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Dee-Zol and Fuel Efficiency Improvement at Hitachi Depot

The most common goal among users of diesel fuel additives is an improvement of the mileage they receive out of each unit of fuel used. This has become especially true in recent years as fuel prices have increased dramatically in the last five years, due to increased demand for fuel worldwide outstripping supply. With diesel fuel approaching \$3.50 per gallon in the United States, users are more concerned than ever about maximizing fuel mileage and managing fuel budgets.

Factors Affecting Fuel Mileage

The best way to determine if a fuel additive will provide a desired level of benefit to a consumer is to test the additive in the actual vehicles used by the consumer. If the vehicles are operated under the same conditions and in the same manner as they would be during normal additive use (should the additive be taken up), then a reasonably accurate benefit picture may be constructed. The most important consideration is to ensure that the factors which most fully influence fuel mileage are equalized to be the same before and during the additive test. Not doing so is to run the risk of producing inaccurate and misleading data, leading to a false conclusion.

Factors which influence the mileage achieved from fuel can be divided into three categories – fuel-related, vehicle-related and environment-related. Fuel-related factors have less variance than other categories due to the general consistency of fuel specifications – these factors can be controlled to a certain extent by the refiner. But these factors tend to be ones like fuel BTU value, fuel density and fuel specific gravity. Vehicle-related factors would include the operating condition of the vehicle, tire pressure and type of oil used – all factors which can impact the vehicle's mileage. Operating factors (which fall under Vehicle Factors) would also be a big contributor toward optimizing mileage – whether the driver of the vehicle operated it in a consistent manner both before and during any comparison test period. Environment-related factors which affect fuel mileage would include traffic patterns, terrain (hilly vs. flat), and even outside air temperature (hot air is less dense than cold air and provides less oxygen for combustion, reducing fuel mileage).

Dee-Zol and Hitachi Depot

In 2006-07, Bell Performance's **Dee-Zol** additive was subjected to a 13-month test with Hitachi Depot, owned by Mitsubishi. The result summary of the test was a 5.7% increase in fuel mileage from before the addition of the additive to during use of the additive. The length of the test (greater than 12 months) and number of vehicles (greater than 10) are positive indicators that the test results show valid improvement in fuel mileage. A 5.7% improvement in fuel mileage, spread out over 1.1 million kilometers of driving, represents a fuel saving of almost 17,000 litres of diesel fuel, worth over \$15,000 in fuel savings for that pool of vehicles alone.

The **Dee-Zol** fuel additive is a multi-purpose fuel additive which has been continuously manufactured and marketed in the United States since 1954. The **Dee-Zol** additive contains multiple ingredients designed to impart benefits to vehicles in the following manner:

- Combustion Improvement
- Deposit Reduction
- Mechanical improvement of the engine
- Improvement of fuel quality



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Combustion Improvement

Dee-Zol contains a naphthenic hydrocarbon formula which improves the combustion of the diesel fuel. This contributes to improved fuel mileage by improving the “burn” of the diesel fuel. More specifically, this happens because fuel treated with **Dee-Zol** combusts more “uniformly” within the combustion chamber in the diesel engine, from the beginning of the combustion cycle (once the fuel ignites due to sufficient pressure to produce heat in excess of auto-ignition temperature) to the end (when all of the fuel which is going to combust finishes burning and imparting heat energy and power). What tends to happen in a diesel engine with poor fuel is that the greatest amount of combustion of fuel occurs at the beginning of the cycle, when the piston is at or near top dead-center position. If the fuel is not burning optimally, there will be less combustion (and less power being delivered) happening at the end of the typical period allotted in the power stroke for power to be delivered by the fuel. When this happens, the amount of “power” – the ability to drive the piston – derived from the amount of fuel burned is not optimal. The combustion improver in **Dee-Zol** will cause the atomized fuel to burn more evenly over the course of the time allowed for power delivery. When this happens, more power is delivered to the piston over a longer period of time through the course of the power-delivery period. The end result is not necessarily more BTU energy being produced per unit of fuel, but is more total power being delivered to the piston and crankshaft through the course of the fuel-burning phase of the engine cycle.

