# Effect of Brown's Gas Enriched Hydrocarbon Combustion on Engine Emissions and Performance

**Submitted to: National Science Foundation**

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## Abstract

This project proposes to test the effect of adding Brown's Gas, from an electrolysis unit, to the air intake of a combustion process. Combustion parameters such as fuel consumption, exhaust emissions and system efficiency will be measured. Tests will be conducted on a hydrocarbon burner to determine the effect of Brown's Gas addition on heating efficiency. The effects of Brown's Gas addition on the fuel consumption and emissions of an engine/generator system will be evaluated. The total cost for this project is budgeted at $10,000. The findings of this project will be formulated into a technical paper and published in the International Journal of Hydrogen Energy.


## Introduction

Hydrocarbon fuels provide the primary source of energy used in the world. These fuels are used for applications such as electrical power generation, heating and transportation. Although hydrocarbon fuels provide energy for our world they have several very serious side effects. These negative side effects include harmful polluting emissions, increased levels of greenhouse gas and catastrophic disasters such as large scale oil spills. High costs and political instability, due to foreign sources, also are negative side effects. Due to the widespread dependence on hydrocarbon fuels and the difficulty of their replacement, it is not economically feasible to completely eliminate their in the near future. Methods are needed to significantly reduce the harmful emissions and consumption of hydrocarbon fuels.

One possible way to reduce consumption and emissions of hydrocarbon fuels is using hydrogen as a fuel supplement. Many studies have shown that adding a small amount of hydrogen gas to the air intake of a combustion process can reduce the emissions and fuel consumption. These studies have shown that hydrogen is able to improve the flame speed, lean burn ability, and flame quenching distance of hydrocarbon combustion in the cylinder leading to reduced fuel consumption and emissions [1,2,3]. The availability and cost of compressed hydrogen have made this process difficult to implement.

Production of Hydrogen rich gas from the electrolysis of water, at the point of use, could solve many of the potential difficulties of using hydrogen as fuel supplement to improve hydrocarbon combustion. This gas, also referred to as Brown's Gas or HHO, has been shown to exhibit properties that make it a much more reactive gas than standard bottled hydrogen. These properties include the ability to melt metals with very high melting temperature but have a relatively cool flame when burned in air [4,5,6,7,8]. Several studies have shown that retrofitting a gasoline/diesel generator or automobile engine with an on-board Brown's Gas generating system, powered by the engine's electrical system, can significantly improve engine emissions, performance and fuel efficiency [9,10,11,12,13,14,15].

## Objectives

This research project seeks to investigate the feasibility of producing a hydrogen rich gas from the electrolysis of water on demand at the point of use in order to improve emissions and fuel consumption of hydrocarbon combustion. The scope of this research seeks to cover two specific applications.

1. Improvement of the heating efficiency, fuel consumption and emissions of a hydrocarbon burner.
2. Improvement of the fuel efficiency and emissions of a stationary hydrocarbon powered engine/generator.

The findings of this project will be formulated into a technical paper and published in the International Journal of Hydrogen Energy.

## Methodology

Hydrocarbon Burner Tests

The hydrocarbon burner test will investigate the effect of adding Brown's Gas to a propane burner flame. These tests will compare the heating of a volume of water using a standard propane flame compared to a propane/Brown's Gas mixture. This test will measure variables such as rate of heat increase, propane consumption, Brown's Gas flow rate and the power required to produce the Brown's Gas. Brown's Gas and propane flow rates will be varied to determine the optimal effect on heating efficiency of adding Brown's Gas to a propane burner. Also, to be investigated will be effects of Brown's Gas quality on heating. Some of the factors that could potentially affect Brown's Gas quality are moisture content and electrolysis cell plate preparation and operating conditions.

Stand-alone Engine Generator Tests

The hydrocarbon engine/generator tests will investigate the effect of adding Brown's Gas to the intake air of a stationary gasoline, diesel or propane engine/generator on hydrocarbon fuel efficiency and emissions. These tests will involve two phases. The first phase will involve powering the electrolysis production of Brown's Gas from an external power source and then adding the Brown's Gas to the air intake of the engine. The second phase will involve using electrical power produced from the engine generator to power the electrolysis production of Brown's Gas. These two phases will be compared to determine the feasibility of using an electrolysis process, powered by the engine, to produce Brown's Gas to improve the fuel consumption and emissions of that engine.

Each phase of testing will look at a wide variety of engine operating conditions. These tests will measure variables such as fuel consumption, engine run-time, exhaust gas temperature, air/fuel ratio, ignition time and engine emissions. Engine operating parameters such as air/fuel ratio, load and ignition timing will be varied to determine their effect on fuel consumption and emissions.

## Personnel

These tests will be conducted in Kennewick Washington by Jacob Wall. Jacob holds a Master's degree in Bioenergy/Biofuels Engineering and a Bachelor's Degree in Mechanical Engineering. He has significant research experience in application of Brown's Gas to hydrocarbon combustion systems. This research experience includes retrofitting a Honda scooter engine to operate on Brown's Gas as a stand-alone and supplemental fuel, Brown's Gas torch flame experiments and retrofit of several vehicles with an on-board Brown's Gas enrichment systems. Jacob has given presentations of his research at several technical conferences (viewable at http://youtube.com/jakerwall) and has published a Journal Review article title, "Effect of Hydrogen Hydrocarbon Combustion on Emissions and Performance".

## Budget

The budget for this project will include the cost of a Brown's Gas electrolysis unit, test engine/generators and instrumentation/test equipment. The total cost of equipment and supplies is budgeted at $9000. The cost of shipping of materials and other variations in equipment and supply costs are covered by a Contingency of 10% of the total budget. The total cost for this project is budgeted at $10,000.

**Table 1: Budget**

| Budget | |
|---|---|
| **Brown's Gas Electrolysis Unit** | |
| 101 Plate Electrolysis Unit | |
| 316 Stainless Steel Plates | |
| Hardware (Wiring, Tubing, etc.) | |
| Shipping | |
| Power Supply | |
| **Torch Test** | |
| Torch/Burner | |
| Propane | |
| Calorimeter Setup | |
| **Generator Test** | |
| MSD Ignition System | |
| Gasoline Generator | |
| Propane Generator | |
| **Instrumentation/Test Equipment** | |
| 5 Gas Exhaust Analyzer | |
| Fuel Metering Equipment | |
| Temperature Data Logger | |
| Scale/Balance | |
| Test Fuel | |
| Equipment and Supplies | $9,000 |
| Contingency (10%) | $1,000 |
| Total Cost | $10,000 |

## References


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