M.I. 1760 *REV. G

Maintenance Instruction

Technical Publications

ELECTRO-MOTIVE

LUBRICATING OIL FOR EMD ENGINES — MARINE, POWER, AND DRILLING RIG —

The necessity for properly lubricating the dynamic components of any engine is readily apparent. The recommendations, suggestions, and comments included in this Maintenance Instruction are offered as a guide in the selection of a suitable engine lubricating oil.

OIL QUALITY

It must be recognized that the only real measure of quality in a lubricating oil is its actual performance in the diesel engine. This is apparent because of the impossibility of establishing limits on all physical and chemical properties of oils which can affect their performance in the engine over a broad range of environmental influences.

Oil quality is the responsibility of the oil supplier, a term applicable to refiners, blenders, and rebranders of engine lubricants. As there are a substantial number of commercial lubricants marketed today, engine manufacturers and consumers cannot completely evaluate the entire spectrum of products available. As a result, the selection of a suitable, heavy duty lubricant must be made in consultation with a reliable oil supplier capable of making product recommendations commensurate with the engine builders specifications and specific environmental influences as well as furnishing such a product on a consistent quality level.

OIL TYPE

An SAE 40, heavy duty additive type engine lubricant conforming to the following specifications should be used in all EMD engine applications:

PROPERTY	ASTM TEST DESIGNATION	NEW, UNUSED OIL LIMITS
Viscosity: Saybolt Universal Seconds at 210° F (98.9 ° C)	D88 or D445	70-85 (12.9-16.8 cSt)
Viscosity Index	D567	60-100
Flash Point	D92	420° F Min. (216° C)
Fire Point	D92	475° F Min. (246° C)
Pour Point	D97	40° F Max. (4.5° C)
Zinc Content (†)		10 ppm Max.
Total Base Number (**)	D-664 D-2896	5-17 7-20

*This bulletin is revised and supersedes previous issues of M.I. 1760, 1762, and 1763. Areas of change are indicated by vertical bars.

NOTE

† Zinc additive compounds, such as zinc dithiophosphate, must not be present in lubricant for EMD engines. Oils containing more than 10 ppm zinc are considered excessively contaminated with zinc dithiophosphate or similar additive compounds which will not satisfactorily lubricate the silver bearings in EMD engines.

†† Certain oils in this TBN range will not provide adequate performance if fuels with sulfur content in excess of 0.5% must be used. For further recommendations in this regard refer to the section on high sulfur fuels.

In addition to the above properties, the oil formulation should have a high resistance to oxidation, a low tendency toward the formation of harmful carbonaceous and/or additive ash deposits, and must be non-corrosive to silver metal at 285° F (140° C) (EMD L.O. 201 test). Oils with sufficient alkaline reserve (TBN) and highly effective detergent-dispersant systems should be employed in line with fuel quality and/or service demands.

QUALIFICATION TESTS FOR ENGINE LUBRICATING OILS

The diesel engine lubricating oil must satisfactorily lubricate the entire engine under all conditions expected to be encountered. While the condition and performance of the engine in actual service provides the criteria in reaching a final judgment of oil suitability, there are several laboratory tests which are useful in making preliminary evaluations of a product, namely:

1. Physical and chemical properties (as previously noted).

2. Corrosion of metals:

   a. Silver and copper — EMD No. L.O. 201 method,
   b. Lead — S.O.D. Method No. 5321-1 (modified).

3. Overall evaluation of oxidation stability by the EMD L.O. 201 method, including:

   a. Viscosity increase characteristics
   b. Retention of alkalinity (additive concentrate)
   c. Development of insolubles.

DEVELOPMENT PROGRAM REQUIREMENTS FOR NEW OIL FORMULATIONS

1. Laboratory Evaluations

   The supplier of the lubricant base stock and the supplier of the additive concentrate are expected to conduct complete laboratory and bench test qualifications by ASTM and EMD methods. EMD will review and monitor such tests and if all results are in good agreement and within acceptable limits, the oil formulation will be considered worthy of 2-567 engine evaluation to determine its silver lubricity characteristics.

