

## On the Possibilities of Using Alternative Fuels in ICE Powered Lawn Mowers and Tractors to Meet Phase III Emissions Standards

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### Abstract

There is a need to use alternative fuels in Internal Combustion Engines (ICE) powered lawn care equipment used around residential, office and reserved areas. This will enable this equipment to meet Phase III emissions standards set by the Environmental Protection Agency. One method of reducing emissions from trimmers, lawn mowers, tractors and blowers is to use alcohol fuels in the next generation of ICE powered devices and also, to make it adaptable to operate on flex-fuels. These devices are not only a great source of noise pollution, they are also a major source of hydrocarbon, NO<sub>x</sub> and CO emissions in the residential neighbourhood from spring to the fall seasons, hence, the need to mandate the use of alcohol and flex fuels to lowers emissions. These changes will require a slight modification of the engine, by way of increasing the compression ratio on one hand, and modifying the fuel system: tank, fuel lines, and fuel dispensing system (carburetor) to meet flex-fuel requirements. This proposed engine modification will meet Phase 3 emissions standards as alcohol fuels possess superior combustion characteristics and lower emissions.

### Keywords:

Environmental pollution; Alternative fuels; Lawn mowers and tractors; Phase III emissions standards

### Introduction

Environmental pollution is an issue of concern to the community and a challenge to the engineering society. A review of fuels used in automobiles or in rotating or reciprocating utility devices show that alternative fuels produce lower environmental emissions than conventional fossil fuels. Hence, a need to introduce alternative fuels into utility-power

producing devices, such as lawn mowers, tractors, trimmers, blowers, etc. This in-turn will require slight modification of the power system to use these fuels. Gaseous fuels produce lower emissions but require larger storage tanks for a comparative operating time as gasoline. Alcohol fuels (methanol and ethanol) require 2.0 and 1.6 times by volume respectively, as one volume of gasoline. Since these utility devices use carburetors, the modification to the fuel system is simplified. However, there are few concerns with the lubrication of the engine components. There is also a need to use a special grade of lubricating oil that will not be degraded in the presence of alcohol fuel, when it blows-by, into the crank case.

### Choice of Alcohol Fuels and their Comparative Properties to Petroleum Fuels

Alcohol fuels (methanol and ethanol) are very good candidates for the flex-fuel substitution for the following reasons: they are commercially available at the gas stations, they are renewable and sustainable and the technology for their production is very mature. Alcohol fuels have been extensively introduced into petroleum fuels with great success. They do not emit particulates.

They are octane number improvers and their high heat of vaporization (chilling effect) reduces cylinder temperature which results in lower NO<sub>x</sub> emissions. On mass basis, Methanol's 3.4 times heat of vaporization compared to gasoline; and 2:1 volumetric ratio to gasoline – meaning, two gallons of methanol to a gallon of gasoline gives an overall 6.8 times effect. This ultimately improves the chilling effect of the cylinder charge and improves the engine volumetric efficiency. Ethanol on the other hand,

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has a comparative 2.6 heat of vaporization gravimetric ratio to gasoline, and 1.6:1 volume of ethanol to one volume of gasoline.

### Sources of Alcohol Fuels

#### Methanol and Ethanol

Ethanol is produced from bio-sources, mainly from fermentation of organic products such as sugar cane (Brazil) or corn (USA). It is also achieved by chemical conversion of syngas to Methanol or Ethanol. Ethanol is credited with higher energy density than methanol. Its introduction into engine fuel cycle increases fuel availability. Methanol is commercially produced from steam methane reformation. It can also be produced via synthesis (syn) gas from biomass. Animal, municipal wastes, agricultural products are also sources of methanol fuel. This information is well documented in literature. Eighty-five percent of alcohol (M-85 and E-85) and fifteen percent gasoline composition are readily available at many gas stations for smooth transition

### Comparative Analysis with Battery-Powered Mowers

The use of battery-powered lawn mower is a known practice, but its application is limited by the size of the lawn, the terrain (flat-landscape or a slope), the region of the country (USA), the budget and battery- life, Gasoline and alcohol powered mowers work favorably during the applicable seasons. Storage of the mowers (push-type or tractor) in garages during the cold months of the year does not shorten the life of the devices. There is no requirement to connect it to a battery charger in the garage during the wintery months

The torque and power characteristics of alcohol-fueled engine are superior to the gasoline counterpart for the following reasons. Alcohol fuel has a higher-octane number, as such, it is not knock limited within the same compression ratio range as its gasoline counterpart. The alcohol fueled engine has a higher

enthalpy of evaporation which improves its volumetric efficiency and makes it operate at a much higher compression ratio. It exhibits superior combustion, torque, and output power characteristics than its gasoline counterpart.

### Conclusion

There is a need to regulate the amount of pollutants from over 54 million lawn mowers and tractors currently in use in USA. The emissions contribute to health complications, such as asthma and other forms of breathing complications, acid rain, and greenhouse gases, etc. The proposed use of alcohol fuels will enhance compliance with Phase 3 of emission standards with minimal retrofit to the mowers and tractors. While significant improvement will be made to air quality. Ecological damage resulting from spills will be significantly reduced. Finally, a gradual transition to alcohol fueled powered systems will be widely accepted.

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