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SeaMerlin

XPrize Contestant to Mitigate CO2 by SeaMerlin

Structured Data

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SeaMerlin is a gas leverage turbine that provides marine propulsion, seawater distillation, CO2 harvesting, and more. The goal is to enter and win the XPrize contest hosted by Elon Musk for Carbon Removal on Earth. The first step is developing a GTL gas to liquids CO2 to plastics and fuel system.

SeaMerlin Announces Entry into Elon Musk's XPrize $100 Million CO2 Challenge

XPRIZE Carbon Removal is aimed at tackling the biggest threat facing humanity - fighting climate change and rebalancing Earth's carbon cycle. Funded by Elon Musk (@elonmusk) and the Musk Foundation, this $100M competition is the largest incentive prize in history, an extraordinary milestone. (from the XPrize website)

SeaMerlin is a project from Infinity Turbine LLC which combines decades of innovation into a product which not only focusses on CO2 removal, but First Principles development of a host of technologies wrapped into one concept, the Gas Leverage Turbine.

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Strategy for CO_2 Removal and Sequestration Hierarchy:

This is our strategy (best practices):

1. Use CO_2 to replace conventional HVAC in residential, commercial applications, and vehicles.
2. Use CO_2 as a working fluid in powerplants to replace water (steam).
3. Use CO_2 to manufacture products to replace oil/gas (example to produce gas, ethanol, methanol, and butanol using a reverse fuel cell or electrolyzer).
4. Use CO_2 in manufacturing of building products.
5. Use CO_2 in manufacture of plastics or insulation (bubble pack) to capture and hold CO_2 so that it is not released into the atmosphere, but provides a fireproof material.

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SeaMerlin Engine Concept

Concept: The concept of the SeaMerlin Engine is to convert or supplement existing marine vessel propulsion to a gas leverage turbine which scavenges CO_2 from saltwater at the same time it provides vessel thrust.

The System: The gas leverage turbine also makes available saltwater distillation (freshwater maker), aeration, and more.

How it Works: The motive power of the gas leverage turbine is provided from either a electric motor, or closed loop CO_2 turbine. The electric motor can be provided by conventional marine power generation (gas turbine, oil turbine, or diesel generator). The advantage of a electrical power generator is that the generator can run at consistent power without gearing down to slower rotational shaft speeds. The closed loop CO_2 turbine can be used with any heat source to make the CO_2 go supercritical (ORC or Brayton Cycle).

Power Delivery: The power from the turbine can be deployed to provide vessel motive power by
(1) shaft horsepower turning a screw, or by
(2) waterjet

In-Situ Carbon Removal and Storage: Using a reverse fuel cell (electrolyzer), the CO_2 can be used immediately to make intermediates such as methanol or Ethylene. The Ethylene can be used to makes plastics as a method of carbon removal and storage.

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Green Chemistry

What can we do with CO_2 ? Using sonochemistry and other methods, we can convert CO_2 to supplement or replace legacy petrochemically based products.

CO_2 Conversion: The gas leverage turbine can use sonochemistry or spinning disc reactor technologies for the deployment of CO_2 conversions.

Multi-Role Propulsion and CO_2 Harvesting from the Ocean:The benefits of in-situ fuel production can be used by vessels at (and under) sea, while scavanging CO_2 from the saltwater while underway, or at anchor.

Producing Ethanol and Methanol from CO_2: We had some of the first strategies to reverse fuel cells in 2005. Instead of producing power from ethanol, methanol, or hydrogen, why not reverse the process?

The net efficiency of our Reverse Oxygenate Fuel Cell, for Ethanol production was:
9.08 kWh/ every liter of Ethanol produced
2.57 cu. meter of CO_2 (at room pressure and temperature)

CO_2 + Water + Electricity: In our own experiments running a fuel cell backwards (using only CO_2, water, and electricity) we were able to produce Methanol, Butanol, and Ethanol. Methanol Production from CO_2:
2.40 kWh / lt(CH_3OH)
4.32 kWh / m3(CO_2)
Note: 1 US Gallon = 3.785 Liters
3.785 x 2.40 kw = 9.08 kW hours to make 1 gallon of liquid fuel (theoretical)

Ethanol Catalyst for Legacy Sabatier Reaction Chemistry: For our lab experiments using Fischer–Tropsch catalysts, our ethanol catalyst was around 461 g L/hr STY, while the methanol catalyst is exceeding 2,400 g L/hr STY.

CO_2 to Gasoline: If we can produce methanol from CO_2, then we can also produce gasoline. Again, this is to supplement or replace legacy petrochemical products where it is cost effective, until electrically powered vehicles are the standard.

