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Study of Deoxygenation Efficiency on the Presence of Sodium Metabisulfite and Ascorbic Acid

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ABSTRACT: Dissolved Oxygen (DO) removal can be defined as deaeration or deoxygenation terms in which various methods are used to remove air molecules from water. In this study, sodium metabisulfite and ascorbic acid are experimentally used to deoxygenate Birjand drinking water, Iran and also they are applied for Retention Time (RT), Temperature (T), Hardness (H) and pH variations to measure deoxygenation efficiency. Regarding, findings showed that as RT increased to 100%, DO reduced to almost 60% as well as when T rose about to 10%, has approximately led to 80% reduction of DO concentration. Furthermore, ascorbic acid effects indicated that DO concentration decreased about 40% as T had increased to 10%. In addition, 20% reduction of RT has caused to 25% removal of DO. The effect of pH revealed that alkaline state worked better than acidic state to improve deoxygenation efficiency, as well.

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1- Introduction

Dissolved Oxygen (DO) is an index of water quality which should be remove in some cases because the high level of DO might decrease water quality. Regrading, DO removal process is known as deaeration or deoxygenation which is performed via conventional methods such as mechanical, thermal and chemical approaches.

2- Materials and Methods

2- 1- Dissolved Oxygen measurement

DO index is commonly used to measure dissolved oxygen in the water. There are several methods to count DO [1-3]. DO meter is used to estimate DO in this study [4]. It is based on the electrometer method which determines the DO concentration. Hence, the device was calibrated before measuring DO.

2- 2- Determining appropriate dose of the deoxidizing substance and test outline deoxidizer

Water samples were taken from drinking water treatment plant in Birjand, and then DO meter was used after calibration to find the proper dose of the DO. Afterwards, the proper dosage was determined using molar relationships [5], and ultimately empirical jar testing [6].

Figure 1 shows DO variations against sodium metabisulfite dose. It is observed when sodium metabisulfite dose increases then DO concentration decreases. According to the Figure 1, when 10 percent increase happens in sodium metabisulfite, results 20 percent decline in DO. Based on the results, the amount of DO residual is about to 0.2 ppm at 95 ppm of sodium metabisulfite.

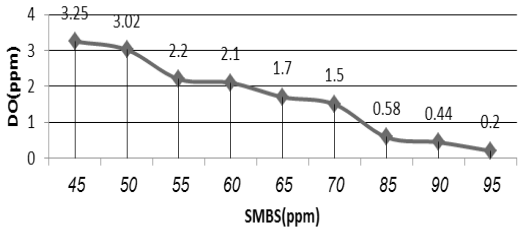

Figure 1. Dissolved oxygen variations in sodium metabisulfite dose

Figure 2 presents DO changes under the effect ascorbic acid variations. It is observed that DO decreases slightly as ascorbic acid is being added in the water.

In the following, the parameters which influence on the deoxygenation process, were examined to reach the descent dose of ascorbic acid.

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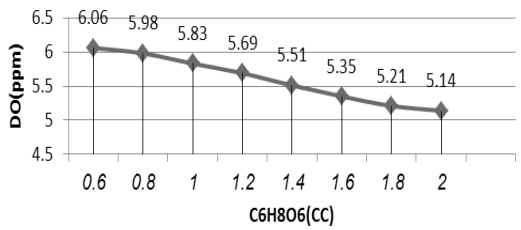

Figure 2. Dissolved oxygen variations in ascorbic acid dose

3- Results and discussion

85 ppm and 1 cc for sodium metabisulfite and ascorbic acid were presumably applied to assess the effect of RT, T, pH and H variations, respectively.

3- 1- Retention Time effect

Figure 3 depicts residual DO after the jar test completion against RT. It is observed while RT is expanding, DO concentration decreases sharply. These variations can be put into percentage where RT rose up to 100 percent, DO falls to 60 percent.

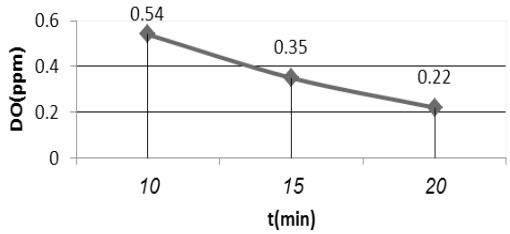

Figure 3. DO changes in RT (on presence of sodium metabisulfite)

According to Figure 4, DO cannot increase considerably by elapsing time, especially in 10 minute-period one. Therefore, it was decided to apply three new samples in which DO, T and ascorbic acid were set to 8 ppm, 26.5 ° C, and 1 cc, respectively. Results shows that, whilst RT is decreasing around 20 percent, DO falls almost 25 percent.

