DIESEL FUEL TREATMENT

CHEMICAL EVALUATION and TEST RESULTS

Document No. 18384

THIS SUBMISSION IS A CONDENSATION OF THE RESULTS OF AN EVALUATION OF CARTEL DIESEL FUEL TREATMENT BY SOUTHWEST RESEARCH INSTITUTE, SAN ANTONIO, TX. COMPLETED MARCH 26, 1984.

TEST PROCEDURES USED WERE ACCORDING TO AAR RECOMMENDED PROCEDURE RP503. THE RESULTS OF BOTH PHASE I (CHEMICAL LABORATORY EVALUATION) AND PHASE II (CATERPILLAR 1-G2 OPERATION EVALUATION) OF THE ABOVE MENTIONED RP503 ARE CONTAINED IN THIS REPORT.

ADDITIONAL TEXT FROM INDEPENDENT SOURCES HAS BEEN INCLUDED WHERE FURTHER CLARIFICATION WAS DEEMED TO BE HELPFUL.

A copy of the complete Evaluation Report (SwRI-7696) may be obtained by request from:

Cartel Products, Inc.
335 N. Eastwood Dr.
Woodstock, IL. 60098

PHASE I
EVALUATION RESULTS
(CHEMICAL LABORATORY EVALUATION)

EXCERPTS FROM REPORT OF PHASE I OF TEST PROCEDURE RP-503 DATED AUGUST 31, 1983

by: SOUTHWEST RESEARCH INSTITUTE

San Antonio, Texas

Subject: Project Report, SwRI Project No. 05-7696,
Evaluation of "Cartel Diesel Fuel Treatment"

The Phase I Evaluation of "Cartel Diesel Fuel Treatment" according to the Association of American Railroads recommended procedure RP-503 has been completed. The results of these tests are described below.

TEST RESULTS, PHASE I

The results of the chemical analysis of the baseline diesel fuel, and this same fuel treated with Cartel diesel fuel treatment, are presented in Table I.

POUR POINT decreased by 17^{O}F when Cartel treatment was added. This test is an indication of the lowest temperature at which the fuel can be pumped. Pour-points generally occur 8 to 10^{O}F below the cloud points and differences of 15 to 20^{O}F are not uncommon.

Additives that are designed to improve the low temperature fluidity of diesel fuels usually work by modifying the wax crystals so that they are less likely to form a rigid structure. Therefore, even though there is no change to the cloud point, the pour point may be lowered dramatically.

CARBON RESIDUE increased from 0.13 to 0.40 weight percent on 10 percent bottoms. On whole oil, these values would be 0.013 to 0.040 weight percent, respectively. This is a measure of the carbonaceous material left in a fuel after all the volatile components are vaporized in the absence of air.

The significance of the carbon residue test results also depends on the type of engine in which the fuel is being used. Fuels with up to 1.5 weight percent carbon residue have been used successfully in medium-speed diesel engines.

ACCELERATED STABILITY increased from 0.09 to 1.20 mg/100 ml. This test is often applied to fuels to measure their stability. A sample of fuel is heated for a fixed period at a given temperature, sometimes in the presence of a catalyst metal, and the amount of sediment and gum formed is taken as a measure of the stability.

Neat #2 diesel fuel will generally form from 1.0 to 1.1 mg of gum during a accelerated stability test. Up to 1.5 mg of gum is acceptable, with little chance of filter plugging.

PARTICULATE CONTAMINATION decreased from 8.7 to 3.1 mg/l. In this test, one liter of fuel is filtered through a 1.2 micron pre-weighed filter. The increase in filter weight after washing and drying determines the amount of contaminants (in milligrams) left on the filter. These contaminants could be dirt, rust, scale and other foreign particles from fuel transfer lines and storage facilities.

CETANE NUMBER increased from 47.8 to 50.1. The cetane number of a diesel fuel is the numerical result of an engine test designed to evaluate fuel ignition delay. The shorter the ignition delay period, the higher the cetane number of the fuel and the smaller the amount of fuel in the combustion chamber when the fuel ignites. Consequently high-cetane number fuels generally cause lower rates of pressure rise and lower peak pressures. Both of these tend to lessen combustion noise and to permit improved control of combustion resulting in increased engine efficiency and power output.

