PRESENTATION ON
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8TH SEM 2ND SHIFT

BATCH :2015-2019

"DEVELOPMENT OF OXYGEN GENERATING SYSTEM FOR UNDERWATER USING COUNTER-FLOW DIFFUSION"

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Problem Statement

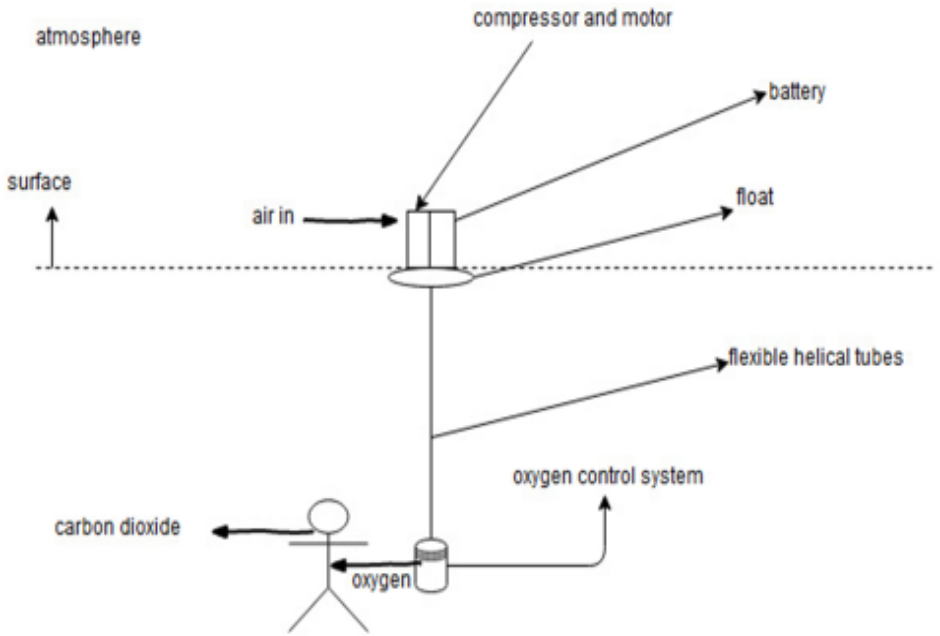
Human beings require about 500 ml. of air per breath when resting. Conventionally, large metal oxygen tanks weighing tens of kilograms are used. This decreases the diving time and restricts us from exploring any deeper parts of the sea.

In this project, we are designing a underwater breathing system modelled from the design of fish gills. This radical approach uses the principle of counterflow diffusion to extract dissolved oxygen from surrounding water and supply it to the body. Potential advantages of this method are as shown below.

	TANKLESS APPARATUS	CONVENTIONAL APPARATUS
WEIGHT	LESS WEIGHT	40 lbs / 20 kg
DIVING TIME	APPROX. 45 MIN.	ABOUT AN HOUR
SIZE	VERY SMALL	LARGE

OUR PREVIOUS IDEAS…

Surface supplied method



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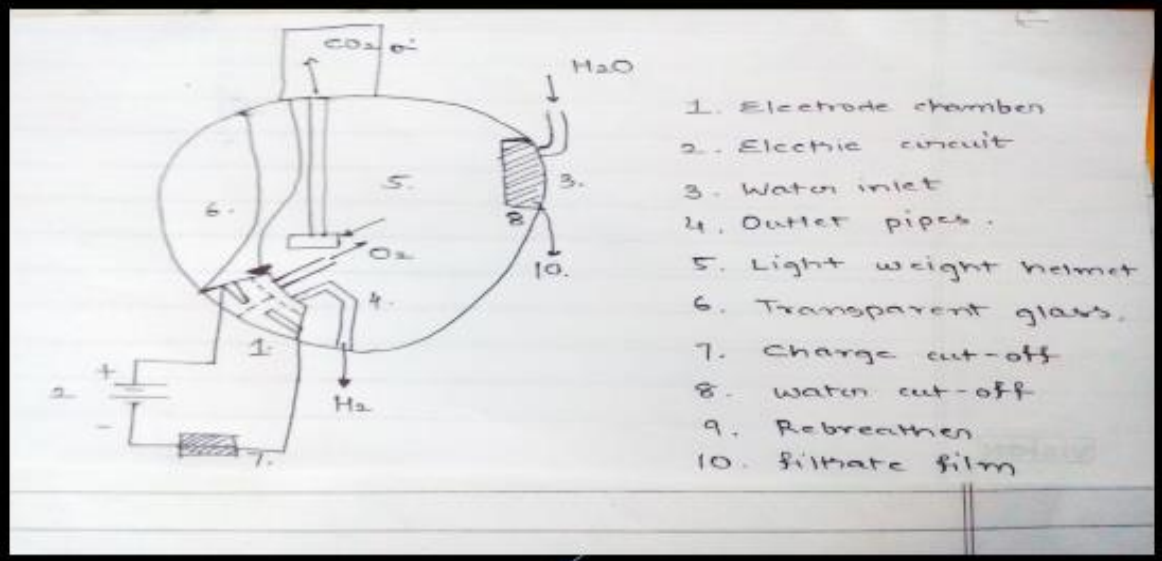
Surface Supplied Method