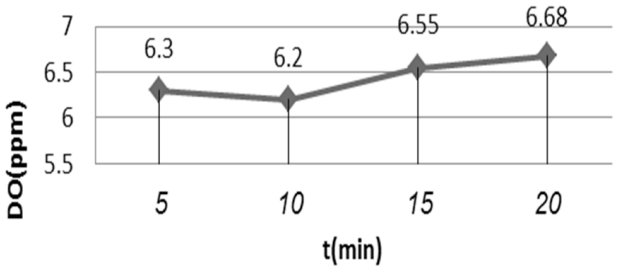

Figure 4. DO changes in RT (on presence of ascorbic acid)

3- 2- Temperature effect

It was used a stirrer which has 30 rpm speed to mix the substances as well as an electric heater that had 130 °C temperature, was applied to warm up the mixture from 25.8 °C to 36 °C. The temperature of the hotter mixture was measured after 10 minutes.

Afterwards, residual dissolved oxygen was measured in sample. The test results are shown in Figure 5. It is observed that, as T increases about 10 percent, DO decreases to 40 percent for ascorbic acid mixture, and also while T reaches to 36 °C (10 percent), DO concentration falls to 0.18 ppm (80 percent) in sodium metabisulfite case.

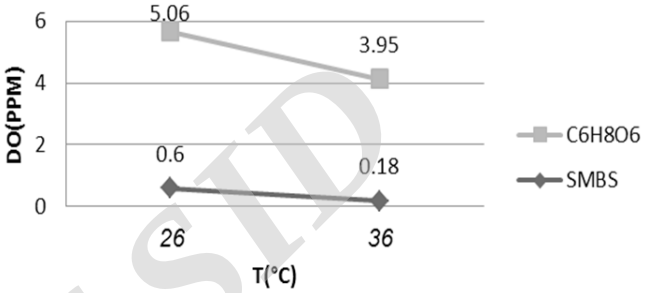

Figure 5. DO concentration in temperature variation

3- 3- pH effect

pH value was measured by pH meter after calibration. The pH meter showed that pH was 7.7 in the initial (witness). Then acidic and alkaline solutions were prepared to change the witness pH to a lower and an upper amount which were around 3.7 and 11.7. Therefore, 1.5 cc and 14 cc of sulfuric acid and sodium hydroxide which were diluted at 2 and 5 percent, were prepared to obtain acidic solution and alkaline solution. Hence, the test was conducted in three condition that were neutral, acidic and alkaline in ascorbic acid. The temperature of the tests was constant around 26 °C. The results are shown in Figure 6.

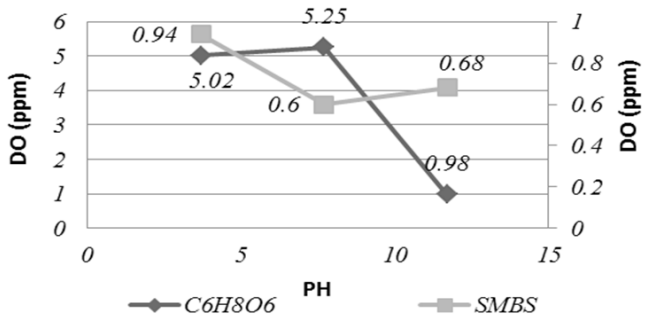

Figure 6. DO in pH variation

pH effect revealed that pH have considerable role on the efficiency of sodium metabisulfite and ascorbic acid deoxygenation. And also, it is observed that sodium metabisulfite and ascorbic acid deoxygenation efficiency

works better in alkaline state. Therefore, pH should be set in the range of alkaline state from neutral (7.7) to alkaline (11.7) to deoxygenate drinking water.

3- 4- Hardness effect

Birjand water treatment tank is filled up from two separated sources. Regarding, Sampling was conducted separately from both sources. Also, dissolved oxygen and total hardness were measured for in each resource separately. The results showed that the total hardness of the sources of (1) and (2) were respectively 548 mg/l $CaCO_3$ and 492 mg/l $CaCO_3$, respectively. Despite the fact that the high amount of hardness is not suitable for drinking water, calcium and magnesium salts are effective in deoxygenation efficiency.

4- Conclusions

Drinking water should be deoxygenated, therefore, current paper was described the effect of adding sodium metabisulfite and ascorbic acid to the water. In this regard, it is experimentally performed in Birjand water treatment plant to estimate deoxygenation efficiency as well as the effect of some parameters such as Retention Time (RT), Temperature (T), pH and Total Hardness (H) were well assessed. The results showed that RT, T, pH and H effect on deoxygenation efficiency.

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