Hydrogen Engines – Efficient & Powerful with HyOx™ Hydrogen & Oxygen Engine Technology

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Earth – 2/3 Water

Our bodies are nearly 2/3 water; similarly, the Earth's Surface is nearly 2/3 water. This is while water is required for all life. As a major component of and supporting all life, our atmosphere manages the water cycle with evaporation, clouds and precipitation. As a part of the water cycle, our rivers, lakes and oceans move water across the Earth's Surface. All of this water and movement of water in the air and on the surface are important to our climate, our health and our world. Unfortunately, over the past century, humanity unknowingly created a support system which affects our water, our air and thereby the water cycle of our world. These affects are negatively affecting Earths' ability to support life.

Today, we know of past mistakes. We have the opportunity to improve upon our support system before irreparable harm is done to our home.

ClearValue's Vision has been that pure water and clean energy will become more important to humanity than oil. It is ClearValue's Mission to bring forth innovations to improve our water, our air, our health and our world. It is ClearValue's direction to bring forth innovations in the context of intellectual property so that capitalism will have an interest to implement ClearValue's innovations, thereby driving change to improve our water, our air, our health and our world. As profit is a great motivator, capitalism can be a great motivator to make improvements for all of humanity.

Earth's atmosphere, compared to the size of our planet, is comparatively as thin as the skin of an apple. This atmosphere, again, supports all life.

A Most Significant Human Challenge

While humanity has been rather creative in the use of fossil fuels, it is without question that excessive fossil fuel use leads to environmental consequences which may be of biblical proportions. As Earth warms, due to CO_2, NO_2, and CH_4 in Earth's atmosphere, Earth adapts. Adaptation is causing changes in weather patterns, including record hurricane and tornado events, along with flooding and drought, depending upon location. Drought causes wildfires, while flooding destroys personal property. These events are seen with only a 1 °C increase in the average Earth Surface Temperature. Computer models predict a 3 to 5 °C increase in the Earth's Average Surface Temperature within the next 50 - 100 years, which will melt glaciers and polar ice caps. Such a melting and thereby dilution of the oceans may stop the oceans' warm water conveyance systems. Should this come to pass, we should remember how cold it is just outside our atmosphere, Space, where the temperature is only 100 K, e.g. – 260 °F. We should also realize that Space has an immense capability to adsorb heat; therefore, it is not hard to imagine that if the northern and southern portions of Earth are not heated via tropical warm waters, as today, that those northern and southern portions of Earth would cover with ice. Therefore, while human activity warms Earth, it is entirely possible that Humanity may cause the next ice age. And, should the ice age scenario not come to pass, that same melting of the glaciers and polar ice caps would raise Earth's oceans over 200 feet, thereby placing many coastal cities under water. The worst case scenario is a rising of the oceans followed by an ice age; as, humanity would have left the oceans for higher altitudes. Once located in the higher altitudes, such would be horrific.

HyOx™ Technology

HyOx™ triples performance efficiency while capable of 5-10 times available power per displacement. HyOx™ has no carbon, nitrogen or sulfur footprint. This is because H_2 can be easily produced via electrolysis of water with Zero Carbon™ Energy, as well as wind, water, nuclear and photovoltaic sources.

The combustion of fossil fuels is the combustion of HYDRO-carbons. HyOx™ is the combustion of HYDRO-gen. The processes are chemically very similar; while, H_2 is very light compared to hydrocarbons, e.g. gasoline is 112 pound/mole, natural gas is 16 pound/mole and H_2 is only 2 pound/mole. On a molar basis, combustion and energy output from each fuel source:

$C_nH_{2n+2} + (2n+1)O_2 \rightarrow nCO_2 + (n+1)H_2O$ + energy
gasoline + 12.5 $O_2 \rightarrow$ 8CO_2 + 9H_2O + 1,300 kcal
nat. gas (CH_4) + 2$O_2 \rightarrow CO_2 + 2H_2O$ + 213 kcal

Combustion of HYDRO-carbons

$2H_2 + O_2 \rightarrow 2H_2O$ + energy
$2H_2 + O_2 \rightarrow 2H_2O$ + 137 kcal
H_2 has 3X the energy per pound

Combustion of HYDRO-gen

(Note: 112 lbs of gasoline converts to 1,300 kcal while 4 pounds of H_2 convert to 137 kcal. In comparison, then, 112 lbs of gasoline results in 1,300/112 = 11.6 kcal per pound while 4 pounds of H_2 (2 X 2) results in 137 kcal ÷ 34.2 kcal per pound. And, 34.2/11.6 = 3.0.)

