CATERPILLAR®

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Operation & Maintenance Manual

G3408 & G3412 Industrial and Generator Set Engines

6NB1-UP
7DB1-UP
6RJ1-UP
3NK1-UP

Includes Standard NA & TA, Low Gas Pressure and Optional Fuel System Arrrangements

Lubricant Specifications

Lubricant Information

Oil properties and performance are designated by several groups: American Petroleum Institute (API), Society of Automotive Engineers (SAE) and American Society of Testing and Materials (ASTM). A booklet of lubricant producers and marketers, together with the performance classification for which they have qualified products, has been issued by the Engine Manufactures Association (EMA). The EMA Lubricating Oils Data Book is available from the EMA. Refer to the Reference Section for the address.

Certain abbreviations follow Society of Automotive Engineers (SAE) J754 nomenclature and some classifications follow SAE J183 abbreviations. The definitions and nomenclature other than Caterpillar definitions and nomenclature will be of assistance in purchasing lubricants. The recommended oil viscosities can be found in the Lubricant Viscosity Recommendation chart in this publication.

The grease is classified by the National Lubricating Grease Institute (NLGI) based on the ASTM D217-68 Worked Penetration characteristics which are given a defined consistency number.

Gaseous fueled engines require oils formulated with an additive system specific to these engines. Since no industry [American Petroleum Institute (API), Society of Automotive Engineers (SAE) and American Society of Testing and Materials (ASTM)] performance specifications are available to define the required performance levels, field test evaluations must be used to define acceptable oils. Some general guidelines will be provided to aid in oil selection for the application, engine fuel system and the type of fuel.

Engine oil performs several basic functions in order to provide adequate lubrication. It keeps the engine clean and free from rust and corrosion. It acts as a coolant and provides a film cushion to minimize metal-to-metal contact, which reduces friction and wear.

Engine Oil

Caterpillar has an engine oil formulated to provide maximum performance and life in your Caterpillar gas engine. This low ash oil has 0.45 percent sulfated ash (ASTM D874) and 5.0 Total Base Number (TBN), (ASTM D2896).

Minimum requirements do not ensure satisfactory performance in specific applications. Some general guidelines are provided to aid in oil selection for the application, engine fuel system and the type of fuel.

The Caterpillar lubricants that follow are offered for the gas engine lubrication requirements.

- Caterpillar Natural Gas Engine Oil (NGEO)
- Caterpillar Lubricating Grease (MPGM)
- Caterpillar Multipurpose Lithium Grease (MPGL)
- Caterpillar Special Purpose Grease (SPG)

Oil recommendation is determined by the type of gas burned and the inlet air conditions.

Units operating on processed natural gas should use oils formulated with additive systems containing between 0.3 percent and 0.5 percent maximum sulfated ash and meet the CB MIL-L-2104A (Supp 1) classification. Your oil supplier knows which oils meet these requirements.

Caterpillar oils have been developed, tested and approved by Caterpillar to provide the performance and life which has been designed and built into Caterpillar gas engines. These oils are currently being used for engine development and are offered by Caterpillar dealers for continued field use. Consult your Caterpillar dealer for these Caterpillar oils.

Natural Gas Engine Oil

- Caterpillar Natural Gas Engine Oil (NGEO)

Caterpillar NGEO is formulated from select base stocks blended with special additives to provide excellent anti-oxidation/nitration properties and thermal stability. Caterpillar NGEO reduces levels of carbon and sludge formation and provides excellent lubrication oil and filter life.

The product has superior resistance to foaming, exhibits good demulsibility and provides protection against corrosion. This oil uses an additive technology which offers excellent valve and seat protection, improved piston cleanliness and control of deposit formation. Other benefits are protection against piston scuffing, scoring and cylinder liner wear.

Caterpillar NGEO is recommended for all Caterpillar gas engines when used with fuels (dry processed gas) not exceeding a concentration of hydrogen sulfide (H_2S) at 0.10 percent by volume or less. This oil is recommended for use with all turbocharged, medium-to-high speed, four-cycle gas engines requiring a low ash level product.

Caterpillar oils are offered in appropriate single viscosity grades to meet the ambient temperature requirements for each compartment. For additional lubricant information, refer to the Literature Section of this Manual. The oil viscosities, container sizes and part numbers are listed in PEHP0004, Natural Gas Engine Oil, and in PEWP9733, Caterpillar Fluids Selector Dial. Consult with your Caterpillar dealer for more information on Caterpillar oils.