The fuel properties that have been altered upon the blending of Cartel diesel fuel treatment with neat #2 diesel fuel are well within the acceptable limits for operation in medium-speed diesel engines.

by: James F. Wakenell
Research Engineer
Department of Engine and Vehicle Research
Energy Systems Research Division

TABLE 1.

FUEL PROPERTY TEST RESULTS FOR AAR FUEL ADDITIVE EVALUATION

Procedure RP-503
Cartel Diesel Fuel Treatment

Fuel Property	ASTM Method	#2-D Specification	Baseline Value	Value w/Additive
Gravity, API @ 60°F	D-287		35.8	35.8
Flash point, °F(°C)	D-93	125 (51.7) min.	159 (71)	159 (71)
Cloud point, °F(°C)	D-2500		0 (-18)	0 (-18)
Pour point, °F(°C)	D-97		0 (-18)	-17 (-27)
Kinematic viscosity @ 100°F, cSt	D-445	min 2.0 max 4.3	2.56	2.55
Distillation range, °F	D-86			
IBP			362	368
10%			418	416
20%			446	442
30%			468	465
40%			488	484
50%			504	502
60%			522	520
70%			540	536
80%			558	556
90%		min 540 max 640	584	582
95%			610	602
EP			634.5	634
Carbon residue (10% bottoms, wt%)	D-524		0.13	0.40
Sulfur content, wt%	D-1266	0.50 max	0.40	0.39
Copper strip corrosion	D-130	3 max	1A	1A
Ash content, wi%	D-482	0.01 max	0	0
Water and sediment content	D-2709	0.05 max	<0.01 sediment	<0.01 sediment
Accelerated stability mg/100ml	D-2274		0.09	1.20
Neutralization number	D-974		0.01	0.01
Particulate contamination, mg/l	D-2276		8.7	3.1
Cetane number	D-613	40 min	47.8	50.1
Heat of combustion, BTU's/lb_m	D-240		19,580	19,516

hemicals company

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RE: Evaluation of Data, Project #05-7696

Our evaluation of diesel fuel treatment test data from the above stated test project is as follows:

GENERAL OBSERVATIONS:

The diesel fuel used as a "baseline" in this test series exhibits some unusual characteristics and is not typical of #2 fuels currently in widespread use in the industry. Cetane numbers averaging 38 to 41, and pour point of - 10^{O}F would be two examples of a more typical fuel. With a pour point of 0^{O}F, the fuel used in this test apparently has an extremely high paraffin wax content. With a more typical fuel-and therefore a lower wax content- it is probable that the additive would have shown an even greater reduction in pour point. Our tests of the additive indicate a reduction of 22^{O}F to 24^{O}F to be more typical. Some of the affects of the additive become even more significant when viewed in this context.

As stated in the Southwest report, the properties of the limits for #2 intended for use in medium speed diesel engines. This is very important and should be of considerable comfort to users of your product. Many, if not the majority, of additive compounds currently on the market cause one or more values of the treated fuel to exceed the acceptable limits required of #2 diesel fuel. Such additives have proven to be detrimental to the operation and/or actual condition of engines subjected to the use of such additives.

SPECIFIC TEST RESULTS:

Many of the test result items shown on Table #1 are of interest primarily to fuel chemists and researchers only, in that they are not generally seen as "in use" concerns by diesel fuel users. However, the importance of the data is to clearly show the ability of this additive to perform its' functions while remaining well within the specified limits of #2 diesel fuel.

The functions of this additive as they effect pour point, particulate contamination, cetane rating, etc. are stated quite succinctly in Southwest Research Institute's report, and require no additional explanation.We do wish to point out two additional functions of this additive that are not addressed in the report. This is not an oversight but is instead due to an absence of ASTM methods for establishing values for those properties in middle distillate fuels.