In all, O_2 is the oxidant and H_2O is a combustion product. In hydrocarbon combustion, though, carbon forms CO_2, a greenhouse gas. (During incomplete combustion, carbon monoxide (CO), a poisonous gas is formed.) To complicate matters, also, hydrocarbon combustion is performed with air instead of O_2. While air is 20% O_2, air is also 80% Nitrogen (N_2). A portion of the N_2 then combusts endothermically (adsorbing energy) to produce oxides of nitrogen, NO_x (NO, NO_2 and NO_3); while, NO_x forms ozone (O_3).

Comparison of HyOx™ to Hydrocarbon ICE

Efficiency - In terms of efficiency, today's internal combustion engine (ICE) is only 15-20% (combustion energy to wheel energy), power generating turbines 30-35% and jet engines 25-30% efficient. In other words, out of every: $1.00 of fuel placed in an automobile, truck or bus, $0.85 is lost; $1.00 spent on your electric bill, $0.70 is lost; and $1.00 spent on jet fuel $0.75 is lost. Just as it costs money to heat your home, that hot engine block, cooling radiator and exhaust are all lost energy.

From the laws of thermodynamics:

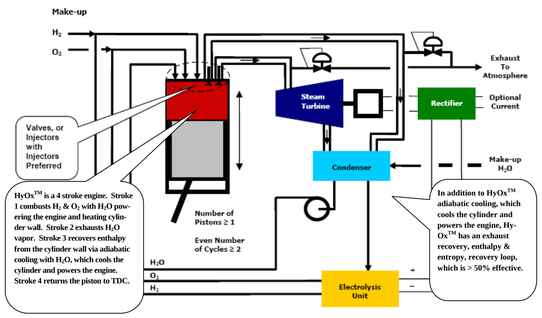
Combustion Energy = Work + Enthalpy Losses + Entropy Losses + Friction and Combustion Losses

Within hydrocarbon ICE, for every $1.00 spent on fuel, most unfortunately:

$1.00 = $0.15 + $0.35 (Cooling) + $0.35 (Exhaust) + $0.15

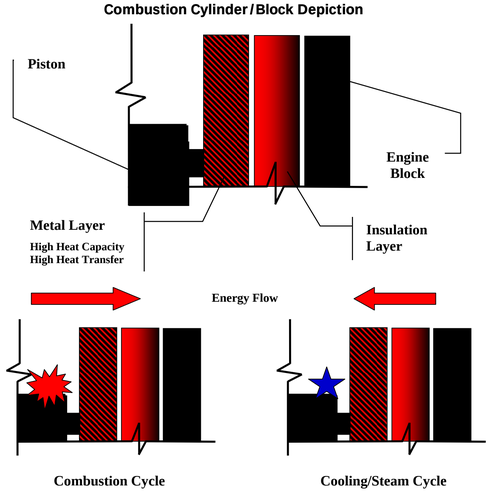
In thermodynamics, cooling losses are termed enthalpy (heat) losses and exhaust losses are termed enthalpy (heat) and entropy (pressure) losses. Therefore, the radiator has enthalpy losses; while, the exhaust has both enthalpy and entropy losses.

Energy Recovery Loop Depiction



Further improvements may be made via an innovative adiabatic cooling/steam cycle, wherein engine operation has an additional cycle between two combustion cycles (a cycle is one revolution of the crankshaft, e.g. one revolution from Top Dead Center (TDC) to TDC). (This same improvement can be made in a turbine at a time/location after combustion.) During this new cooling/steam cycle, combustion heat energy previously absorbed into the combustion chamber is reclaimed as work. Low pressure steam is injected into the combustion chamber; and, heat energy is turned into steam energy (pressure) during cooling.

