## GLOBAL WARMING REDUCTION BY POLYMERS IN AUTOMOTIVE FUELS

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### Introduction

The presence of high molecular weight elastomers alters the physical form of hydrocarbon (HC) fuel droplets introduced into the combustion chambers of internal combustion (IC) engines. The size distribution is narrowed and the submicron sized droplets are reduced. Consequently, the high temperature spike, frequently observed in the combustion of neat fuels, is moderated sufficiently that the Nitrogen molecules dissociate at much lower rates, and the NOx, which is generated with neat fuels in both gasoline and diesel engines, is greatly reduced. The moderation of the spike temperature, and the altered rate of burning of the more uniform fuel droplets, produce an overall lower operating temperature in the engine (1).

The absence of the high temperature spike relates to the paucity of low and submicron sized droplets, with their high surface area per unit mass, which promote the rapid chemistry that produces the spike and simultaneously depletes certain regions of oxygen when ordinary fuels are burned. The lack of oxygen promotes the formation of the pollutants HC, CO, partially oxidized HC and particulates. IC engines operating at lower temperatures require fuels of lesser octane rating (2). Correlatively, a substance which lowers the operating temperature at which a fuel burns, increases the octane rating of the fuel-in-use. The enhanced octane rating increases the efficiency of the system, and less $CO_2$ is produced for a given unit of work accomplished.

### Experimental Materials

Test fuels were prepared with 10 ppm of polyisobutylene (M = 7 Mdaltons), and measurements were conducted by reputable engineers using routine protocols.

### Results and Discussion

In Figure 1, temperature measurements were recorded on a new Yanmar diesel engine driving a drum skimmer on the Ohio River. The thermocouple was placed in a well adjacent to the exhaust valve. The blue bars represent measurements without polymer, the red bars, with polymer. The 260°F differential at maximum RPM is noteworthy.

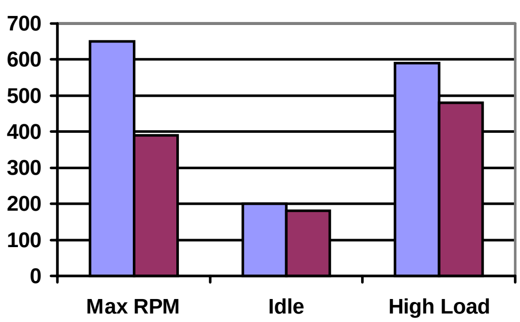


**Figure 1: Yanmar Diesel Engine Test in °F**

Figure 2 shows test data on a Caterpillar diesel engine with 94,000 miles of use, measured at 1900 RPM, at the Alban Diesel Truck testing facility in Baltimore, MD. The blue bars represent data collected with neat fuel; the red bars are values recorded with polymer in the fuel. The lower intake pressure with the polymer reflects the lower concentration of minute droplets and the lower vaporization of the more volatile constituents from the larger fuel droplets. The decrease in exhaust pressure, due to the polymer, is in accord with the decreased rate of fuel consumption yielding fewer gaseous molecules per unit time in the exhaust manifold. The lower brake specific fuel consumption confirms the increase in efficiency of fuel use with the polymer present. The increase in horsepower with the polymer, likewise, reflects the increase in efficiency

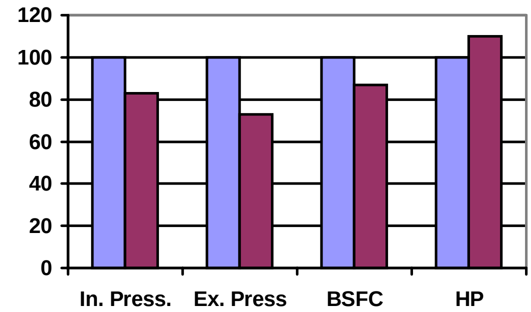


**Figure 2: Caterpillar Diesel Engine Test**

Temperatures measured on a Briggs & Stratton four-cycle, single-cylinder engine at the D.A.M. engine shop in Duchess County, NY, are presented in Table 1. The polymer clearly has a dramatic effect on the operating temperature of the engine. Additional benefits the polymer confers on these engines are that they operate more quietly, and that they start almost universally on first engagement.

