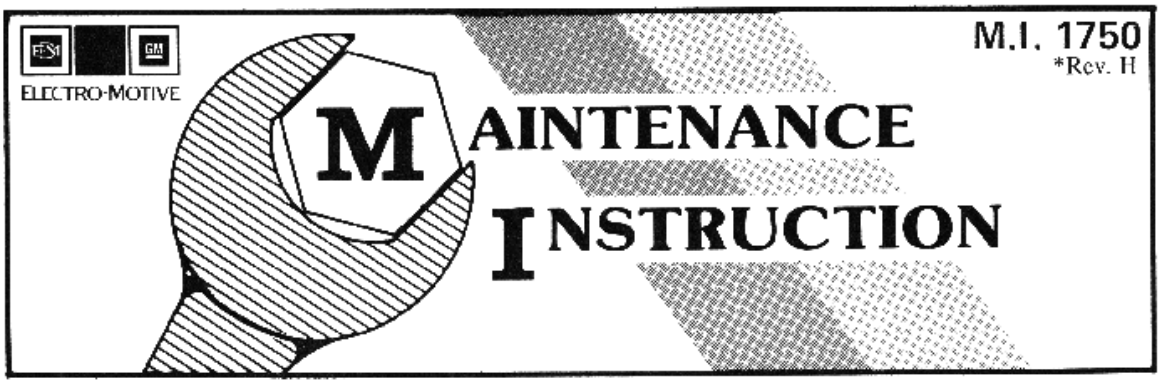

DIESEL FUEL RECOMMENDATIONS
ALL EMD AND FORMER CDED ENGINES

It has been and continues to be General Motors policy to manufacture engines that will operate satisfactorily on good quality commercial fuels that are regularly provided by the petroleum industry and meet the requirements of this maintenance instruction. As a result, EMD does not recommend the use of supplementary fuel additives marketed under such designations as conditioners, smoke suppressants, or graphitizers.

These recommendations, which are based on many years of operating experience, provide test limits for qualifying fuels being supplied to the engine. The inherently low level of maintenance required by our engines can best be realized if the engine fuel systems are supplied with fuel which meets these recommendations.

The cleanliness, quality, and uniformity of the fuels supplied to the engine fuel tanks are the responsibilities

RECOMMENDED LIMITS FOR FUELS

As Supplied to EMD and Former CDED Engine Fuel Systems

Method Of Test	ASTM Designation	Limits
Calculated Cetane Number	D-976	40 (Min.)
90% Boiling Point	D-86	650° F (Max.)
Final Boiling Point	D-86	100° F (Max.)
Distillation Recovery	D-86	99.0% (Min.)
Total Sulfur	D-1552 0.	50% (Max.) - Note 1
Corrosive Sulfur (3 hr. @212°F)	Modified D-130	No. 2 Strip Or Better
Conradson Carbon Residue (on 10% bottoms)	D-189	0.35% (Max.)
Water And Sediment	D-1796	0.05% (Max.)
Cloud And Pour Point	D-2500, D-97	Note 2
Flash Point	D-93	Note 3
Organic Chlorides	U.O.P. Method No. 588-65	20 ppm Total Chloride (Max.)-Note 4
Filtration Cleanliness Test (solid matter such as rust, cracking catalyst, and clays)	EMD Standard Laboratory Practice No. 102	1.3 mg. Per Liter (Max.) Of Ash Residue On 0.80 Micron Filter – Note 5.
Viscosity	D-445	32-45 SUS at 100° F (1.8 - 5.8 cs)
Ash, Weight %	D-482	0.02% (Max.)

*This bulletin is revised and supersedes all previous Fuel Oil Recommendation bulletins.

of all who are involved in the manufacture, transportation, and handling of the fuels. The fuel should be free from acid, which, when in contact with any metal, forms enough soap to plug the fuel filters. Electro-Motive will consult, upon request, with any user, supplier, or petroleum refiner on any question pertaining to fuels to be used in our engines.