Combustion Cylinder/Block Depiction



Computer models demonstrate this cooling/steam cycle to be rather efficient in work and efficacious in displacement. One such model:

Moles of H_2O		0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
Initial Temp	K	773	773	773	773	773	773	773	773
Initial volume	L	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Final volume	L	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Initial pressure	atm	725.3	634.6	544.0	453.3	362.6	272.0	181.3	90.7
Work	L-atm	81.2	71.1	60.9	50.8	40.6	30.5	20.3	10.2
Heat	cal	10569.6	9248.4	7927.2	6606.0	5284.8	3963.6	2642.4	1321.2
	L-atm	435.0	380.6	326.2	271.9	217.5	163.1	108.7	54.4
Delta T	K	2113.9	1849.7	1585.4	1321.2	1057.0	792.7	528.5	264.2
Final pressure	atm	20.31	17.77	15.23	12.69	10.16	7.62	5.08	2.54
Final temp	K	278	278	278	278	278	278	278	278

Now, with HyOx™, every $1.00 spent on fuel becomes:

$1.00 = $0.55 + $0.15 (Cooling) + $0.15 (Exhaust) + $0.15

Powerful – HyOx™ has the capability of producing 2 to 10 times the power of hydrocarbon ICE per displacement:

The HyOx™ oxidizer is O_2, not air. Air is 80% N_2, while N_2 produces NO_x. Further, NO_x formation takes power away from combustion as NO_x formation adsorbs energy. Therefore, HyOx™ operates with a 4 to 5 fold increase in available O_2 while limiting NO_x formation.

HyOx™ has the capability to add H_2 fuel and pure O_2 oxidizer to the combustion chamber under pressure. Therefore, HyOx™ has the capability to add H_2 and O_2 to the combustion chamber in amounts here-to-fore unavailable with hydrocarbon fuel and air combustion systems.

HyOx™, incorporating the Haase Cycle, a variant of the traditional Otto Cycle, furthers the power envelop, as presented in PCT/US2006/048057.

HyOx™ Computer models demonstrate that the above advantages provide significant power improvement.

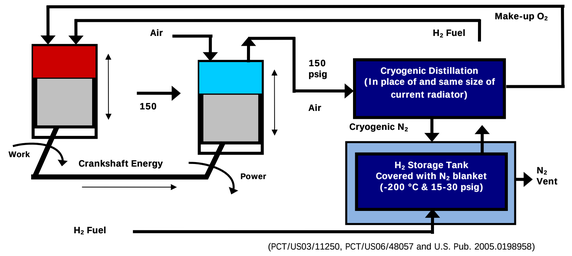
HyOx™ Computer Model – High Torque

(PCT/US03/11250, PCT/US06/48057 and U.S. Pub. 2005 0198958)