INITIAL PROBLEM SOLVED

1) USING ALTERNATIVE OXYGEN AND ELCTRICITY CUT OFFS.
2) USING REBREATHER TO REPLENISH O2 WITH CO2.
3) USING FINE OSMOTIC MEMBRANE.
4) TRYING TO FIND THE SOLUTION.
5) PURIFY THE SEA WATER USING OSMOSIS.

Electrolysis

CHEMICAL REACTIONS

Catalytic decomposition of hydrogen peroxide.

$$2H_2O_2 \xrightarrow{\text{catalase}} 2H_2O + O_2$$

Hydrogen peroxide on decomposition generates steam and oxygen.
But the reaction releases high amount of energy.
Hydrogen peroxide is toxic. According to the calculation
1 liter of HYDROGEN PEROXIDE generates about 30 liters of oxygen, the amount of oxygen required per minute is about 110 ml so oxygen required to breathe 1 hour is 6600ml(6.6 liter) and that requires about 0.22 liter which is less.
The only limitation is high temperature generated .

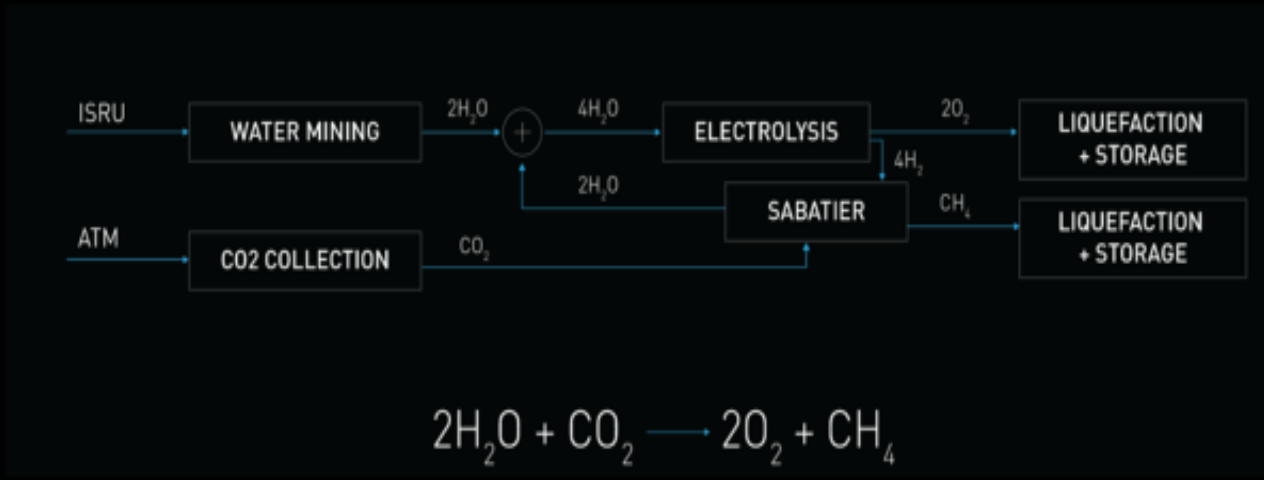
Sabatier Reaction

Reaction generating oxygen by reaction of water and carbon dioxide.
SPACEX planning to use this reaction on MARS to get propellant.
The reaction shown below is reaction to get oxygen on mars.

