INCREASING SEPARATION OF DISSOLVED GASES USING A PORTABLE SYSTEM WITH HOLLOW FIBER MEMBRANE MODULES INCLUDING TWO INLETS

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Abstract - ***To increase the amounts of separation of membrane module is very important in view of decreasing weight of the separation system. The amounts of supplying water need to be increased in order to enhance separation of dissolved oxygen from water for same membrane module. If the number of membrane modules is decreased, both of size and weight of separation system are decreased and it leads to favorable condition in view of commercializing separation system.***

In this study, the system to increase separation of dissolved oxygen with low weight was proposed to apply to a portable device. The membrane module with two inlets was proposed to increase the amounts of supplying water. A water pump was designed to decrease the weights of the separation system. 2 membrane modules were used, but separation of proposed system proved to be 1.9299 L/min of flow rate.

Key Words: *two inlets, increasing separation, dissolved gases, hollow fiber, suction type.*

1. INTRODUCTION

Dissolved oxygen contained in water in the boiler can lead to makeking corrosion, reducing heat transfer coefficient and low efficiency for system performance. By reducing this kind of dissolved oxygen, efficiency for system performance can be enhanced. The hollow fiber membrane which has high surface area over a volume and compact size is generally used in order to retain high purity water in Bio-MEMS and other industrial area [1].

Power source in the portable device is very important part to supply electrical energy. In particular, supplying power source in the underwater portable device is more important. The MFC (micro fuel cell) takes use of materials which are excluded from plants and oxygen. Separation of dissolved oxygen from water is needed to use MFC under water. Power source can be supplied into the portable device by taking use of plants and dissolved oxygen. So, effective separation technique of dissolved oxygen from water is very important to enhance system performance for MFC under water [2].

Insects in the air will die if insects are drowned. They cannot breathe under water. But some insects can breathe for a few hours. Bubbles between a lot of furs on the surface of insects make it possible to survive under water. Even if they are drowned, by keeping bubble without breaking out, it's possible to make use of oxygen contained in the bubble. Consumed oxygen is supplemented from water due to difference of concentration. Shirtcliffe et al. represented dissolved oxygen was transferred from water into inside of the vacant box by using hydrophobic porous materials. Collection of dissolved oxygens from water is possible if this kind of characteristic is used. If the amounts of dissolved oxygens collected from water are properly controlled, these kinds of porous materials can be applied into development of underwater breathing technique [3].

Geometrical shape of furs on the surface of insects is related to breaking bubbles out. Diameter, length between furs and contact angle are related to periods to start breaking bubbles. As underwater depth of insects from surface is increased, water pressure is increased and bubbles start to break out at the some depth because underwater pressure is larger than one at vacant spaces filled with airs inside of bubbles. As length between furs is decreased, bubbles can endure more water pressure under more depth. So proper design of geometrical shape of furs, length between two furs and contact angles on the surface of the fur can lead to bubbles which survive under more underwater depth [4].

High solubility solution such as hemoglobin can be used as carrier to increase separation of dissolved oxygen from water. This solution has the effects that concentrate water containing dissolved oxygens and lead to making solution with high dissolved oxygens. So, it's possible to increase separation of dissolved oxygens from water under same condition because hemoglobin solution contains more dissolved oxygens [5].

The amounts of separation of dissolved oxygens are related to the surface area of membrane. By increasing surface area, separation of dissolved oxygens from water can be enhanced. The module with high surface area is

inclined to lead to increasing the size of separation system, proper design of separation system is needed to develop a portable device for taking use of dissolved oxygens. Efficient consideration between performance and weight for separation system is needed [6]
To increase the amounts of separation of membrane module is very important in view of decreasing weight of the separation system. The amounts of supplying water need to be increased in order to enhance separation of dissolved oxygen from water for same membrane module. If the number of membrane modules is decreased, both of size and weight of separation system are decreased and it leads to favorable condition in view of commercializing separation system.
In this study, the system to increase separation of dissolved oxygen with low weight was proposed to apply to a portable device. The membrane module with two inlets was proposed to increase the amounts of supplying water. A water pump was designed to decrease the weights of the separation system. 2 membrane modules were used, but separation of proposed system proved to be 1.9299 L/min of flow rate.

2. METHODS

Fig. 1 shows outline for experimental devices which include water pumps, hollow fiber membrane modules, a vacuum pump, controller and a battery. Hollow fiber membrane modules which are made from a Liqui-Cel company and have two inlets on both dead-end are used. Specifications of hollow fibers contained in the membrane modules are showed in the Table 1. A vacuum pump is made from a KNF company and 32 L/min of flow rates. Its specifications are show in Table 2. A water pump is showed in Fig. 2 and has specifications as showed in Table 3. This composes of a motor and a impeller. The water pump is depicted as a suction type in Fig. 2(a) and a discharging type in Fig. 2(b) by arrangements of the motor and the impeller.