NOTES ON TEST LIMITS:

1. For maximum engine life, the fuel sulfur content should not exceed the 0.5% recommended in this M.I.

   As fuel sulfur content increases, engine wear and maintenance costs will also increase. As a result, the user should carefully weigh the economics of less expensive high sulfur fuels against such increases in maintenance costs.

   The effect of high sulfur fuels on the diesel engine lubricant is also one of increased severity, and demands the use of high alkaline reserve lubricants as well as more frequent laboratory analysis and oil change intervals to assist in minimizing the effects of high sulfur fuels as well as insuring effective levels of engine protection. In this regard, EMD will assist, upon request, in the selection of a qualified lubricant formulated for such applications. Obviously, due considerations must be given to legal limits on fuel sulfur content where they apply.

   2.The cloud and pour point of a fuel are measures of the formation of wax crystals and fluidity at low temperatures. To insure adequate flow through the fuel system filtration media during cold weather, the customer must specify the appropriate cloud and pour point requirements based on the lowest fuel system temperature expected. As a general rule, the cloud point should be 10° F (6° C) below the lowest expected fuel temperature to preclude the plugging of filtration media with wax precipitates.

3. Fuels normally used have minimum flash points of 150° F. Fuels with lower flash points can be used without affecting engine operation, however, fuel handling and storage may require added precautions.

4. The use of fuel containing organic chlorides results in rapid wear of chrome plated and iron surfaces in the combustion chamber. The presence of organic chlorides in fuel is rare but can occur from the use of halogenated dewaxing agents in cold weather pipeline operations, or from improper desalting of crude oils at an inexperienced refinery, followed by a reaction between the olefins and salt in the distillation unit. From past experiences, most refineries in the U.S.A. are alert to prevent the presence of chlorides in the fuel. Their precautions are now so automatic that cases of chlorides in the fuel seldom occur, and since routine control testing for chlorides is a time consuming procedure involving relatively large samples of fuel, it is not considered necessary in the United States.

   When testing for chlorides, EMD prefers the U.O.P. method No. 588-65, which employs the sodium biphenyl reduction procedure to obtain ppm of the organic chloride.

5. Until recently, "Filtration Cleanliness Tests" have not been generally employed or required in connection with diesel fuel. Experience has been that usual foreign contaminants, rust for instance, are removed by the filtration facilities at fueling stations, and by the filtration equipment normally supplied with engines. The increasing use of catalytically cracked fuels, however, has produced instances where minute catalyst fines were accidentally introduced into the diesel fuel production. These cannot be removed by the commercial filters used at fueling stations and on engines. The "Filtration Cleanliness Test" has been added to our diesel fuel recommendations to guard against contaminants of this nature.

   Because an involved laboratory procedure is required to distinguish the objectionable catalyst particles from other impurities, EMD suggests that all ashable material should not exceed 1.3 mg per liter of fuel when filtered through an 0.80 micron millipore paper. In those cases where contamination from catalyst fines is suspect, a sample of at least one gallon should be taken at the refinery where any significant ash content is most likely attributable to catalyst fines.

   In checking the cleanliness of diesel fuel samples taken from tank cars or customer fuel storage tanks, the sample should be taken by acceptable sampling methods. Cleanliness properties are then evaluated using EMD Standard Laboratory Practice No. 102 which utilizes the entire fuel sample as a measure of the ashable solids present in the fuel. This procedure has been appended to the M.I. to assist customers who may wish to perform their own analysis of fuel cleanliness.

Although the "Filtration Cleanliness Test" will check the fuel for ashable contaminants, it does not limit the amount of combustible organic contaminants. If fuel filters plug prematurely, the fuel should be checked for bacteria or fungus contamination and be treated with suitable biocide, if necessary.

