10.7251/AGSY1303982R

ENVIRONMENTAL AND ECONOMIC EFFECTS OF FUEL ADDITIVES

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Abstract

Today's public transportation still actively uses buses with outdated diesel engines that require significant investment for renovation and upgrading to facilitate modern filters. Possible solution is found in using additives based on saponified naphthenic acids, aliphatic hydrocarbons and copper. Utilizing these additives accelerates the engine's combustion process, reducing carbon and other exhaust gasses emission, carbon monoxide and particulate matter as well as fuel consumption, resulting in increased fuel economy.
Author's primary goal was to determine effects of additive utilization on fossil fuel combustion, emission of exhaust gases along with possible effects on fuel economy. Research was conducted in two cycles on public transport buses, one of an older type and one of the newer type. Data on fuel consumption was collected without additives for the first cycle and with fuel additives on the second one.
Keywords: environmental-economic effects, catalysts (additives), exhaust gases, savings, frugality

Introduction

In recent years, the energy crisis has steered liquid fuel consumers towards a critical analysis of the fuel combustion process and discovering means for its reduction. An entire array of problems that affect the efficiency of the entire combustion process is evident, therefore the fuel consumption as well. Problems are mainly caused by (non) quality of the oil derivatives (fuel oil, heavy, medium, light and extra light). The presence of mineral impurities and moisture reduces the fuel caloric value thus impeding its preparation and combustion.
It is a fact that the liquid fuel tanks over time accumulate mud and water that are always present within the fuel. Sludge is composed of combustible and non-combustible components. Combustible organic components can be converted into fuel with the use of additives, while non-flammable components remain deposited on the bottom of the tank and must be cleaned mechanically.
In parallel, work was been invested in the development of combustion additives and other means of reducing emissions, thereby protecting the environment from pollution. Today, diesel fuel additives are often added to improve the physical and chemical properties of fuels to meet the growing requirements as well as to improve the performance of the fuel in use. Using various additives must also take into account that they do not induce any damage (corrosive properties and being prone to forming sludge and deposits in vital parts of the engine).
Formation of sediments occurs if the compounds in the form of salts are added as additives, as they might interact between themselves. The result of these chemical reactions might produce insoluble precipitates in the fuel. When using additives in diesel fuels, solubility of certain additives in diesel fuels as well as their compatibility and possible chemical reactions have to

be taken into account. These occasional adverse effects, however, do not reduce the potential for the use of diesel fuel additives.
In this research the authors have describe the applications and effects in treating diesel fuels with F.O.E. 32 additive.
Using F.O.E. 32 as a combustion catalyst has proven it as a significant figure in the efforts for energy saving as will be further explained.

Problem definition
Today's public transportation still actively uses buses with outdated diesel engines that require significant investment for renovation and upgrading to facilitate modern filters.
Possible solution is found in utilizing additives based on metal-organic compounds, solvents and spray system dispersant agents. Additive F.O.E. 32 was developed by Vestal Chemed Corporation, Manchester Avenue Missouri, USA[1] for improving diesel fuel combustion. It is defined as a catalyst to accelerate the fuel combustion process with a significant effect in reducing the amount of air required for complete combustion of the fuel.
The use of additives reduces exhaust gas emission, as well as particulate matter and carbon monoxide, improves combustion and fuel efficiency. Rationale for utilizing fuel additives is found in the multiple effects it has on all stages of the combustion process - before, during and after combustion. Consumption amount of diesel fuel in the engine depends on several factors: fuel quality, the degree of engine functionality (aging), use patterns and season of the year.
Natural liquid fuel in its elemental analysis contains carbon (C), hydrogen (H), oxygen (O), sulfur (S) and mineral admixtures (ash and water). Mineral adulterants containing moisture reduce the content of combustibles and the fuel caloric value.
Fuel ignition temperature is very important for diesel engines, it should be lower than the temperature at the end of the compression cycle in the engine cylinder (550-600° C).
Engine workflow is also affected by the time from the fuel suction into the cylinder to its ignition - the induction period. Cetane number of diesel fuel amounts to 40-60 units and can be increased by 12-20 units if added fuel additives that enhance and accelerate its oxidation (burning).
At low cetane numbers the induction period of the engine lasts longer and leads to the in-cylinder piling up of fuel, its vapors and peroxides, which after ignition burn with a shockwaves.
Cetane number of the fuel affects the engine starting characteristics, smooth operation of the engine and the complete combustion as evidenced in reduced smoking and improved smoke quotient in the exhaust gases. The main effects of the use and benefits of additives FOE 32 can be classified into three groups:

a) **Economic effects** - savings in the consumption of liquid fuels of 2-6 % depending on the fuel quality.
b) **Environmental effects** - by using additives, the quality of the exhaust gases is regulated and reduced below the allowed limits (CO_2, SO_2, VOx, etc.). Improving combustion is followed by quieter engine operation, lowered residue and corrosion development at the head of the piston and exhaust valve; that produce pressure loss and lower power on the cylinder. Preventing the corrosion on the pump and the fuel intake ensures longer engine life while decreasing negative environmental effects.