First ship will have small propellant plant, which will be expanded over time

Effectively unlimited supplies of carbon dioxide and water on Mars

- 5 million cubic km ice
- 25 trillion metric tons CO2

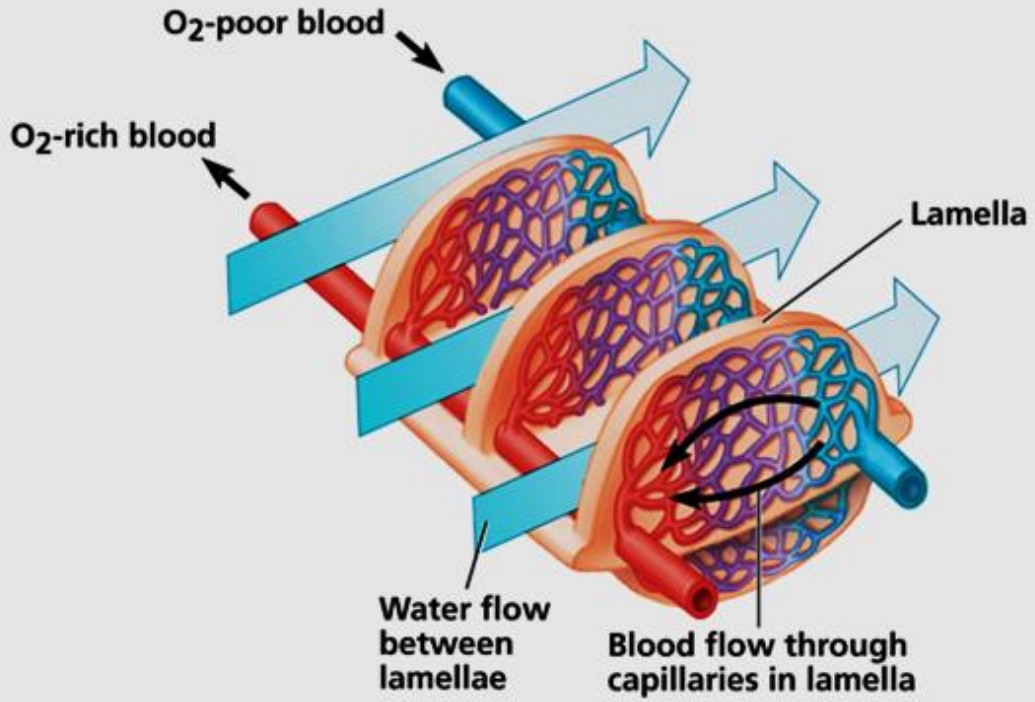


$$2H_2O + CO_2 \longrightarrow 2O_2 + CH_4$$

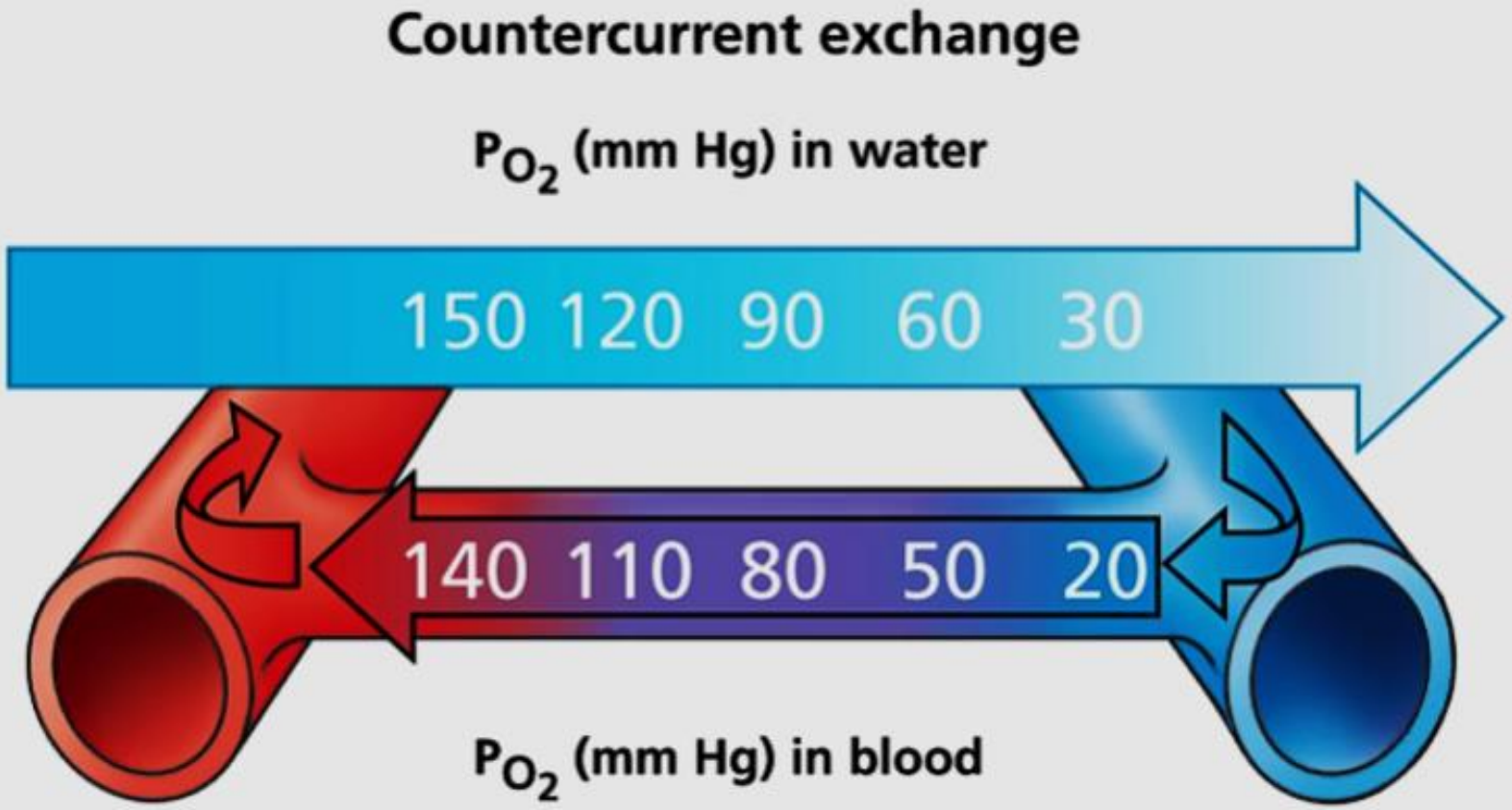
Our Concept

The proposed design of the breathing system is mimicked from fish gills. Each of these gill filaments contains a complex structure known as the lamellae.