1) Our tests indicate that this additive has the ability to disperse water in amounts equal to the volume of the treatment itself. In that it is widely understood in the industry that water, in its' various forms, is a substantial contributor to the problems associated with the use of diesel fuel, it is our opinion that this function is of substantial benefit to the user.

2) In addition, the biocidal function of this additive should be understood. Microbial activity occurs at freezing levels, but is considered to be a substantial problem only at summer temperatures or in warmer climates. High levels of activity also occur in heated fuel systems of course. The "algae growth" results in increased sludge content, and increased acidity and corrosion levels. Short fuel filter life is the most easily observable result.

The biomassdisperant agent in this additive is both fuel-and water-soluble,and is thus effective in both "still" storage and in vehicle fuel systems.

CONCLUSION:

The test results, in our opinion, indicate a substantial improvement in those qualities of diesel fuel that are of greatest concern to its' users.

Of the common methods used to avoid winter problems:

A mixture of #1 and #2 fuels increases costs and reduces BTU's.

The use of alcohol decreases cetane rating, reduces the lubrication qualities of the fuel, and decreases the flash point.

Depending upon the cost of this additive, as measured in "cost attractive alternative to the more common methods used to attempt similar results.

Respectfully,

Sherwin Doorn,
President

PHASE II
EVALUATION RESULTS
(CHEMICAL 1-G2 EVALUATION)

TEST PROCEDURE

The Caterpillar 1-G2 engine tests were conducted to determine the effect of the Cartel Products Corporation diesel fuel treatment on piston ring sticking, power assembly wear (ring, liner, ring groove), and accumulation of combustion deposits. A baseline test was run without the additive in the fuel, followed by a test with the additive mixed into the baseline fuel at the specified ration of 1000:1 (fuel:additive). The two tests were performed with the same engine (rebuilt between tests) which was mounted on the same test stand. A qualified oil (URSA Super Plus) was used in both tests.

The test was conducted without an oil drain, although make-up oil was added as required every 12 hours. The normal procedure (in the 480 hour test) is to drain and replace the oil every 120 hours, with 12-hour oil checks/ additions. The reason that the oil was not changed during the shortened test is that the oil would not become degraded in 200 hours. The justification is that, again, the test objective is to make a relative comparison between results obtained with and without the fuel additive, and the oil is a constant factor in the two tests.

EXCERPTS FROM SUMMARY RESULTS

WITHOUT CARTEL ADDITIVE	WITH CARTEL ADDITIVE
Lube Oil Used:	
Texaco URSA Super Plus	Texaco URSA Super Plus
Data Test Completed:	
2/2/84	2/18/84
Fuel Used:	
Baseline	Baseline w/Cartel additive
Test Length:	
200 hours	200 hours
Piston Deposits:	
Total Weighted Demerit 202.5 Top (ring) groove filling 55	Total Weighted Demerit 223.1 Top (ring) groove filling
Piston Crown Scuffing:	
Few fine vertical line cuttings	Numerous fine vertical line cuttings
Deposits On Oil Ring Slots:	
Nil	Nil
Piston Skirt Condition:	
Polished areas normal with few fine to coarse vertical lines	Polished areas normal with few fine to coarse vertical lines
Liner Condition:	
Normal	Normal
Ring Gap Increase:	
0.001	0.001
Liner Wear Step:	
.0004	.0003
Blowby, CFH:	
13.51	11.71
Oil Consumption #/BHP-HR:	
.00125	.00101

OBSERVATIONS OF RESULTS
by CARTEL PRODUCTS personnel

The test results may be more easily understood and quantified by the use of additional comparisons. Piston deposit results, for example, can be put into better focus when compared with data supplied by SwRI from many similar tests with other lubricating oils. These tests generated Total Weighted Demerit figures ranging from 159.1 to 463.1 and top (ring) groove filling figures from 24 to 86. The results in our test are therefore clearly in the mid-range of total testing experience.

The combination of less liner wear, less blowby, and less oil consumption, suggest the possibility of improved wear characteristics in this area with the resulting potential of extended service life for cyl. liner, piston and ring components.