2. 2-567 Silver Lubricity Test

   The purpose of this test is to determine that the laboratory qualified oil formulation will satisfactorily lubricate the silver wrist pin bearing. This test evaluation is also expected to be conducted and/or contracted by the oil or additive supplier with review and monitoring of the results by EMD.

3. Full Scale Field Test

   Upon successful completion of the laboratory and silver lubricity tests, an oil formulation will be considered worthy of full scale field test evaluation. Field tests should be conducted in a minimum of three (3) EMD engines, preferably in heavy duty service, for a period of not less than one year.

   During the field evaluation and its conclusion, EMD will review the oil and engine performance data generated by the supplier(s).

   After successful completion of the field test program the oil will be considered satisfactory for limited use, but should be closely monitored during the following two years of commercial introduction.

Oil formulations established and proven by this development program must remain exactly the same with no subsequent changes in their make-up.

If an oil or additive improvement program is desireable or necessary, the revised formulation must be evaluated by going through the complete development program.

USE OF ONE OIL

The use of a single brand name lubricant is recommended. This recommendation of long standing is substantially supported by observations of performance of many units with a single oil compared to performance of units with mixed oil products.

MIXING OF LUBRICATING OILS

EMD has continually recommended that lubricating oils should not be mixed. The combining of lubricants with different additive and base stock components creates a chemical mixture which cannot be readily evaluated in the laboratory, and its field performance cannot be reliably predicted.

RECLAIMED OILS

Considered as a general category, reclaimed oils are not recommended for lubrication of EMD engines.

HIGH SULFUR FUELS

EMD strongly recommends the use of distillate fuels with sulfur content of les than 0.5% in order to realize optimum life expectancies of both the engine and the lubricating oil. It should also be noted, that scheduled maintenace programs are based on fuel sulfur levels of .5% or less and other properties as shown in M.I. 1750.

In applications where fuel of recommended sulfur level cannot be obtained, it may be necessary to make specific engine modifications (contact your local EMD Service Representative) and follow the lubricating guidelines mentioned in this section, in order to achieve reasonable performance and wear rates.

In addition, EMD considers the use of high alkaline reserve lubricants as mandatory where high sulfur fuels must be employed. Specifically, the use of lubricants with new oil total base number of 10 to 17 by ASTM D-664 (13 to 20 by ASTM D-2896) are recommended under these conditions.

EMD guidelines for lubricant alkalinity as a function of fuel sulfur content are shown in Fig. 1 for values up to and exceeding 1%. It should be noted that extensive operation at low sulfur levels with high base number oils is not recommended due to excessive formation of additive ash deposits. Conversely, operation with low base number oils and high sulfur fuels will not provide adequate engine protection.

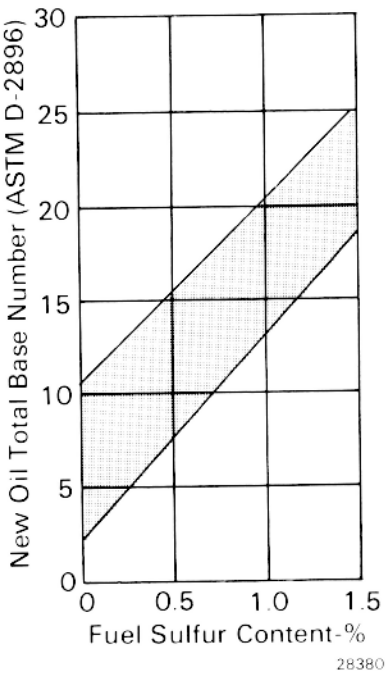

Fig.1 – Recommended Alkalinity Level Of New Lube Oil Vs. Fuel Sulfur Content

It is emphasized that the use of high sulfur fuels results in significant reductions in both engine wear life and lubricant life. Recommendations offered in conjunction with the use of high sulfur fuels are essential in minimizing these effects, but are limited in what they accomplish. As a result, the user of high sulfur fuels must anticipate shorter intervals between engine overhauls as well as more frequent oil changes under such conditions.