From this diagram, it can be seen that the flow of blood in the lamellae and the flow of water are counter-current. The blood vessels bring the deoxygenated blood to gills and take it back.



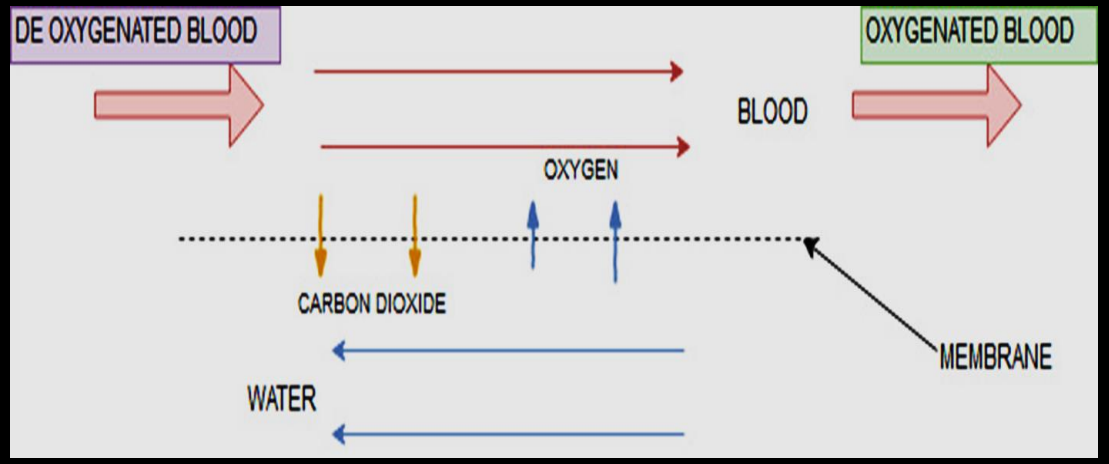
The concentration of oxygen present in the blood and water depends on the partial pressure of oxygen. It can be seen from the figure that due to the partial pressure difference of oxygen in blood and water, oxygen diffuses into the blood. The main advantage of counterflow diffusion lies in the homogeneous transfer of oxygen from the water to blood.