This reduced wear effect had been observed but not quantified in earlier field tests and it is our belief that it is the result of a more controlled fuel burn and increased cetane number together with a higher level of injection efficiency.

Field tests have also shown fuel efficiency improvements and, although not quantified to our satisfaction to date, the results are sufficiently consistent to be mentioned. We feel that any additional fuel efficiency generated by the use of the additive is simply a function of the above mentioned improved combustion chamber characteristics and injection tip condition.

CONCLUSIONS

Carterl's effort - in years of research, development, and field testing - has been to create a fuel additive that provided the multiple benefits of:

substantially improved cold flowability

increased cetane

reduced particulate contamination

water emulsion ability

biomass dispersant properties

in a formulation that would also aid in the maintenance and operating efficiency of the fuel handling and injection systems.

Integral with that effort, however, was the knowledge that those goals must be achieved while causing no negative effects, relative to the operation or wear characteristics, of the engine itself.

These goals appear clearly to have been achieved with this product. We quote the following from Southwest Research Institute's Phase II Conclusions:

> "Under the specific conditions of these tests, the fuel additive produced a total weighted demerit value that indicates no harmful effects are produced relative to the baseline results. The difference between the baseline test results and the fuel with additive test results were within rater repeatability."

Indeed there is no other product, known by us to exist, that has achieved and substantiated the levels of performance detailed herein by Cartel RMF-83 diesel fuel treatment.

***DIESEL FUEL TREATMENT* concentrate is a formulation of the most effective elements yet discovered to treat the complex effects of diesel fuel on engines and fuel delivery systems. It contains biocides, flow improvers, corrosion inhibitors, wax crystal modifiers, pour point depressants, and--most important--water solubilizers.**

As a “middle distillate fuel”, diesel fuel contains certain amounts of water, carbon and gum residues, sulfur, paraffin wax and other impurities which are not removed in the refining process. These factors - either alone or with the help of various weather conditions - can cause substantial problems in the operation of diesel powered vehicles.

WATER is present in all diesel fuel. In addition to the moisture that remains through the refining process, additional water is often introduced from condensation and improper handling or storage. The presence of moisture causes corrosion, fuel blockage by freezing, algae growth, clogged filters, and ultimately, injector nozzle deterioration, incomplete combustion, increased fuel consumption, and complete operational failure. CARTEL is extremely effective in absorbing water. By combining molecularly with the water and then dispersing the resultant product throughout the fuel, the effects of water in the fuel are totally neutralized.

CORROSION remains a problem, although substantially diminished by removing the water, because of the presence of sulfur in the fuel. Sulfur content has increased dramatically in the recent past as lower grades of crude are being used to produce diesel fuel. CARTEL neutralizes the resulting sulfuric acid and also coats all metal surfaces with a microscopically thin but tough molecular protectant that stops corrosion in it’s tracks. Increased engine wear resulting from contaminated crankcase oil is thus prevented.

WAX crystals form when the temperature falls below the fuel’s “cloud point” (+25^{O}F +10^{O}F for most #2 fuels). Wax crystal formation can very effectively clog fuel lines and filters in cold or freezing weather. CARTEL prevents the formation of paraffin wax crystals, and the “gelling” and filter clogging that results, by reducing the pour point approximately 20^{O}F at suggested winter treatment ratio. Freezing weather “pour point” and “fuel flow” problems are thus prevented.

CETANE values in diesel fuel appear to have been steadily deterioration in the past few years. While most engine manufacturers require a cetane rating of 45 or above, it is virtually impossible to find this quality of fuel in most sections of the country. Fuels with ratings of 38 to 40 cetane are very typical - and result in engine pre-ignition and a loss of fuel efficiency. CARTEL increases cetane at least two numbers without the use of potentially harmful metallic substances.

ALGAE and bacterial growth, which is aided by warm weather and the presence of water, is stopped dead by the very effective biomass dispersant agent in CARTEL. Year round use of CARTEL is extremely effective in eliminating the filter clogging “sludge” that is a common occurrence in untreated fuel systems.

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