C.R. =	10																
D.S. =	0.069	Liter															
Vo =	0.69	Liter															
To =	300	K															
					Compression				Combustion			Expansion		Output			
Ps	n (H2O)	n (H2)	Po	gamma	P1	T1	Q	delta T	T2	P2	P3	T3	W 0-->1	W 2-->3	net work	net work	HP
atm	moles	moles	atm		atm	K	kJ	K	K	atm	atm	K	l-atm	l-atm	l-atm	kJ	
1	0.0000	0.06	3.21	1.40	80.7	754	17.22	7757	8510	607.6	24.2	3388	-8.38	63.08	54.70	5.541	**1114**
1	0.0000	0.07	3.75	1.40	94.1	754	20.09	7757	8510	708.8	28.2	3388	-9.77	73.59	63.82	6.465	**1300**
1	0.0000	0.08	4.28	1.40	107.6	754	22.96	7757	8510	810.1	32.3	3388	-11.17	84.11	72.94	7.389	**1486**
1	0.0000	0.1	5.35	1.40	134.5	754	28.70	7757	8510	1012.6	40.3	3388	-13.96	105.14	91.17	9.236	**1857**
2	0.0100	0.06	3.57	1.39	88.0	740	17.22	6649	7388	615.4	24.5	2941	-9.31	63.89	54.58	5.529	**1112**
2	0.0100	0.07	4.11	1.39	101.5	742	20.09	6787	7529	716.7	28.5	2997	-10.71	74.41	63.70	6.453	**1298**
2	0.0100	0.08	4.64	1.39	114.9	743	22.96	6895	7638	817.9	32.6	3041	-12.10	84.92	72.82	7.377	**1483**
2	0.0100	0.1	5.71	1.40	141.8	745	28.70	7052	7797	1020.4	40.6	3104	-14.90	105.95	91.05	9.224	**1855**
3	0.0200	0.06	3.93	1.39	95.4	729	17.22	5818	6546	623.1	24.8	2606	-10.24	64.70	54.46	5.517	**1109**
3	0.0200	0.07	4.46	1.39	108.8	732	20.09	6033	6765	724.4	28.8	2693	-11.64	75.21	63.58	6.440	**1295**
3	0.0200	0.08	5.00	1.39	122.3	734	22.96	6205	6939	825.7	32.9	2763	-13.03	85.73	72.70	7.364	**1481**
3	0.0200	0.1	6.07	1.39	149.2	737	28.70	6464	7201	1028.2	40.9	2867	-15.83	106.76	90.93	9.211	**1852**

O_2 and Cryogenic N_2 – As a safety measure, HyOx™ stores little to no O_2. HyOx™ makes its own O_2 as needed with cryogenic air distillation, which is the same process used for decades in the chemical industry. Further, this cryogenic distillation is "free" compared to hydrocarbon ICE. This is because HyOx™ requires no engine backpressure to atomize fuel; backpressure is negative energy, taking away power. H_2 is gaseous; therefore, HyOx™ has no need to atomize fuel. Hydrocarbon engines have about 150 psig of backpressure to atomize fuel; while, only 150 psig air is required for cryogenic air distillation. Therefore, HyOx™ obtains a significant power increase and eliminates NO_x formation by simply moving a negative energy, backpressure, of 150 psig from the combustion chamber to an air compressor.

Air Separation/Fuel Storage Depiction



(PCT/US03/11250, PCT/US06/48057 and U.S. Pub. 2005.0198958)

Another benefit of air distillation is cryogenic N_2, which is a good heat sink (absorbs heat). Cryogenic N_2 provides HyOx™ an ability to store H_2 at cryogenic temperatures, about -350 °F. At -120 °F and below, H_2 is easily chilled or liquefied, thereby increasing fuel storage density while storing H_2 at reasonable and safe pressures, e.g. 15 to 30 psig. This is a significant safety improvement over fuel cell applications at 1000's of psig.

The same thermodynamics which make HyOx™ a success in ICE, presents combustion solutions in power and jet propulsion applications. Attached is a diagram of a turbine power application along with a description of the minimal changes necessary within a jet engine to provide for HyOx™ jet propulsion.

Comparison of HyOx™ to Fuel Cells and Electric Vehicles

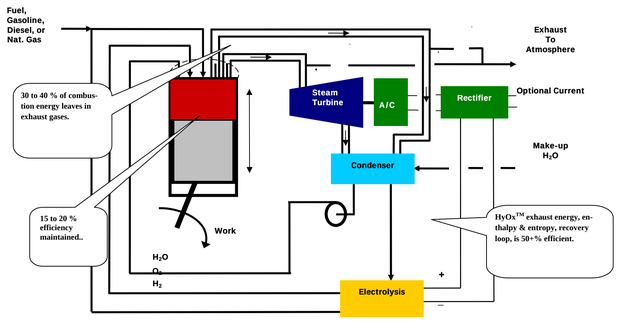
First and foremost, literally billions of research $ have been invested in fuel cells worldwide. With these research $, fuel cells remain: 1) requiring platinum, wherein there is not enough platinum in the Earth's Crust for 1 year's automotive production, 2) expensive, wherein there is still no capability to manufacture a fuel cell vehicle at less than $100,000, 3) requiring overhaul, as fuel cells require a complete cleaning every 40,000 – 50,000 miles, 4) with fuel storage challenges, as H_2 is stored at 1,000's of psig, which is a safety issue, and 5) having power limitations, while the consumer has come to appreciate the power and feel of ICE.