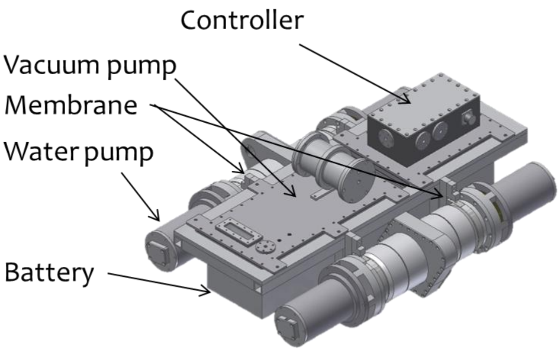
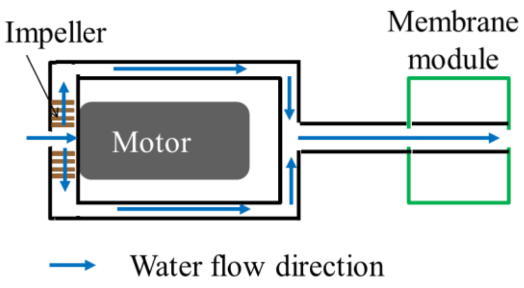
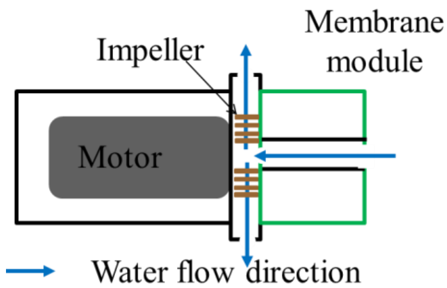


Fig -1: Outline for the portable system



(a) discharging type



(b) suction type

Fig -2: Water Pump

Table -1: Hollow fiber characteristics

Name	Spec.
Material	Polypropylene
Potting materials	Epoxy
Surface area (m2)	8.1
Porosity (%)	~25
OD/ID (μm)	300/200
Shell side volume (L)	1.26
Lumen side volume (L)	0.61
Height (mm)	512
Diameter (mm)	116.1
Maximum water flow (m3/hr)	6.8
Pressure drop (bar) at 6.1 m3/hr water flow	0.69

Table -2: Vacuum pump characteristics

Name	Spec.
Delivery at atm. pressure (L/min)	32
Pressure (bar)	0.5
Vacuum (mbar)	100
Voltage (V)	24
Current (A)	1.9
Weight (kg)	2.2

Table -3: Water pump characteristics

Name	Spec.
Weight (kg)	2.3
Power (W)	160
Maximum flow (L/min)	105
Head (m)	7
Voltage (V)	24
Diameter (mm)	135
Height (mm)	245

3. RESULTS AND DISCUSSIONS

Fig. 3 shows separation characteristics of dissolved gases. The amounts of separation of dissolved gases were decreased at the first state and kept almost constant. Table 4 shows quantitative amounts of separation of dissolved gases. 1.9399 L/min of separation of dissolved gases from water was represented. Fig. 4 represents composition of dissolved oxygen contained in separated gases. Almost constant composition of dissolved oxygen was represented. In Table 4, 29.071% of separation of dissolved oxygen contained in the separated gases was represented.

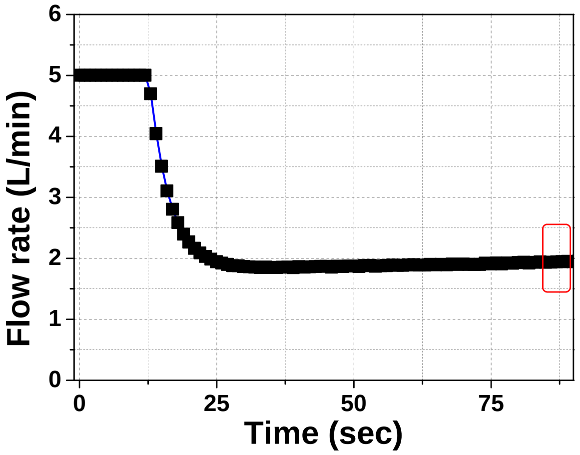


Fig -3: Separation of dissolved gases

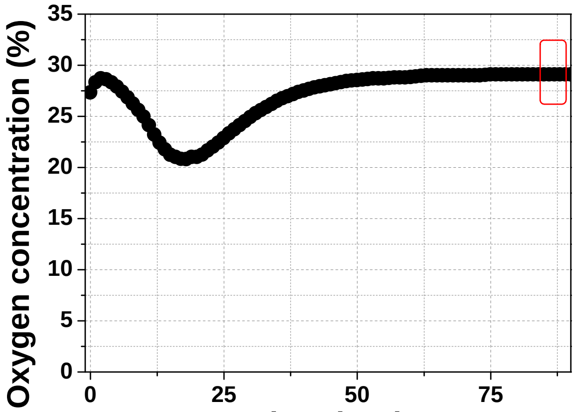


Fig -4: Oxygen concentration

Table -4: Water pump characteristics

No.	Separation (L/min)	Oxygen Concentration
1	1.926	29.071
2	1.929	29.071
3	1.935	29.071
4	1.941	29.071
5	1.944	29.071
6	1.938	29.071
7	1.948	29.071
8	1.943	29.071
9	1.947	29.071
10	1.948	29.071
Mean	1.9399	29.071

3. CONCLUSION

In this study, a portable separation system of dissolved gases was proposed. This system has advantages in view of low weight and good performance. This membrane module has two inlets on the dead-end to increase the amounts of water supplying. The amounts of separation of dissolved gases had 1.9299 L/min of flow rates. Composition of dissolved oxygen contained in gases separated from water showed 29.071%. The size and the weight of a portable separation device of dissolved gases from water were decreased by making use of 2 membrane modules. So this membrane module expects to be applied to the development of the portable separation system technique under water.

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BIOGRAPHIES

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