

## COMPETITIVE ANALYSIS

### Aquafuel's EcoTec™ vs HHO

Since stored hydrogen is not economically feasible, the only competition in providing hydrogen enhanced combustion for internal combustion engines is HHO. The following is a breakdown of the differences between the two.

#### THE UNIQUENESS OF EcoTec™ PEM TECHNOLOGY

- Does not produce hydrogen gas through caustic chemical electrolysis, as most other systems do, therefore removing all HAZMAT concerns.
- Separates the hydrogen/oxygen gasses until they enter the engine - a significant safety feature (no flashbacks). Most, if not all other systems do not.
- Creates high quality, pure H<sub>2</sub> and O<sub>2</sub> gases using *only* distilled water. Other companies promote 'only add water', when in fact, it is false - they add electrolyte.
- Patented proton exchange membrane (**PEM**) cell configuration utilizes a widely accepted hydrogen production process used for decades in industrial applications worldwide.
- The *only* PEM Cell offering for hydrogen enhanced combustion in internal combustion engines, making it a technological breakthrough of immense proportions.
- Extreme low maintenance – only add water
- Full scalability to match a myriad of applications, in both AC and DC current modes

#### OPERATIONAL/SUSTAINABILITY CONCERNS OF HHO SYSTEMS

Caustic electrolytes such as drain cleaner (NaOH) and lye (KOH) (registered HAZMAT concerns) are the electrolytes commonly used in HHO systems. These systems need significant protection to keep from carrying these electrolytes, along with water (in the form of steam), into critical engine parts. Most systems require high maintenance, which can include removal, flushing, and re-installation of the electrolyte. Operational stability is ALWAYS in question during extended use due to proper water/electrolyte percentages required for proper performance.

HHO systems require the addition of chemical 'antifreeze' in exacting amounts during cold months to protect from freezing. This adversely affects hydrogen production and causes electrical draw to increase, further reducing performance.

Engine manufacturers have not approved HHO systems for use, partially because of these issues.

#### SAFETY CONCERNS OF HHO SYSTEMS

Besides HAZMAT issues associated with caustic electrolytes, most offerings utilize stainless steel in their cell construction, which can produce Hexavalent Chromium, a deadly carcinogen. Of major concern,

which needs to be addressed, are human contact and disposal requirements of these hazardous materials. Since frequent service and maintenance intervals are usually required, employees can become exposed to these contaminants, which can cause serious burns, blindness, diseases such as cancer, etc, through contact. *Even if a different metal used in cell construction is brought forth and is proven to be safe, the electrolyte issue is still present, as of the date of this writing.*

## **SUSTAINABILITY/OPERATION OF EcoTec™**

AquaFuel's **EcoTec** utilizes hydrogen *proton exchange membrane* (PEM cell) technology. The following is a synopsis of the PEM fuel cell, as found in Wikipedia:

**Proton exchange membrane fuel cells**, also known as polymer electrolyte membrane (PEM) fuel cells (PEMFC), are a type of fuel cell being developed for transport applications as well as for stationary fuel cell applications and portable fuel cell applications. Their distinguishing features include lower temperature/pressure ranges (50 to 100 °C) and a special polymer electrolyte membrane. Compared to other types of fuel cells, PEMFC's generate more power for a given volume or weight of fuel cell. This high-power density characteristic makes them compact and lightweight. In addition, the operating temperature is less than 100°C, which allows rapid start-up. These traits and the ability to rapidly change power output are some of the characteristics that make the PEMFC the top candidate for automotive power applications.

Other advantages result from the electrolyte being a solid material, compared to a liquid. The sealing of the anode and cathode gases is simpler with a solid electrolyte, and therefore, less expensive to manufacture. The solid electrolyte is also more immune to difficulties with orientation and has less problems with corrosion, compared to many of the other electrolytes, thus leading to a longer cell life.

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AquaFuel's patented PEM fuel cell technology, utilizing proprietary solid electrolytic membranes, fuel cell construction, electronic circuitry and other proprietary components provide a commercially viable hydrogen fuel cell technology to significantly reduce fossil fuel emissions and consumption on internal combustion engines.

## **SUMMARY**

EcoTec does *not* demonstrate or resemble any of the concerns associated with HHO systems. EcoTec is in process of C.A.R.B approval and SAE III testing. It has been tested and monitored on a 3rd party fleet account for more than three years now, proving emissions/fuel reductions and product longevity. R & D, 3rd party testing and product improvements will continue.