In addition, literally decades and billions of research $ have been invested in batteries. Electric vehicles are energy storage limited, thereby distance and/or power limited.

HyOx™ Interim/Assist

While the before mentioned HyOx™ presentation is the preferred means for HyOx™, at this time humanity has not developed an infrastructure for H_2 or electric vehicles. In any event, should a H_2 infrastructure be available today, there exist in excess of 600 million vehicles in the world today which operate with gasoline, diesel or propane. HyOx™ Interim is utilization of HyOx™ with hydrocarbon fuel. In combination, HyOx™ Interim increases fuel efficiency by near 100%; yes, a doubling of fuel efficiency, which means a reduction of 50% in fuel and a 50% reduction of CO_x and NO_x emissions.

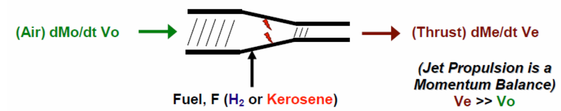
HyOx™ Assist Depiction



PCT/US03/11250, PCT/US06/48057, U.S. Pubs. 2005. 0198958 & 2009.0194996.

HyOx™ - Jet Propulsion

(U.S. Pat. Pub. 2005.0198958)



Thrust = dMe/dt Ve – dMo/dt Vo, Let Me = Mo + M_F, M_F = mass of fuel.

$F = \int_{to}^{t1} {}_{Vo}\int^{Ve} Me - Mo = \int_{to}^{t1} {}_{Vo}\int^{Ve} Mo + M_F - Mo = \int_{to}^{t1} {}_{Vo}\int^{Ve} M_F$

$F_{WCT} = \int_{to}^{t1} {}_{Vo}\int^{Ve} \{M_{H2} + M_{O2} + M_{H2O} + M_{AIR}\}$, for Kerosene $F = \int_{to}^{t1} {}_{Vo}\int^{Ve} \{M_{FK} + M_{AIR}\}$

Is, $F_{WCT} \geq F_K$?; ∴ is, $\{M_{H2} + M_{O2} + M_{H2O}\} \geq \{M_K\}$?
And, if air is used instead of O_2, then is $\{M_{H2} + M_{H2O} + M_{AIR}\} \geq \{M_K + M_{AIR}\}$?

ΔH_{H2} = 51,571 BTU/lb., ΔH_K = 19,314 BTU/lb.,

$H_2 + ½\ O_2 \rightarrow H_2O$ lb.+ 8 lb. → 9 lb.

$C_{14}H_{30} + 43/2\ O_2 \rightarrow 14\ CO_2 + 15\ H_2O$ 1 lb. + 3.47 lb. → 3.11 lb. + 1.36 lb.

Cp_K = 0.6 BTU °F/lb., $Cp_{H2O} \approx 0.46$ BTU °F/lb., Cp_{H2} = 3.45 BTU °F/lb., Cp_{AIR} = 0.46 BTU °F/lb., $\Delta H_{V,H2O}$ = 974 BTU/lb., $\Delta H_{F,H2O}$ = 144 BTU/lb., Kerosene(K) a liquid, H_2 vaporizes @ STP

ΔH Combustion = Σ ΔH's

$\Delta H_K = Cp_K$ (lb. K)(1000) + Cp_{AIR} (3.47/0.18)(1000) + Cp_{AIR}(lb. AIR)(1000)
19,314 = (0.6)(1)(1000) + 0.46(3.47/0.18)(1000) + 0.46(lb. Air)(1000) .

∴ **For Kerosene, 1 lb. K/40.3 lb. air = 41.3 lb. thrust @ 1000°F.**

ΔH_{H2} = 3.45(1)(1000) + 0.46(8/0.18)(1000) + 0.46(lb. H_2O)(1000) + 974(lb. H_2O)
51,571 = 3450 + 20,444 + 1434(lb. H_2O), H_2O cooling = 19.3 lb., Air = 8/0.18 = 44.4 lb.