Mathematical Model

Rate of Diffusion:

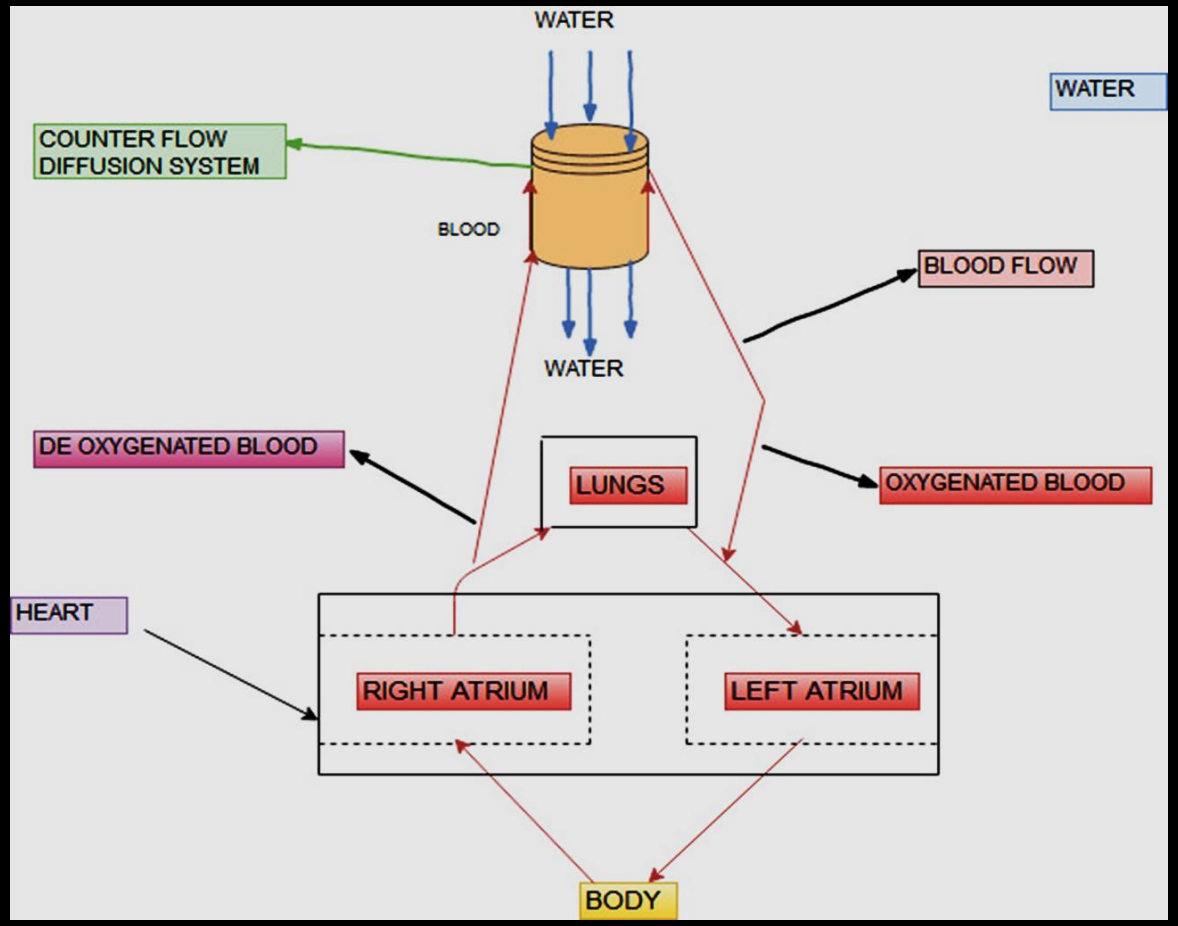
$$\text{Rate of Diffusion} = D\,A\,\frac{\partial P}{\partial x}$$