FILTER CHANGES

Regular monitoring of lube oil filter tank pressure should be used to determine filter condition. Replacement of oil filter elements should be made according to the Scheduled Maintenance Program unless pressure monitoring or laboratory analysis of the lubricating oil dictates earlier replacement.

Replacement elements must be of the EMD type or equivalent in all respects. Elements intended for use with other types of engines are not suitable.

Where highly dispersant oils are employed, carbonaceous matter may be suspended so finely in the oil that it is essentially unfilterable. In such situations, it might appear that an extension of the filter replacement interval may be justified. Caution should be exercised when contemplating such action since filter materials have not yet been developed that will tolerate prolonged exposure to lubricants at high temperature without deterioration and or possible disintegration of the filter media.

INTERPRETATION OF LUBE OIL SAMPLE ANALYSIS

LUBE OIL ANALYSIS	BASIS FOR ANALYSIS	NORMAL No Action Required	BORDERLINE Take Extra Oil Samples	HIGH Correct Condition	RECOMMENDED ACTION ■ Shut Down Engine. Drain Lube Oil. Change Filters. □ Change Filters Only.
Fuel Leak	Viscosity & Flash Point — Check for dilution if flash point less than 400° F or oil viscosity drops 15% or more at 100° F.	0 to 2%	2 to 5%		Borderline — find and fix fuel leak.
				Above 5%	High – check main bearings per maintenance manual.
Water Leak	Free Water	None		Any	Resample with dry container. Find and fix leak. Check main bearings per maintenance manual.
	Chromate Inhibitor	0 to 20 ppm	20 to 40 ppm	Above 40 ppm	Find and fix water leak. Check lube oil filter tank pressure.
	Boron Inhibitor	0 to 10 ppm	10 to 20 ppm	Above 20 ppm	
Air Filtration	Silicon	0 to 5 ppm	5 to 10 ppm	Above 10 ppm	Improved air filter maintenance required. Anti-foam agent present in new oil.
Excessive Oxidation	TBN (D-664) TBN (D-2896) Viscosity Rise pH Pentane Insolubles			*Min TBN (D-664) 0.5 (D-2896) 1.0 Max. Vis. Rise In S U S @ 100° F. 30% Min. pH 5.0 Max. Pent. Insol. 2%	Change Oil. If short oil life persists, check lube oil quality, fuel sulfur content, oil cooler efficiency, engine temperature controls, power output (governor and rack settings), engine condition (worn rings, cracked pistons, poor combustion), oil filtration, or oil pump suction leak.
Contaminated fuel (cracking catalyst)	Aluminum, Silicon, and/or Magnesium		Above 5 ppm		Check fuel cleanliness. Notify fuel supplier. If engine smokes, check injector calibration and tip erosion. Check if piston rings are excessively worn.
Oil Contamination	Zinc	0 to 10 ppm	Above 10 ppm becomes more dangerous with increasing values.		Check if oil is contacting galvanized or zinc painted surfaces. Check if make up oil in stock is within specifications. Notify lube oil supplier. Check for silver bearing failures.
	Silver	0 to 1 ppm	1 to 2 ppm	Above 2 ppm	Check if oil contains zinc or is corrosive to silver. Check for broken piston cooling tubes, inefficient oil cooler, or improper temperature control. Feel sides of piston pins for signs of distress. Measure piston to head clearance with lead readings. ‡ Oil draining is not mandatory. Check strainers and bottom of oil pan for debris. Consider turbo bearing condition.