Gas to Liquids (GTL): In a process developed in the 70's by Mobil, a catalyst known as ZSM-5 had an efficient (up to 99%) conversion rate of methanol-to-gasoline (MTG process). This gas-to-liquids process is widely know with off-the-shelf catalysts. Patents on the Mobile ZSM-5 catalyst have expired, and anyone can develop and manufacture the catalyst. The conversion rate is at about 2 gallons of methanol to 1.4 gallons of gasoline.

In-Situ Carbon Removal and Storage: Using a reverse fuel cell (electrolyzer), the CO_2 can be used immediately to make intermediates such as methanol or Ethylene. The Ethylene can be used to makes plastics as a method of carbon removal and storage.

Infinity Turbine GTL Module $150,000 Experimenters Platform

Infinity is now offering an experimenters platform for those who wish to develop liquid or gas CO_2 to plastics and alcohol fuels. Inputs: CO_2, H20, DC electricity, and Nafion or other membrane catalysts.

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CO_2 Turbine: Organic Rankine Cycle and Gas to Liquids (alcohol) Production

Legacy power plants use water as the working fluid in a Rankine Cycle. Water is heated into steam (pressure) and then that pressure is reduced over an expander to provide shaft horsepower (work) to spin a generator. What if we replaced water with liquid CO_2 ? It turns out that CO_2 is a better working fluid than water, and reduces turbomachinery sizes by a factor of 10. The main inherencies with CO_2 are the huge pressures which necessitate seal technology to withstand the high pressures.

CO_2 is a candidate to replace legacy refrigerants such as R134fa, R245, and Freon (banned by most countries but still produced). Legacy refrigerants (Freon) have been shown to create holes in the Ozone because Freon contains chlorine atoms which separate by UV light and chemically bonds with Ozone to generate a Ozone hole in space.

CO_2 can be used for making power, pumping, and sonochemistry to make plastics, recycle precious metals from Lithium batteries and E-waste and more.

CO_2 pressurizes (supercritical) at a very low boiling point 31 C or 87.8 F and at 74 bar (555504.5 mmHg).

Infinity has built CO_2 phase change demonstrator carts, as well as more than 100 ORC supercritical CO_2 systems for extracting oil from plants. You can purchase a phase-change demonstrator which allows you to experiment with Nafion and making gas-to-liquids experiments including converting CO_2 to alcohols. Best of all, you can use the power from closed-loop cycle to produce the alcohol fuel. For the ORC cycle, waste heat is used to build pressure with the CO_2, so the only parasitic power needed is for the CO_2 pump and chiller.

Gas Leverage Turbine

SeaWater Turbine:
High bypass flow to reduce acoustic and thermal signature.
Used to aereate water to release CO_2, saltwater distillation (water maker), and more.

CO_2 Turbine (Brayton Cycle or Organic Rankine Cycle):
Used for making power, pumping, and sonochemistry to make plastics, recycle precious metals from Lithium batteries and E-waste and more.

In-Situ Carbon Removal and Storage: Using a reverse fuel cell (electrolyzer), the CO_2 can be used immediately to make intermediates such as methanol or Ethylene. The Ethylene can be used to makes plastics as a method of carbon removal and storage.

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Producing Alcohol from Liquid CO2

Infinity has already built lots of closed-loop supercritical CO2 systems, and experimented with CO2 cavitation to make a one-moving-part liquid CO2 pump.

Infinity currently sells a cart-mounted portable on-demand supercritical CO2 phase change system for $150,000 which can be used for the experiments listed below, along with many others. It is a cart which was designed to fit through any standard door, hallway, or elevator and has heaving duty casters for mobility.

We are currently looking for funding to develop the following:

1. On-Demand CO2 to Alcohol: Using our closed-loop liquid CO2 phase change system, adding Nafion in the process to make alcohol. Inputs: Liquid CO2, water, and electricity. About 3-4 kW to make a liter of alcohol (from lab experiments).

2. CO2 to Alcohol with In-Situ Power Generation: Using our closed-loop supercritical CO2 phase change system, produce the power via miniature CO2 turbine generator of static electricity generator (SEG) to power the conversion via Nafion.

3. Spin-To-Liquid (STL): A novel one-step approach to producing alcohol from liquid CO2 using a cavitation device with Nafion. This is a one-moving-part device employing sonochemistry with inputs of water and liquid CO2. Electricity is produced in-situ. Shaft rotation is required to spin the device (this can be done via a electric motor, pressure expanding turbine, or other shaft rotation such as a wind turbine).

You can further our efforts by buying our $150,000 systems (which we build - and have four in stock) or by considering an investment to fund our development.

