Novel Membranes for Synthetic Lungs and Planetary Applications

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The primary objective of this science fair project was to develop a novel membrane configuration capable of efficiently and rapidly separating oxygen and carbon dioxide from ambient gases or an air mixture. A secondary objective was to explore configurations that would assist in killing biological agents. In this project, materials considered for membrane development were primarily those made of nontoxic aqueous membranes with impregnated catalysts. Initially, physical transport mechanisms were studied followed by the fabrication of a test membrane for separating CO2 from O2. The separation membrane was accomplished using an aqueous cellulose acetate membrane impregnated with the enzyme catalyst carbonic anhydrase. The preliminary results were promising. Next, cesium bicarbonate, potassium bicarbonate, and zinc catalysts were examined. Preliminary tests were done by wrapping this membrane around a dual glass cylinder structure containing three different ratios of oxygen and carbon dioxide gases and testing for permeability through gas chromatography tests. A high permeability for carbon dioxide of up to 95% and an increased separation factor were demonstrated by the catalyzed membranes. Based on these test results, an advanced breathing mask was designed. Next, an innovative hybrid polymer material based on polysiloxane was added for protection against biological agents such as airborne bacteria. These advanced masks would have applications in the protection of military and homeland security personnel from airborne chemical and biological agents. Configurations for synthetic lungs, CO2 scrubbers for submarines and CO2 sequestration for space crafts were investigated. For Mars and other planets, these techniques would help in retaining oxygen.