A Hybrid Polymer-ceramic Carbon Free Combustor

Technology #14644

Applications

Carbon capture is necessary to continue the use of existing fossil fuels while reducing CO_2 emissions, and thereby mitigating global climate change. Due to the high degree of separation of air needed for oxyfuel combustion, membrane technology has risen in popularity for its small scale separation capabilities of oxygen enriched air. This technology will be useful in combustor design in the power generation and transportation fields by lessening the emission of CO_2 from combustors.

Problem Addressed

Membrane separation material options generally fall into one of two categories, polymeric or ceramic. These two membrane types provide very different performance and operating characteristics. The first, polymer membranes, operates at ambient temperatures. Polymer membranes are usually considered for producing O_2-enriched air. Polymer membranes and/or zeolites are good for oxygen separation. However, the purity of oxygen is not high, meaning, making it insufficient for oxyfuel combustion with efficient carbon capture. The second type is the high-temperature ceramic membrane, or Ion Transport Membranes (ITM). Ceramic membranes produce very high purity oxygen, but they require high operating temperatures and have higher material cost per productivity. The permeability (oxygen flux rate) of ITMs depends on the partial pressure of O_2 in the oxygen-nitrogen mixture. Increasing the concentration of O_2 by using O_2-enriched air rather than air improves the performance of the ITM. Combining polymeric with ceramic membranes can improve the overall efficiency of the system.

Technology

The invention is a combustor including a polymer membrane structure for receiving air at an input and for delivering oxygen-enriched at an outlet. The first component is a polymer membrane, which produces oxygen-enriched air. The second component is an ion transport membrane (ITM), and it is used to produce high quality oxygen. Integrating the polymer and ceramic membranes with combustion systems, such as gas turbine combustion chambers, can provide high temperature environment and high oxygen flux rates. This allows for large concentration gradients across the membrane, which is needed to achieve high fluxes of oxygen. Moreover, fuel oxidation converts chemical to thermal energy and maintains the high temperature required to activate the materials of the oxygen transport membrane. The two components provide high purity oxygen to burn with the fuel producing CO_2 and water vapor. The water vapor can be separated by cooling, allowing for the CO_2 to be easily captured, thus making the combustor carbon-free.

Advantages

- Increases efficiency
- Carbon-free
- High stability

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- Reduced volume/surface area of membranes
- Low material cost

Categories For This Invention:

Energy
Hydrocarbons
CO2 Capture & Storage
Power Plants

Intellectual Property:

Integrated polymeric-ceramic membrane based oxy-fuel combustor
Issued US Patent
9,004,909

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Publications:

Operating Pressure Dependence of the Pressurized Oxy-Fuel Combustion Power Cycle
Energy. Volume 35, Issue 12
December 2010, Pages 5391–5399
Concentrating Emissions
MIT News
September 17, 2009
A Review Of Recent Developments In Carbon Capture Utilizing Oxy-Fuel Combustion In Conventional And Ion Transport Membrane Syste
International Journal of Energy Research
Volume 35, Issue 9 July 2011 Pages 741–764
Ion Transport Membrane Reactors For Oxy-Combustion–Part II: Analysis And Comparison Of Alternatives
Energy Volume 36, Issue 8
August 2011, Pages 4721-473

External Links:

Electrochemical Energy Laboratory
http://web.mit.edu/eel/index.html
Reacting Gas-Dynamics Laboratory
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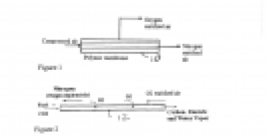

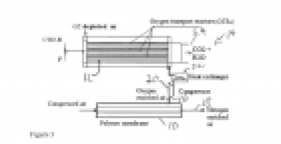

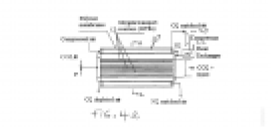

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