In-Situ Carbon Removal and Storage: Using a reverse fuel cell (electrolyzer), the CO2 can be used immediately to make intermediates such as methanol or Ethylene. The Ethylene can be used to makes plastics as a method of carbon removal and storage.

Teaser: Why was Nikola Tesla so fascinated with static electricity and spinning discs ? Our guess is that he had already found the worlds best battery - water. The Tesla turbine (while a fascinating pump) was actually a static electricity generator originally designed to charge water. All of his Colorado Springs experiments revolved around static electricity. Power generation and (wireless) transportation was via static electricity.

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Solid State Turbine

During our years of experimenting with CO_2, the shop workers were continually experiencing static discharge (corona discharge) from the interaction of CO_2 and air. What we found is that when CO_2 is pressure reduced over a hybrid material, a huge static charge occurs. We actually took advantage of this process in our commercial extraction machines as a ESP (electro-static precipitator) to help collect plant oil. Further experiments allowed us to produce DC electricity with the same format. This concept allowed us to completely remove the rotating components of a power extraction turbine to produce static electricity (solid state). Harvesting static electricity is as simple as using static whips or spikes.

TriboGen: The next leap forward in power generation will be the development and production of a solid-state turbine generator. The leapfrog technology is called Tribo-effect electrical power generation.

On a small scale, it already exists as the Triboelectric Nanogenerator or TNG. The development flow of this cycle is 100 times faster than a traditional mechanical motion based (either linear or rotary based) power generation equipment. Putting aside the need for mechanical bearings (or expensive magnetic bearings) and copper wound generators. This not only saves design time, but materials and production time. The result is a maintenance-free power generation system. The advantage of using the robust CO_2 as the working fluid allows access to low grade heat (as low as 31C). Best of all, this cycle can be scaled from nano-size to powerplant size installations without any loss.

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Legend

HYDROGEN: H_2 - 1 pound = 191 cubic feet = 5 cubic meters
.14 kw / cubic foot = 4.8 kw per cubic meter
27 kw per pound (electrolysis)
1 pound = 52,000 btu

CARBON DIOXIDE: CO_2 - 1 pound = 8.74 cubic feet = .229 cubic meters
1 ton = 17,483 cubic feet = 458 cubic meters

1 kilogram = 2.2 pounds
1 cubic meter = 35 cubic feet

METHANOL: .79 g/ml density

BIODIESEL:
100 lbs oil, 15 lbs methanol, 1 lb sodium hydroxide --
Produces: biodiesel(methyl esters- the chemical name for biodiesel) and glycerin

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Modular fluid handling device II (Components of the Gas Leverage Turbine)

A modular fluid handling device includes at least one block having opposing block faces shaped as tessellating regular polygons, and a series of block sides therebetween. Each block includes a central bore and fluid passages extending between the block faces, and possibly ducts extending between the bore and the fluid passages. The blocks may be rapidly horizontally and/or vertically affixed with their bores and/or fluid passages in communication to form a fluid handling device having the desired configuration (e.g., with the bores and fluid passages forming a desired process flow path, fluid circuit, or the like). Star wheels and/or rotor discs can be provided within the block bores for purposes of pumping fluids flowing within the bores, and/or for purposes of deriving power from fluid flow within the bores.

FIELD OF THE INVENTION

This document concerns an invention relating generally to devices for processing and sampling of gases and liquids, and more specifically to devices allowing rapid construction of fluid reactors, distillers, extractors, homogenizers, filtration/separation devices, process models (e.g., devices for modeling engine cycles, refrigeration cycles, etc.), and other devices for handling fluids.

BACKGROUND OF THE INVENTION

Fluid handling devices including fermenters, distillers, filtration tanks, evaporators, etc. (or combinations of these components) are exceedingly common in industry and in research labs. Researchers and engineers also often need to experiment with models for common thermodynamic cycles, e.g., refrigeration cycles (vapor compression cycle, Einstein cycle, etc.) and power cycles (Otto cycle, Diesel cycle, Brayton cycle, Rankine cycle, etc.). While it is often desirable to generate prototypes or small-scale versions of such devices, they are usually time-consuming, difficult, and expensive to construct. One approach commonly used in laboratories is to connect glassware vessels (e.g., flasks, towers, heat exchangers, etc.) with rubber tubing so that the vessels form some desired fluid process model. Even apart from the significant time and expense required for their construction, these are quite fragile, are unsuitable for pressurized processes, and are also usually unsuitable for processes involving extreme temperatures or corrosive materials owing to the weakness of the tubing. In some cases, more durable fluid handling devices can be formed from metal vessels connected with (for example) brazed copper tubing, but these involve even greater time, cost, and fabrication burdens.