Deposit Reduction

Dee-Zol contains multiple ingredients to reduce and remove deposits which can accumulate within a diesel engine. Diesel fuel is more prone than gasoline to leave deposits, both in the combustion chamber and in injectors, due to the “less-refined” nature of the fuel (as compared to the more-refined gasoline). This tendency is not insignificant because engines are designed to function from a state of clean perfection. When an engine is new, clean, and free of deposits, it will function as close to a 100% optimal level as is possible. In this state, it is not really possible to improve the performance of the engine – it is as good as it is going to get at this point. However, as the engine compiles mileage, deposits develop with the combustion chamber and within the injectors, and these deposits have a number of detrimental effects.

Injector deposits will adversely affect the spray pattern of the diesel fuel. An engine which is new and free of injector deposits will exhibit a fuel atomization spray pattern which is as close to optimal as is possible, and this spray pattern will be a contributing factor to the optimal combustion of diesel fuel and the obtaining of maximize fuel mileage. As injectors develop deposits, the spray pattern is distorted and less than optimum. This will contribute to a loss of fuel mileage and also causes the delivery of fuel in such a manner that the fuel won’t be completely combusted within the power stroke and will contribute either to increased deposits in the combustion chamber or an increase in unburned fuel and black smoke leaving the post-combustion area of the engine (exhaust).

Combustion chamber deposits can start to build up within a few thousand miles of an engine’s starting life. As these deposits build up, the volume of the combustion chamber is decreased from its optimum volume and the nature of the combustion process moves away from an optimal point. The cetane requirement of the engine is changed at this point and the performance of the engine is degraded, which can have a negative impact on fuel mileage.

The **Dee-Zol** additive contains effective detergents to remove both kinds of deposits as well as ingredients which will prevent further deposits from gathering. Introducing the additive to an engine with deposits will cause a cleaning action of the engine (which reduces mileage in the short-term as the deposits are actually burned as fuel). Once the deposits are removed, the mileage inevitably increases above the mileage of the deposit-laden engine, as the engine’s injector and combustion chamber conditions are restored to what they were when it was a new engine operating at 100% optimal efficiency. With the vehicles at the Hitachi Depot, this was no doubt a contributing factor to the mileage improvement.



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Mechanical Improvement of the Engine – Increased Lubrication

The **Dee-Zol** fuel additive contains a top cylinder lubricant which improves the lubrication of parts in the fuel delivery system (including injectors), rubber o-rings, cylinder liners and the top cylinder area of the combustion chamber. This lubricant does not have a significant effect upon fuel mileage, but improves the lubrication of said parts in such a manner that the potential of mechanical breakdown of the engine (especially due to ineffective lubricity of ultra low sulfur diesel fuel) is reduced.

Improvement of Fuel Quality

Dee-Zol contains an alcohol-free moisture eliminator which emulsifies water which can build up within diesel fuel storage tanks and within fuel tanks. Water can collect within vehicle fuel tanks as the diesel fuel used to cool the injectors is returned to the fuel tank containing cooler fuel. Condensation occurs and water collects in the fuel tank, yielding the potential for injector damage and microbial growth. **Dee-Zol** contains two surfactants which emulsify water into micro-sized droplets, enabling them to pass through the injectors and into the combustion chambers where they are burned off with no adverse effect. The impact of this upon fuel mileage is dependent upon the amount of water present in the fuel of the test pool, but should not be a significant factor in fuel mileage change in any normal situation. The advantage of this product feature is the reduction of the potential for costly maintenance problems relating to injector damage from water and microbial infestation of vehicle fuel tanks and fuel storage tanks.

Conclusion

The multi-purpose **Dee-Zol** fuel additive produced significant fuel mileage improvement over a 13-month test period. The components of the **Dee-Zol** additive which most contributed to this documented improvement were the naphthenic combustion improver and the deposit control agents.

We trust that this technical explanation will provide a basis for explanation of the product benefits for you and your customers.

Best Regards,

A handwritten signature in black ink that reads "Erik Bjornstad".

Erik Bjornstad
Technical Sales
Bell Performance, Inc.