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Abnormal Wear Or Corrosion (Rapid increases within normal range should be considered borderline condition).	Chromium (Not applicable if chromate coolant inhibitor is used)	0 to 10 ppm	10 to 20 ppm	Above 20 ppm	Check for rapid wear of rings & liners.
	Copper	0 to 75 ppm	75 to 150 ppm	Above 150 ppm	Measure piston to head clearance with lead readings to locate worn piston thrust washers. ‡‡ Check connecting rod bearing blade thrust faces for distress.
			High iron and copper increase oxidation rates		
	Iron	0 to 75 ppm	75 to 125 ppm	Above 125 ppm	Check for rapid wear of rings & liners.
	Lead	0 to 50 ppm	50 to 75 ppm	Above 75 ppm	Most likely lead flash is dissolving off bearings. Premature lead removal, before bearings are broken in, can lead to bearing distress. Inspect and replace upper con rod bearings in service less than 6 months if lead flash has been removed from the unloaded area of the fishback bearing surface on turbocharged engines. If con rod bearings require replacement, wrist pin bearings should also be checked and replaced if lead flash has been removed.
In Combination	Copper Iron Lead		Two out of three elements in borderline or high range.		Check for debris under crankshaft gear indicative of gear train bushing distress. Check idler gear bearing clearances. Check main and con rod bearings per maintenance manual. Oil draining is not mandatory.
In Combination	Tin	0 to 20 ppm	20 to 40 ppm	Above 40 ppm	1. When in combination with iron or chrome rise, check for piston distress. 2. When in combination with lead or copper rise, check for bearing distress.

* In applications where fuel sulfur content is 0.5 to 1.0%, the TBN level should not be allowed to drop below 1.0 (D664) or 2.0 (D-2896); and where fuel sulfur content is greater than 1.0%, TBN should not be allowed to drop below 3.0 (D-664) or 4.0 (D-2896).

‡‡ Due to carbon buildup on both the fire face of the cylinder head and the crown of the piston during service life, lead wire readings should not be used as a basis for power assembly changeout. Lead wire readings may continue to be used to indicate wear trends. Significant clearance increases should be investigated as possible component failures.

LUBRICATING OIL CHANGES

Oil change intervals prescribed in the applicable Scheduled Maintenanced Program are based on average operating conditions with quality fuels of less than 0.5% sulfur content.

When oil change intervals are overextended, serious and costly engine problems may result. This can occur if the additive concentrate is depleted beyond acceptable limits, and the lubricant loses essential properties including alkalinity, detergency, and dispersancy. In the absence of vital reserves of these properties, the lubricant no longer provides satisfactory protection of the engine in limiting harmful deposit formations from oxidized oil and other contaminants, or adequate control of the corrosive products of combustion.

Oils which have experienced severe additive depletion will result in accelerated engine wear, stuck or broken piston rings, liner scuffing, and corrosive attack and or frictional failure of vital bearing surfaces.

Regular laboratory analysis of the lubricant is a valuable means of judging the condition of the lubricant, and is of equal value in reflecting the condition of the engine. Both engine and oil condition must be given careful consideration when planning to extend oil change intervals beyond those recommended.

In addition, EMD strongly advises the conscientious use of laboratory analysis where high sulfur fuels must be used. The degree of satisfactory performance in such applications is heavily dependent on the establishment of proper oil change intervals under the actual service condition and high end of the fuel sulfur range that can be expected. Therefore, an expeditious well planned program of frequent analysis is most essential in establishing a safe oil change interval for a given lubricant under these conditions.

Under no circumstances should a set time interval for oil changes with high sulfur fuels be arrived at without first establishing such an interval by careful laboratory analysis and or close consultation with the oil supplier.

Among the key parameters for judging the need for an oil change, total base number (TBN) is one of primary importance. When this or other key indicators approach or reach prescribed minimum, or condemning limits, appropriate action must be taken. To assist maintenance personnel in the interpretation and recommended actions associated with the regular laboratory analysis of the engine lubricating oil, a summary of guidelines has been included in this Maintenance Instruction. While some variations from guideline values may exist due to method or analysis techniques employed, significant deviations from the normal lubricant history should still be detectable, and the proper evaluation of such indicators as a means of implementing preventive maintenance can serve well in avoiding potential engine damage of a more serious nature.