Study On Use Of Bubble Column To Enhance The Dissolved Oxygen In Water

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Abstract: The Bubble columns are used for dissolving the oxygen in it or carrying out any absorption of gases in any fluid. We have used simple bubble column in which the water is sprayed from the top of the column. As it flows down long height of the column, the dissolved oxygen in it increases. The amount of oxygen is determined using Winker method. It is found that as the flow rate of both water and air is increased of the fluid both the dissolved oxygen also increases. It is found that at the laboratory level dissolved oxygen saturation level is 8.4mg/L for 20 min.

1. Introduction

There are three main types of Bubble column reactors like fluidized bed reactor, the bubble column reactor and the trickle bed reactor (fixed or packed bed). A bubble column reactor mainly composed of a vessel fitted with a distributor placed at the bottom through which the gas is distributed. In this generally the gas is passed from the sparger in the form of bubbles into a liquid phase. In chemical, petrochemical, biochemical and metallurgical industries, these are intensively utilized as multiphase contactors and reactors. The chemical processes that involves reactions mainyalkylation, chlorination, oxidation, hydrogenation, polymerization, by biochemical processes such as fermentation [1-3].

The bubble column allows it to build in large size within reasonable price range. Bubble column provide excellent heat and mass transfer coefficients thus they possess good mass transfer characteristics. The bubble columns are simple in construction as they do not have any operated parts. Also they possess high thermal stability, good mixing and low power requirements. Little maintenance and very low operating costs is also one added advantage for them. Bubble columns can be used as reactors, strippers or absorption columns in many processes.

The bubble columns is a unit process in which the gas in the form of bubbles are in contact with the liquid entering the column as the aim here is just to mix them. Sometimes it is also called as the phase
transfer as in it for example the gaseous reactants are dissolved in the liquid reaction productions [4-9].

Apart from the mentioned advantage of the easy to handle and low maintenance, it also offers the long life of the catalyst and material used for packing. It offers on the spot addition of the catalyst and withdrawal of the same thus making them more suitable for the use of attractive choice of reactor since past twenty five years. In the bubble column, both axial and radial mixing both takes place when the liquid is getting dispersed in it. Both the terms are used to tell how the mixing takes place in the bubble column.

The kind of mixing taking place in the column is defined by the term dispersion coefficient which is same as the dispersion coefficient term in the Ficks law of diffusion. Like diffusion the dispersion is due to the convective motion of the liquid because of the two main reasons: relative motion of both the gas and the liquid phase. Bubbles then coalesce and break up. Figure 1 shows the Bubble column figure.

In the present work we are using the bubble column to find the dissolved oxygen in water. We are using Winkler method for this purpose. The dissolved oxygen in the fresh water systems is generally found by using this method. Mostly the dissolved oxygen determines the healthy condition of water bodies. Generally this test is performed on-site only as carrying the sample from one place to another may alter or change the oxygen content [9-14].

2. Experimental

The gas is introduced from the bottom of the column which also leads to turbulent stream, thus enhancing the optimum gas exchange. Gas sparging requires less energy compared to mechanical stirring and sparging also causes stirring effect.
The flow of liquid can be counter current or parallel flow. To find solubility of air in water, Henry’s Law is used. In any system, the quantity of air dissolved in a liquid is directly proportional to the pressure and can be expressed as:

\[ C = \frac{pg}{kH} \]

Where \( C \) = solubility of dissolved gas and 
\( kH \) = proportionality constant that depends on the nature of gas and solvent

The water is sparged for different time (min) and the samples are collected for titrations using Winkler method where the sodium thiosulfate used to calculate the dissolved oxygen present in water. The observations were made as shown in the Table 1.

### 3. Conclusion:

In the present work, experimental study of axial mixing in bubble column is conducted to calculate DO in water. On the basis of above study it is clear that the lot of factors affect the performance of the Bubble Column. It can be temperature, pressure, air velocity, liquid distribution system, sparger type, but the main influencing parameter is Column diameter and column height.

### Table 1: Effect of time of fluid flow on the Dissolved oxygen

<table>
<thead>
<tr>
<th>Trial No.</th>
<th>Temperature (°C)</th>
<th>Time (min.)</th>
<th>Volume of sample (mL)</th>
<th>Burette Reading (mL)</th>
<th>Volume Of Titrant (mL)</th>
<th>Dissolved Oxygen (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>20.0</td>
<td>10</td>
<td>200</td>
<td>0</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td>2.</td>
<td>20.0</td>
<td>15</td>
<td>200</td>
<td>0</td>
<td>8.1</td>
<td>8.1</td>
</tr>
<tr>
<td>3.</td>
<td>20.0</td>
<td>20</td>
<td>200</td>
<td>0</td>
<td>8.4</td>
<td>8.4</td>
</tr>
</tbody>
</table>

It is observed that by changing value of both (air and water flow rate) we obtain different result. Based on that result we can optimize the design of the Bubble column to obtain maximum DO in water. From various paper studies it is found that the counter flow pattern has better efficiency. From the above studies it is found that at the laboratory level dissolved oxygen saturation level is 8.4mg/L for 20 min. and as temperature increases the Dissolved oxygen saturation reduces. So the operation must be
carried out at minimum temperature of water. Maximum DO in water is found in bubbly flow regime.

4. References:

1. Experimental study of liquid dispersion in Bubble column HayderAbd Al-kareamMuhsin1 and Mohammad Fadhil Abid21,2Chemical Engineering Department, University of Technology – Baghdad (Received:27/4/2008 ; Accepted:14/6/2008)