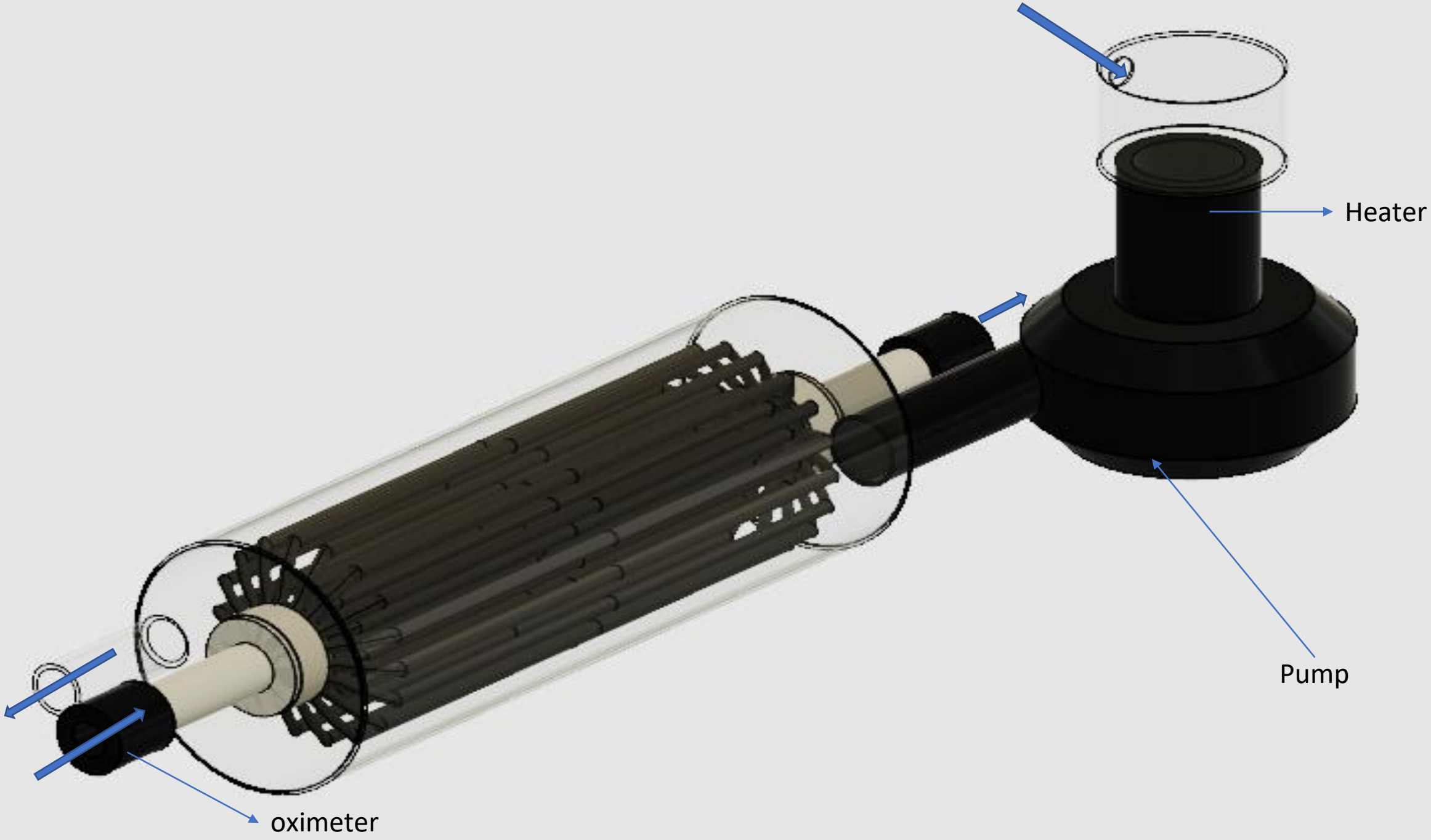


The transfer of gases across the membrane obeys Fick's Law.

The equation implies that the rate of diffusion of oxygen depends upon the partial pressure gradient, the area of gas exchange and the diffusion constant.

Our Elementary Idea




Heater
Pump
oximeter


water
Carbon dioxide
oxygen
membrane
Blood

COMPARISONS

	ELECTROLYSIS	CHEMICAL REACTIONS	DIFFUSION
SIZE	INTERMEDIATE	LARGE	SMALL
SAFETY			
DIVING TIME			
WEIGHT			
TUBE LENGTH			
WATER FLOW-RATE	LESS	N/A	COMPREHENSIBLE
REBREATHER	YES	YES	YES
RELIABILITY			

 GOOD  OK  BAD

Current Challenges

- Size of the molecules such as the oxygen and carbon dioxide which are to be exchanged are in the nanometre range. The membrane with such a pore size is very expensive to manufacture.
- The system`s working involves the process of bypassing the blood from lungs which is could be consequential.