1.Vestal Chemed Corporation, Missuri, USA

c) **Marketing effects** – advent of international competition, increased environmental awareness and media interest in environmental issues are a factor influencing the

domestic producers of liquid fuels, forcing them to differentiate themselves from the competition and perform better in the market. The use of modern additives in liquid fuels is a strong marketing advantage that might be used in order to improve the company position on the market.

Additive F.O.E. 32 contains:

- Agents and dispersants that allow a uniform distribution of additives to all parts of the storage tank.
- Solvents of asphalt compounds, which tend to sediment on the bottom of the tank during mixing of incompatible fuels.
  Application of additives prevents settling and creates conditions for moving homogenous and uniform fluid which enables significantly more uniform combustion.
- Dispersing agents that develop water–oil emulsification effect and have the property to disperse water residue in a uniform manner in the form of microscopic particles that can be easily combusted without affecting the controlled combustion process.
- Copper based additive F.O.E. 32 has several advantages over other additives. It is an excellent emulsifier, meaning that it dissolves organic particles that remain dispersed in the fuel, not allowing them to deposit as sludge at the bottom of the tank.

The environmental benefits character of using additives should not be ignored, especially regarding the necessity of standardization of energy production business activities. Quality Management System (ISO 9000), environment management system and preventive actions to protect the environment (ISO 14000) are adopted to ensure efficient operations, particularly in the aspect of air quality management, municipal and hazardous waste management and preservation of water quality.

As the laws on the protection of the environment constrain the allowed amount of particles that may be emitted into the atmosphere, this incentivizes the industry to further reduce the carbon residue in the flue gases. Combustion catalysts can reduce carbon emissions by improving the efficiency of the combustion process.

Energy conservation and environmental protection are obviously of great importance. However, the use of catalytic combustion can bring additional benefits.

In order to further improve the effects resulting from use of additives FOE 32, additives are produced in different composition for each type of fuel. It is added to the central tank, transport tank and the consumer’s tank. The most rational solution is mixing it in the central tank or cistern after loading.

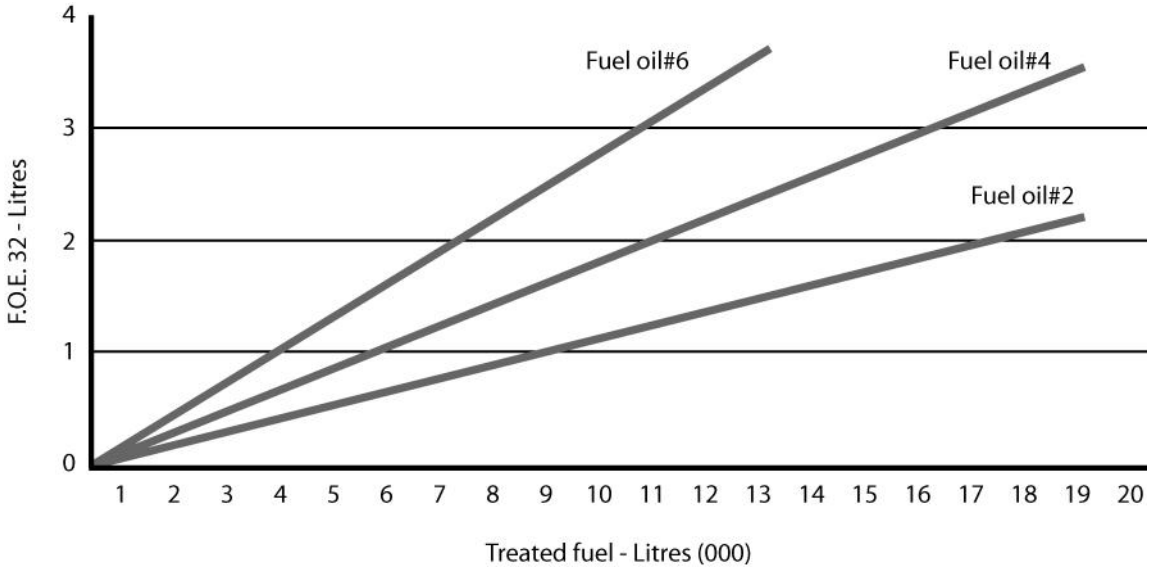
Financial effects are achieved by the savings in fuel exploitation treated with an additive. For example, gasoline savings are min. 1,5 - 2%, 3-5% for diesel, fuel oil 3-5%, heating oil 3-6%.