A prior patent (U.S. Pat. No. 7,146,999 to Giese et al., which is incorporated by reference herein) describes a modular fluid handling system wherein modular blocks bear passageways for carrying fluids, and wherein inserts having different functionality—e.g., valve inserts, filter inserts, turbine inserts, pump inserts, heating/cooling inserts, sensor inserts, flow routing/diverting inserts, etc.—can be inserted into selected blocks. The blocks, with or without inserts, can be affixed together to construct a durable fluid handling device. This document relates to improvements and additions to the modular fluid handling system described in U.S. Pat. No. 7,146,999 to Giese et al.

CO2 to Fuels Experimental Developer Platform Processor

The purpose of this platform is to provide experimentation and development of novel gas to liquids (GTL) technologies for the utilization and mitigation of carbon dioxide.

Infinity is now providing experimental platforms for developing modular cart mounted GTL (gas to liquids) fuel processing from CO2. Using Nafion or similar catalysts (available in sheets, tubes, pellets, and more), the inputs are CO2, water, and electricity to make alcohol (ethanol, methanol, and butanol). The selectivity of the output will depend on your formula for the inputs and catalyst.

The Infinity GTL Processor allows you to adjust the flow of CO2, water, and electricity. The platform also allows you to incorporate and modulate in-situ power production, static electricity generation (SEG), and other unique functions.

In-Situ Carbon Removal and Storage: Using a reverse fuel cell (electrolyzer), the CO2 can be used immediately to make intermediates such as methanol or Ethylene. The Ethylene can be used to makes plastics as a method of carbon removal and storage.

The processor platform is available in a completed cart or parts in kit form for developers who want to configure their own system.

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Supercritical CO2 to treat Nafion for Direct Methanol Fuel Cells

Supercritical carbon dioxide treatment was used to enhance performance of NR212. The microstructure of NR212 membranes was reorganized after the Sc-CO2 treatment. The treated NR212 membranes showed higher proton conductivity than Nafion 117. The treated NR212 membranes showed lower methanol permeability than Nafion 117. Direct Methanol Fuel Cell (DMFC) performance of the treated NR212 membranes was better than Nafion 117 (2012). The Nafion-grafted-polystyrene sulfonic acid (N-g-pssa) exhibits higher ion conductivity and lower methanol permeability than that of Nafion 115. The N-g-pssa membranes are tested as electrolytes in a direct methanol fuel cell. Compared with the as-received NR212 membranes, all the Sc-CO2 treated NR212 membranes show higher proton conductivity and better capacity of barrier to methanol crossover. From Fenton test, it can be found that the Sc-CO2 treated NR212 membranes have better chemical stability than that of NR212 membranes. Therefore, NR212 membranes treated by the Sc-CO2 method may be promising candidate electrolytes for DMFC applications (2020).

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Publications for XPrize Elon Musk Carbon Removal

We will be adding to this pdf list weekly.

Publications for XPrize Elon Musk Carbon Removal: Green Chemistry

Many industrial chemical reactions, extraction, chemical separations and cleaning processes involve the use of organic solvents. In addition to the handling and disposal issues associated in these operations, these solvents can pose a number of environmental concerns such as atmospheric and land toxicity. In many cases, conventional organic solvents are regulated as volatile organic compound because of their contribution to the green house effect. In addition, certain organic solvents are under restriction due to their ozone-depletion potential.

Supercritical carbon dioxide is an attractive alternative solvent in place of traditional organic solvents. Early applications of supercritical fluid include chromatography applications and extraction applications particularly caffeine extraction from tea and coffee. There have been an increasing number of commercialized and potential applications for supercritical fluids in reactions, catalysis, extraction involving natural products and pharmaceutical, polymer production and processing, environmental and soil remediation, cleaning processes, semiconductor processing, and powder production.

This report reviews the fundamental of supercritical CO2 processing, current and potential applications, and patents. The technological and economical challenges involved in implementation of the technology in different applications are discussed. We also include process economic evaluation analyses of several supercritical CO2 applications: (1) Hydroformylation of octene, (2) Extraction using supercritical CO2, (3) Fluoropolymer production with supercritical CO2 as a polymerization medium, and (4) Polycarbonate production with supercritical CO2
as a raw material.

Supercritical carbon dioxide is an attractive alternative in place of traditional organic solvents. CO2 is not considered a VOC. Although CO2 is a greenhouse gas, if it is withdrawn from the environment, used in a process, and then returned to the environment, it does not contribute to the greenhouse effect. There have been an increasing number of commercialized and potential applications for supercritical fluids. This article summarizes the fundamentals of supercritical CO2 properties and processing, and presents a number of current and potential applications.

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