**Table 1. EFFECT OF ADDITIVE ON THE TEMPERATURES OF A FOUR-CYCLE BRIGGS & STRATTON 8 HP ENGINE**

| | | | |
|---|---|---|---|
| **CYLINDER HEAD - EXHAUST** | | | |
| | RANGE | AVERAGE | DIFFERENCE |
| NO ADDITIVE | 290°F - 300°F | 295°F | |
| ADDITIVE | 260°F - 270°F | 265°F | -30°F |
| **EXHAUST MANIFOLD** | | | |
| | RANGE | AVERAGE | DIFFERENCE |
| NO ADDITIVE | 1280°F - 1360°F | 1320°F | |
| ADDITIVE | 1208°F - 1248°F | 1228°F | -92°F |
| **TAILPIPE** | | | |
| | RANGE | AVERAGE | DIFFERENCE |
| ADDITIVE | 980°F - 1110°F | 1045°F | |
| NO ADDITIVE | 798°F - 862°F | 830°F | -215°F |

Figure 3 displays the results of fuel consumption tests on a Nissan 300 ZX gasoline engine, with an odometer reading of 180,000 miles, measured by engineers at EG & G, Inc., San Antonio, TX. The blue bars represent fuel without polymer; the red bars, fuel with polymer. The results demonstrate that the polymer is particularly effective, under acceleration conditions, where engines are least efficient and normal fuels are most polluting, the situation most often met in urban driving.

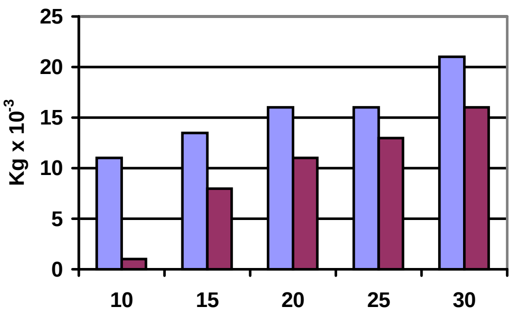


**Figure 3: Fuel Consumption to Reach Indicated mph**

Figure 4 contains representative values of dynamometer-test emissions data, recorded at an official State of Maryland testing facility, for a gasoline-powered Nissan 300 ZX, with 200,000 odometer miles. The blue bars indicate the maximum allowable emissions; the red bars show the emissions with polymer-fortified fuel. The effectiveness of the poymer in reducing emissions is significant.

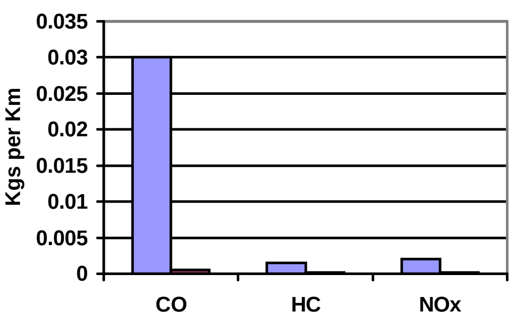


**Figure 4: MD Dynamometer Emissions Test Data**

**Conclusions**

Each of the aforementioned leads to an overall reduction in the thermal burden of global warming. The reductions of the overall operating temperatures due to the polymer are dramatic. The decline in the rate of $CO_2$ production reduces the contribution of that compound to the greenhouse effect. The reduction in pollutants proscribes the contributions to the greenhouse effect that these species, with their high order vibrational modes, would otherwise make. The effect of the polymer on global warming is holistic in the sense that, in addition to moderating the contribution of the emissions gases to the greenhouse warming phenomenon, the enhanced efficiency of combustion reduces the thermal output not only of individual vehicles, but that from the refinery producing the prospectively-saved fuels as well as the heat emanating from the vehicles used to transport those fuels.

**References**


(1) Trippe, J.C., Hadermann, A.F. and Cole, J.A., HIGH MOLECULAR WEIGHT FUEL ADDITIVE, US Patent, 5,906,665, May 25, 1999.

(2) Valtadoros, T.H., Wong, V.H. and Heywood, J.B., Division of Petroleum Chemistry Preprints, Vol. 36, No.1, pp 66-78, 1991.