EMD STANDARD LABORATORY PRACTICE NO. 102

DETERMINATION OF PARTICULATE CONTAMINANT IN FUEL OIL BY LABORATORY FILTRATION

Scope

This method covers time gravimetric procedure for determination of particulate contaminant in fuel oil by laboratory filtration.

Summary Of Method

A known volume of fuel is filtered through a preweighed membrane filter and the increase in membrane weight determined after washing and drying.

Apparatus

For determining the total contaminant: (Ref. Fig. 1).

1. Analytical balance, single or double-pan, whose precision standard deviation must be 0.07 mg or better.

2. Oven, of the static type (without fan assisted circulation), controlling to 90 ± 5° C.

3. Petri dish, approximately 125 mm in diameter with removable glass supports for membrane filters.

4. Forceps, flat-bladed with unserrated nonpointed tips.

5. Vacuum system.

6. Test membrane filters, plain 47 mm diameter, nominal pore size 0.8 pm .

7. Filtration apparatus, funnel and funnel base with a filter support, such that a membrane filter can be clamped between the sealing surfaces of the funnel and its base, by means of a metal clamp. (Millipore Filter Corp. apparatus.)

8. Muffle furnace, capable of maintaining a temperature of 775 ± 25° C.

9. Porcelain crucible, wide form, glazed throughout, 29 to 31 ml capacity, 46 to 49 mm (1.81" to 1.93") in rim diameter.

Reagents

Isopropyl Alcohol
N-Pentane (flushing fluid)
Distilled Water
Liquid Detergent, Water Soluble

Filtered Reagents

Filtered through a 0.45 pm membrane filter.

Preparation Of Apparatus
And Sample Containers

All components of the filtration apparatus, sample containers, and their caps must be thoroughly cleaned and rinsed thoroughly with filtered reagents.
Laboratory Filtration And Total Contaminant Determination Thoroughly clean the outside of the sample container in the region of the cap by washing with detergent and water, rinsing with tap water and filtered isopropyl alcohol. Shake the sample container vigorously for about 1/2 minute. Remove the cap and any external contaminant that may be present in the threads of the sample container by washing with filtered flushing fluid ensuring that none of the washings enter the container.

Pour some of the sample,into the filter funnel. Apply vacuum to the flask and maintain a liquid head in the funnel until completion of filtration by suitable transference of the remainder of the sample, agitating the sample container before each addition. Disconnect the vacuum and record the volume of filtered sample.
Use 250 ml to 350 ml of filtered flushing fluid in this and succeeding paragraph. Wash the sample container with four 50 ml quantities of filtered flushing fluid to complete the transference of the contaminant to the membrane filter.

Wash down the inside of the funnel and outside joint between the funnel and filter base with filtered flushing fluid. With the vacuum applied, carefully remove the clamp and funnel. Wash the periphery of the membrane filter by directing a gentle stream of flushing fluid from the edge to the center, taking care not to wash any of the contaminant from the surface of the membrane filter. Maintain vacuum after the final washing only for the few seconds necessary to remove the excess flushing fluid from the membrane filter.

Fig. 1 - Millipore Filter Apparatus

Using the clean forceps, carefully remove the membrane filter from the filter base, and place it in a clean, covered petri dish. Dry and reweigh membrane filter, taking care not to disturb the contaminant on the surface of the membrane filter.

Calculation And Report
Of Total Contaminant

Subtract the initial weight of the test membrane filter from the final weight. Report the results to the nearest 0.01 mg/liter as total contaminant mg/liter and also the sample volume used in the test.

Determination Of Non-Combustible
Contaminant

Place the membrane filter in a clean porcelain crucible and soak with filtered isopropyl alcohol. Ignite the membrane filter until it is charred. Place the crucible containing the charred membrane filter in a muffle furnace at 775 ± 25° C for 1 hour, allow to cool, and weigh.

Calculation And Report Of
Non-Combustible Contaminants

Divide the increase in the crucible weight by the volume of sample filtered and report the results to the nearest 0.01 mg/liter as, total ash mg/liter and also the volume used in the test.