The advantages of using F.O.E 32 additive:

- ✓ Improved combustion
- ✓ Reduced fuel costs
- ✓ Elimination of tank corrosion
- ✓ Reduced cleaning costs
- ✓ Increase of the tank capacity
- ✓ Easy to use
- ✓ Positive for ecology
- ✓ Very economical

In recent years the energy crisis has forced company managements to a critical review of all aspects of the work, in order to determine the possibilities for the energy consumption

reduction. As an example, in 1974 the American Institute of paper launched the voluntary action program to improve energy efficiency in the industry. The main task was to reduce energy consumption by 10% by 1980. In June of 1976, the paper industry has achieved 10.7% reduction in fossil fuel use and fuel per unit of production compared to the first six months of 1972. At the same time, the use of self-generated and waste fuel increased by 3.9% per unit of output, so that the total energy used in manufacturing declined by 4.6% over the five year period. Despite this success, there is clearly a large number of steps to save energy that are still to be taken.



Graph 1.Additivation Vestal F.O.E. 32 combustion catalyst

Materials and methods

Authors' method is based on the application of catalyst FOE 32 as follows:
Selected are two buses with different years of construction, bus no. 749, made in 1998. and bus no. 788, made in 2003. During the research, fuel consumption was measured in each bus during ten working days as well as the route traveled. At the end of the cycle the average fuel consumption was calculated. Exhaust emissions were monitored and recorded during the research.
The next test cycle consisted of the following steps:
The same buses were used with the addition of the F.O.E. 32 catalyst, proportional to the amount of fuel in the tanks. Monitoring of the fuel consumption and distance have continued. Two days of monitoring were selected when the buses were subjected to emissions recording. After the next ten working days period, the average fuel consumption has been calculated again.

Technical specification of the F.O.E. 32 catalyst:

Ingredients:

- 6% Cu-complexone
- 39% saponified naphthenic acids
- 55% aliphatic hydrocarbons

Appearance:

Clear liquid of blue-green color.

Dosage:

The optimal dose is 5 litres of F.O.E. 32 on 25 000 litres of fuel.
If the fuel is heavier in impurities, that is, if the fuel has more than the average amount of impurities to be combusted, a higher dose of the catalyst can be recommended.
The recommended dose should be added to the storage tank before the fuel is tanked in it. This method enables better mixing of the catalyst with fuel.

Results and Discussion

Research was conducted on two test buses Volvo B10 M, garage numbers 749 and 788, JGSP Novi Sad. Additive treatment was done over a period of 11–25th of November 2005.

Table 1.

BUS 749	No additive treatment	With additive treatment	
Period	29.10. – 10.11.2005.	11.11. – 25.11.2005.	
Distance (km)	3.276	3.499	
Fuel consumption (lit.)	1.688	1.494	
Average fuel consumption (lit./100 km)	50,9	46,7	
Smoke quotient	0,608	0,578	0,466

Table 2.

BUS 788	No additive treatment	With additive treatment	
Period	29.10. – 10.11.2005.	11.11. – 25.11.2005.	
Distance (km)	3.133	3.065	
Fuel consumption (lit.)	1.494	1.436	
Average fuel consumption (lit./100 km)	47,7	46,9	
Smoke quotient	0,023	0,023	0,023

Survey results indicate:

- Fuel consumption of both observed buses was reduced using the F.O.E. 32 catalyst - by 8.25% on the bus 749 and by 1.7% on the bus 788.
- Exhaust gases were significantly reduced for the bus 749 and for the bus 788 exhaust gases remained at the same level.
- In both cases the exhaust emissions were below the allowed limits of the smoke quotient, which was the result of a more complete fuel combustion.

Conclusion

- Conclusion of this paper is that there is great advantage of additive use in the period before combustion, during and after combustion process, according to the given results.

- The most important effect of catalyst use is ecological effect, because using a catalyst improves combustion, regulates emissions, prevents formation of deposits and corrosion.
- As for the financial impact, there is a significant saving for the diesel fuel in about 2-6 %.
- Catalyst can be applied in all liquid fuels. Due to its effect on the reduction of emissions, reduced fuel consumption it also has an economic justification so it remains highly recommended to be utilized for fuel treatment.
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