Utilization of Microalgae (Nannochloropsis oculata) as Support Material to Supply of Oxygen in Advanced Function of Respirator Mask in Preventing Society from URI Disease

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ABSTRACT

Volcanic ash product after mountain eruption could induce a severe concern to health effect for respiration disease. Unfortunately, the ability of commercial mask which were provided for volcano victim is under health standards to protect from pyroclastic ash due to the material particle size. By supplying enough oxygen environment upon the respiratory mask is expected could minimize this disease. On the other hand, microalgae Nannochloropsis oculata approximately able to release 1 kg O\(_2\) by converting 1 kg CO\(_2\) as a side product during the photosynthesis process. The promising oxygen production from Nannochloropsis oculata could be able to replace the commercial mask by addition modification which can apply in respirator mask. The objective of this research is to design respiratory mask which has additional modification to supply oxygen. Microalgae Nannochloropsis oculata was used as addition material to supply oxygen in respirator mask. Membrane respiratory N95 to be used as base of repirator mask. The respirator mask had been designed with production rate of oxygen \(v = 3.885 \times 10^{-11}\) ml/cell. With that amount of oxygen, it can prevent the volcanic ash from entering the lung, and URI can be prevented.

Keywords: URI disease, microalgae, respirator mask, support material

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INTRODUCTION

Indonesia is one of the countries who have a lot of volcanic mountains due to the position on passed through Ring of Fire, which can erupt any time [1]. When volcanoes eruptions, some of the material be exploded such as bomb, lapili, pyroclastic ash, etc. [2] and it calls URI (Upper Respiratory Tract Infection). URI is kind of disease which attacks lung by damaging alveolar under a process of loading pyroclastic ash movement. Ministry of Health Indonesia states that in the early of February, the number of people who are infected with URI’s disease quite high. After Kelud mount erupted on first February 2014, the victim infected URI’s disease about 955 people [3].

However, the commercial mask provided for volcano victim is under health standards to protect from pyroclastic ash. Mineralogical composition as eruption product can not filtered properly by commercial mask due to the materials particle size. The dangerous symptom if the victim is exposure in the long-term. By supplying enough oxygen environment upon respiratory mask is expected could minimize this disease.

On another hand, the side product of microalgae photosynthesis from Nannochloropsis oculata is oxygen beyond the gluceses as main product. The empirical equation to converting CO\(_2\) and water become a biomass and oxygen can be written as follows [4]:

\[
6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow{\text{light energy (hv)}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2
\]  

(1)

Nannochloropsis is marine genus of the Eustigmatophyceae [5] which has been receiving research interest by its ability to synthesize neutral lipids for biodiesel and Eicosapentaenoic acid in food functional [6]. However, the utilization of Nannochloropsis s.p. only struggling with the biomass sector as renewable energy production. In this research, would optimize the promising oxygen production from Nannochloropsis s.p. can produce 1 kg O\(_2\) by converting 1 kg CO\(_2\) as a side product during the photosynthesis process.
The government supports people by giving under helath standard respirator mask 3 ply used to protect from pyroclastic ash. However, this respirator mask can not filter pyroclastic ash properly. Hence, it makes society get suffer URI’s disease after have inhaled pyroclastic ash. Current research about support material for respirator mask is less than other country. In addition, the utilization of the supporting material for the respirator mask, not many do. Paramedics in this country use under health standard tools to handle and prevent URI’s disease. For the example, respirator mask to prevent from ash, is not filtering the ash properly. Then, some respiration disease can occur possibly. Ministry of Health Indonesia for each region should conduct socialization for society to use proper respirator mask to prevent from ash. Furthermore, when volcanic mount gets eruption, the respirator mask is improtant to be used for preventing pyroclastic ash.