∴ **lb. H_2/44.4 lb. air/19.3 lb. H_2O = 64.7 lb. thrust. (Requires 10% air increase @ 1000°F).**

∴ **H_2 w/air cooling, 0.37 lb. H_2/39.22 lb. Air = 39.6 lb. Thrust**

∴ **Lb. thrust/lb. fuel: H_2/Air = 39.6; Kerosene/Air = 41.3; H_2/H_2O = 3.18**

∴ ***Previous H_2 issues now obvious; H_2 w/air simply requires more air.***

∴ **H_2/air Engines Require Increased Air Compression to Balance Thermodynamics, e.g. about 160% more air.**

∴ **Liquid O_2 and H_2O supplement combustion at high altitudes, and**

∴ **H_2O & H_2O/Air JtC Can Cool Exhaust Reducing Heat Trail.**

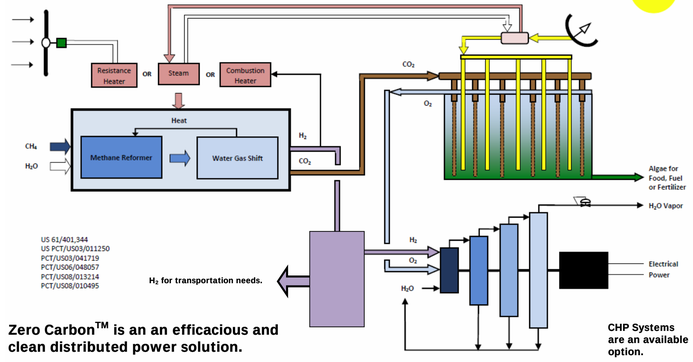
Zero Carbon™ – comprises two previous ClearValue innovations, CONOX™ and HyOx™. Zero Carbon™ Power is an innovative and proprietary means to produce clean electrical power from a liquid or gas hydrocarbon. Zero Carbon™ Power provides electrical power at 60+% efficiency, hydrocarbon to electron, while, producing no CO_x, NO_x or SO_x. Zero Carbon™ Power units are sized from 1 kW to 500 MW. While the larger units are more efficient than small, Zero Carbon™ is efficient and scalable. Zero Carbon™ units are capable of producing electrical power at $0.04/kWh, depending on fuel price. Zero Carbon™ units are capable to produce hydrogen at less than $2/pound, depending on fuel price.

CONOX™ Technology – Bacteria are Nature's (God's) little housekeepers. Bacteria provide that clean lake, that beautiful stream and that picturesque field. Algae are Nature's (God's) little terra-formers. Over time, algae developed the Earth's Atmosphere. Algae grow hundreds of times faster than any other plant. Algae convert every pound of CO_2 to ½ pound of algae and ¾ pound of oxygen.

CONOX™ uses sunlight, CO_2, nutrients (ammonia/phosphate) and water to produce marketable products, including hydrocarbon fuels. While the CO_2 can be obtained from any source, a point source is preferred. CONOX™ incorporates innovative means of photon collection and photo-bio-reactor (PBR) design while incorporating established bio-mass handling techniques, as known in the water treatment industries. CONOX™ concentrates algae into a 3-dimenional PBR (3dPBR), thereby improving upon 2-dimentional PBR means and significantly reducing required footprint. CONOX™ further collects sunlight, transferring to and filtering sunlight for the photo-bio-reactor. Within the PBR, optimal algal growth is obtained by managing: photon concentration, pH, temperature, CO_2, nutrients, algal strain and contaminants. 2-dimensional systems do not have these capabilities.

Zero Carbon™ Energy Depiction

PCT/US2011/001415



Zero Carbon™ is an an efficacious and clean distributed power solution.

CHP Systems are an available option.

In combination, Zero Carbon™, CONOX™ and HyOx™ provide efficacious and clean energy solutions in both power generation and in transportation.

Natural gas is a plentiful resource; while, there exists enough landfill natural gas, which converted to H_2, and used in HyOx™ engines, could power about 1/2 of our transportion needs, regardless of well production.