.0	10	0.85
	650	56.9	9	0.97
45	**532**	**52.2**	**11**	0.97
	650	65.4	7	0.99
55	**532**	60.9	9	0.92
	650	69.8	8	0.99
65	**532**	68.3	6	0.95

	650	**81.8**	**3**	**0.92**
75	**532**	66.4	7	0.92
	650	54.9	10	0.99
85	**532**	59.3	6	0.97
	650	**81.8**	**3**	**0.92**
95	**532**	53.7	10	0.92
	650	72.7	5	0.91
100	**532**	57.1	9	0.99
	650	55.5	10	0.91

From the various data shown in **Table 1**, one can figure out the characters of particular behaviors of this well water contaminated $CaCO_3$ as depicted in **Fig. 4**. The average transmittance of the contaminated water is ranging from ~52 to ~82 %. The largest T is found by using 650 nm wavelength measurement at 65 and 85 ^{0}C, respectively. However, at the same condition, the transmittance of the same sample has a different transmittance about 9 degree Celcius measured at λ = 532 nm. Such finding contributes to the sensitivity of the $CaCO_3$ aggregation formation to green laser light (532 nm). Such findings are also supported with the α measurement as shown in **Fig. 4(a)** and the t vs. T character in **Fig. 1**.

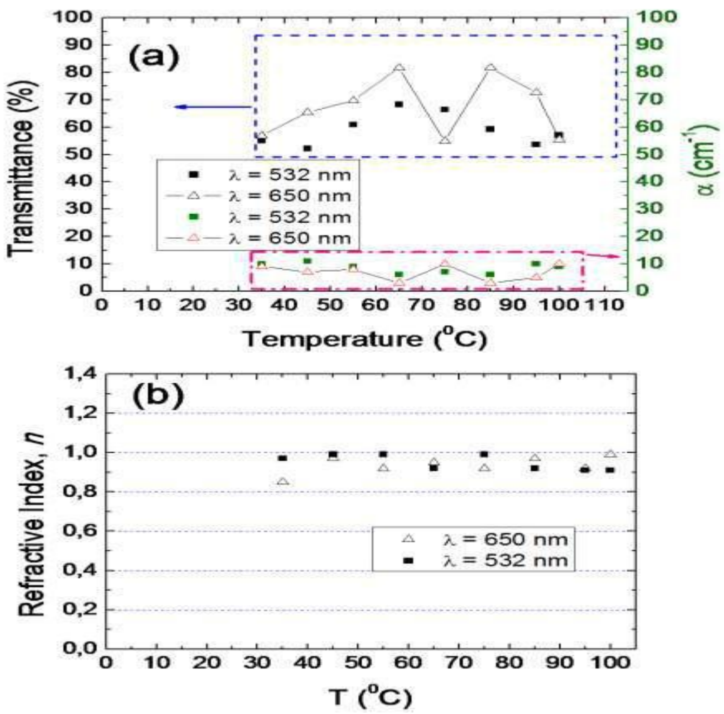

Figure 4. (**a**) Optical behavior based on the transmittance (T) and linear absorption coefficient (α) of well water contaminated with $CaCO_3$ aggregation investigated with two different wavelengths (λ = 532 nm and 650 nm). (**b**) The main contribution of the optical properties is due to the bubble formation in the system with the significant indicator from $n < 1$ smaller than the refractive index of water.

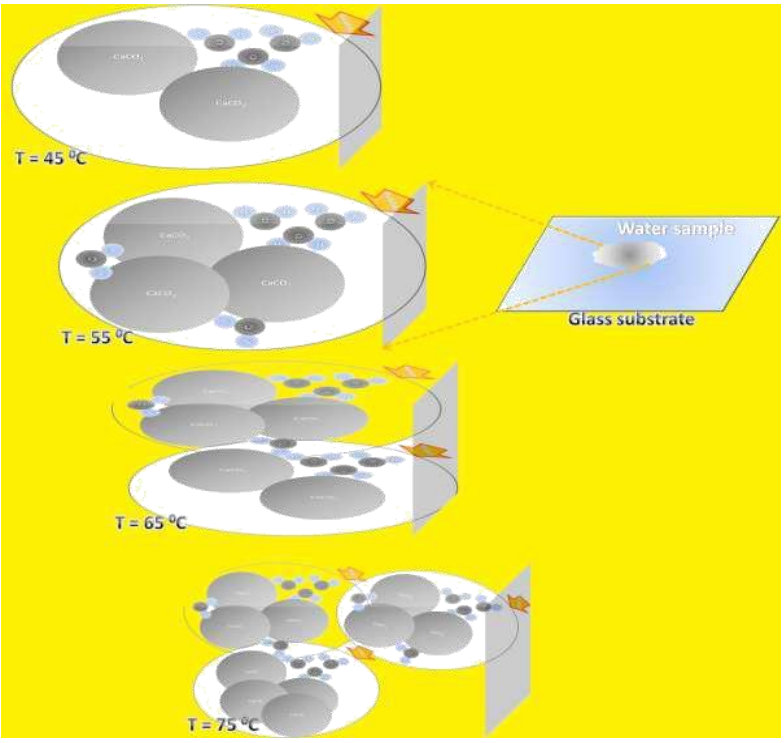

Figure 5. A proposed illustration of the explanation about the optical attitudes of the well water contaminated by the aggregation $CaCO_3$-temperature dependence.

Figure 4(b) shows the refractive index behavior of the contaminated water measured in different temperature. It points out that the average *n* of the system is about 0.91 – 0.99 or smaller than *n* of water. This indicates that such optical properties are mainly contributed by bubbles formation or many gas particles existed due to a very strong interaction between $CaCO_3$ formation and water molecules. Figure 5 describes a propose explanation of such behavior. From the *n* measurement at two different wavelengths of 532 nm and 650 nm as listed in **Table 1**, one can see that these kinds of bubbles are stable and mainly contributing to the refractive index of the optical system. Based on our formal intensive investigation on the optical limiting and nonlinear optical properties of various carbon nanomaterials such fullerene derivatives **[5,6,13]**, carbon nanoballs **[7,8]**, multiwalled carbon nanotubes (CNT). **[11]**, dan coated multiwalled CNT with metallics or semiconducting particles **[14]**, the nonlinear optical behaviors were due to bubble formation of the nanomaterials inside various solvents such as toluene, water, DMF and THF. Therefore, the largest contribution of the optical properties in the bubbles formation of the contaminated $CaCO_3$ water can cause a large scattering in such physical system which is similar to that in the carbon nanoparticles system **[5-8, 11,13-14]**.

CONCLUSION

In conclusion, water contaminated $CaCO_3$ and its optical process of aggregation have been intensively studied by using a simple technique with the incorporation of a simple integrated electronic system of time versus temperature and optical parameters measurements of transmittance, linear absorption coefficient and refractive index simultaneously. We obtain that the contaminated well water located about few kilometers from the ocean of Batu Merah Dalam, Ambon, Indonesia with a complex environmental problems of floods area has interesting physical properties in terms of its $CaCO_3$ aggregation process and bubbles formation during the heating temperature process from 35 to 100 ^{0}C. The process of aggregation formation increases as the temperature of the well water increases. While the refractive index of the system is mainly due to the bubble formation associated with a strong interaction of $CaCO_3$ aggregation process and the water molecules. This study suggests a strong scattering from microbubbles bahavior which needs further detail research in the future for a better understanding about this complicated liquid system.

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