This research objective is to integrate support material e.g. microalgae (Nannochloropsis oculata) as a supplier of oxygen to enhance the advanced functionality of the respirator mask in preventing the proliferation of URI’s disease. The respirator mask has efficiency 95% in filtering pyroclastic ash. This respirator mask helps society to protect them from piroclastic ash and it can not be absorbed in respiration system. Microalgae (Nannochloropsis oculata) be used to supply amount of oxygen which is needed in respiration system. This kind of microalgae can produce oxygen from photosynthesis and make user convenient of breathing. For the result, any kind of respiration disease such as URI can be prevented by using this respirator mask. Hence, the society feels comfort and relieved to breathe in environment under contaminated of pyroclastic ash.

**EXPERIMENTAL**

**Preparation**

Prepare microalgae with density 100mg/liter. Microalgae Nannochloropsis oculata is cultivated until 14 days as can be seen in Fig. 1. In day 15th, microalgae are harvested and ready to be used as support material for respirator mask. This study uses microalgae Nannochloropsis oculata because it is easier to be cultivated than the other species. Then, this kind of microalgae could be found near university. Use membrane of respiratory N95 and its filter. Implant microalgae to the membrane that have integrated of the respirator mask.

**Testing**

There are two kind of material testing. They are filtering testing and dissolved oxygen testing. Procedure for this test based on ASTM F2100 where wind machine blows pyroclastic ash then the mask will filter the ash. This machine can determine the efficiency of the mask. The second test is to measure dissolved oxygen of microalgae Nannochloropsis oculata. Tool for this test is Lutron DO 5510 Dissolved Oxygen Meter with calibration system Dissolved Oxygen 0,1 mg/liter, Oxygen Meter 0,1% O2 and temperature 0,1. The carefulness of this tool can measure up to 20,0 mg/liter Dissolved Oxygen with efficiency 0-100% dissolved oxygen.

**Design respirator mask RM SC 101**

Equipments are needed to create respiratory mask RM SC 101 mentioned as follow: the mask N95, solder, tin, hose, elastic strap, safety foam, clear-bottle, electrical circuit as compound of lamp, batteries, switch, and glue. Design of the respirator mask can be seen in Fig. 2.
Figure 2. Design of Respiratory Mask SC 101, a) front side, b) right side, c) behind side

Note:
1. Adhesive layer: made of elastic material which can stick perfectly in the face.
2. Filtration layer: filter material based on the mask N95 which consist non-woven layer, activated carbon, filter paper and gauze.
3. Binder layer: made of elastic material which can highly stick than adhesive layer.
4. The channel of microalgae hoses: elastic hose which drains oxygen from channel microalgae up to channel of oxygen which is directly absorbed by the user.
5. Channel microalgae: plastic bottle which contains microalgae with volume 100 ml. This channel is a clear bottle and has permeable to the light involved LED light from photosynthesis.
6. Elastic belt: made of elastic material so that adapt to head form of user and comfort to be used in all age.

RESULTS AND DISCUSSION

Measurement density of microalgae

This experiment was done in Ecology Laboratory Biology ITS. The object study is density population of microalgae that had been cultivated in 14 days as can be seen in Fig. 3. Species of microalgae had been cultivated is Nannochloropsis oculata. As follow are equipment needed to measure the density of microalgae: haemocytometer, optical microscope, measuring cup, and drop pipette. The first section is preparing optical microscope with magnification up to 100 x. Take sample of microalgae by drop pipette then drop it to haemocytometer amount of two tips. Cover the sample with a glass side and observe density population of microalgae by microscope. Take a picture of this observation and measure density by this formula:

\[
\text{Density (cell/ml)} = n \times P \times V
\]

(2)

N = number of cell microalgae (cell)
P = dilution = 10x
V = Volume = 2,5 ml

<table>
<thead>
<tr>
<th>Sample</th>
<th>Density (cell/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12,100 cells/ml</td>
</tr>
<tr>
<td>2</td>
<td>15,900 cells/ml</td>
</tr>
<tr>
<td>Average</td>
<td>14,000 cells/ml</td>
</tr>
</tbody>
</table>

Figure 3. Cell of microalgae Nannochloropsis oculata
**Measurement of dissolved oxygen**

This experiment was done in Ecology Laboratory Biology ITS as can be seen in Fig. 4. The object study is the rate of oxygen production of microalgae *Nannochloropsis oculata*. The following tools used are Lutron DO 5510 Oxygen Meter, measuring cup 100 ml, Philips 18W fluorescent lamp 2 pieces, light installation 1 set, stopwatch. Setting up a 100 ml measuring cup filled microalgae as much as 100 ml. Reform the lighting fixtures and the current sample is conditioned as microalgae cultivated. Measure the concentration of dissolved oxygen in the sample microalgae, and then record it. The first stage is lighting microalgae with one light. Turn on the light, and press the stopwatch. Wait the process of photosynthesis microalgae for 15 minutes. Then measure the dissolved oxygen content of it and noted. Furthermore, lit two lamps and pressing stopwatch for 15 minutes. Measure the dissolved oxygen content of it, and take notes. Calculating the rate of oxygen production of microalgae to the formula below:

![Figure 4. Measuring dissolved oxygen of microalgae](image)

After we passed several steps, then our product has done 100%, by stringing a respiratory mask system with *Nannochloropsis oculata* for oxygen supplier where the oxygen production rate is 3,885 X 10^-11 ml. From the result of dissolved oxygen, it is still too low for a people to breath with that amount, because the minimum amount is 25.5 ml/s. The microalgae installed in the form is culture mode, so it can produces oxygen and cultivation process until its maximum culture day (14 days).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Difference of dissolved oxygen (mg/L)</th>
<th>Oxygen production rate (ml/cell)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.30 mg/L</td>
<td>3,330 x 10^-11 ml/cell</td>
</tr>
<tr>
<td>2</td>
<td>0.40 mg/L</td>
<td>4,440 x 10^-11 ml/cell</td>
</tr>
<tr>
<td>Average</td>
<td>0.35 mg/L</td>
<td>3,885 x 10^-11 ml/cell</td>
</tr>
</tbody>
</table>

![Figure 5. Electric stringing that have done: a) face; b) tails](image)

Then, the second part is electric instalation part, in this part we use LED white light about 6 pc and all of the lamp string by using paralel method, then the lamp can turn on with the same brightness and when there is a short circuit, another lamp will not shut down, then we used PCB (printed Circuit Board) to stringing the lamp, we used switch too to connect or cut off electric current, the last is power supply two AA batteries. And all of the material mix into one using GTAW (Gas Tungsten Arc Welding) or as we known soldering process with melted tin.

![Figure 6. Design of respiratory mask RM SC 101](image)

And after all of this part stringing we can got product as can be seen in Fig. 6. The method of this respiratory mask with standard mask in general, the difference just the increasing of microalgae channel and the lifetime of the mask.
Table 4 Differences respiratory mask RM SC 101

<table>
<thead>
<tr>
<th>Differences</th>
<th>Masker Bedah (Umum)</th>
<th>Respiratory Mask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life time</td>
<td>Max. 3 days</td>
<td>Max. 14 days</td>
</tr>
<tr>
<td>Used time (per day)</td>
<td>Max. 8 hours</td>
<td>Max. 12 hours</td>
</tr>
<tr>
<td>Way to wear</td>
<td>Easy</td>
<td>More difficult</td>
</tr>
<tr>
<td>Supply of oxygen</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Efficiency of filtering</td>
<td>40%</td>
<td>95%</td>
</tr>
</tbody>
</table>

CONCLUSION

This research has found out, design of respiratory mask which has additional feature to filter pyroclastic ash with efficiency 95%. The way to advance function of the mask is integrating microalgae (Nannochloropsis oculata) in medium to the respiratory mask. Medium is used to store microalgae that is clear bottle. The mask can produce amount of oxygen from photosynthesis of microalgae with rate of oxygen production $v = 3.885 \times 10^{-11}$ ml/cell.

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REFERENCES