Commercial Oil Alternatives to NGEO

If an oil other than Caterpillar NGEO is to be used, use the guidelines that follow.

- Caterpillar recommends oils that have sulfated ash values between 0.30 and 0.50 percent. Oils for gas engines that meet the requirements of the 7000 hour field trial are acceptable regardless of ash content.

- The recommended commercial lubrication oil for Caterpillar gas engines is a natural gas type oil with a general performance classification of API CD and a maximum of 0.5 percent sulfated ash (for preferred fuels). Higher sulfated ash level together with higher TBN (higher alkalinity) will be required for some permissible fuels with elevated corrosion effects.

The guidelines that follow have been provided for commercial oils to be used in Caterpillar gas engines. These oil requirements are for low corrosive gas ("sweet" natural gas, LP Gas, etc).

Caterpillar does not recommend lubrication oils by brand name. Field operation may identify oil brands which yield good results. The oils which may be listed as having good field operating results do not form a Caterpillar recommendation, but serve only as potential oils which may be successful in your application. The particular oil company has control of their product and should be accountable for its performance.

Therefore, it is the responsibility of the lubrication oil supplier to recommend an oil which will perform acceptably for that application, power output and operating duty cycle. Discussion with oil companies about particular oil brands should establish product consistency before using that product.

NOTICE

Failure to follow these recommendations can cause shortened engine life due to carbon deposits or excessive wear.

- Ashless (0.0 to 0.1 percent sulfated ash) oils that have performed acceptably in the G Series engines are still acceptable in those engines. All other Caterpillar Gas engines should use oils that meet the previously defined oil ash level and performance requirements.

Caterpillar has recommended ashless oils for use in the G Series gas engines for many years. These ashless oils have provided proper lubrication and good operating life for these early engines. However, newer engine designs require oils with higher ash levels for long life operation. Engines in the field operating with ashless oils with proven success may continue to use these types of oils.

NOTICE

Caterpillar recommends the use of oils formulated specifically for heavy duty spark ignited gaseous fueled engines. Oils formulated for gasoline engines only or for diesel engines only should not be used.

- Caterpillar recommends oils that successfully complete 6000 to 7000 hours of documented field service in standard and/or lean burn engine configurations. The field trial must be performed in a similar configuration to the proposed engine and at a power level that meets or exceeds the proposed engine. During the field trial, the parameters that follow must be monitored: oil consumption, oil deterioration and valve stem projection.

At the completion of the field trial, the condition of the oil and the engine must be within the limits listed:

- No ring sticking or ring scuffing
- No liner scuffing or carbon cutting from excessive piston top land deposits
- Valve recession must not exceed the limits established by Caterpillar for the engine
- Oil consumption must not exceed two times the initial oil consumption (initial oil consumption is established during the first 1000 hours of operation.)
- At the end of all specified oil change periods, the oil condition must remain within Caterpillar's limit for: oxidation, nitration, sulfur products, viscosity increase and TBN.

Sour Gas and Alternate Fuel Gas Applications

NOTE: Refer to topic in the Fuel Specifications in this manual for additional information.

Sour gas generally refers to fuels containing sulfur compounds, primarily hydrogen sulfide. (Gases containing no sulfur compounds are referred to as "sweet gas".) Severe damage to the engine can occur if this contaminant is ignored.

Water vapor and sulfur oxides formed during combustion can combine to form sulfuric acid compounds. Internal components, particularly valve guides, piston rings and cylinder liners will be subjected to corrosive wear shortening engine service life.

If analysis of the fuel shows the concentration of hydrogen sulfide to be greater than 0.1 percent by volume, the fuel should be treated (scrubbed) to lower the H_2S level below 0.1 percent. When using fuels with 0.1 percent H_2S or less, consult your Caterpillar dealer for additional information on lubrication oil selection and oil change interval recommendations.

When sour gas, landfill or sewer gas is used as engine fuel, a gas engine lubricant with higher reserve alkalinity (higher TBN) will probably be required. These alternate fuel sources are becoming increasingly important. The scrubbing (removal) of the fuel's corrosive materials is one approach to assure engine service life. If the decision is made to use these alternate fuels with little or no treatment, the user should be aware that higher maintenance costs will be associated with the engine operation.

Alternate fuels create additional problems for the engine and its crankcase oil. The sulfur bearing compounds (H_2S, etc) and the halide constituents in these fuels produce corrosive effects. The recommendations that follow will aid in reducing corrosive effects produced by gaseous fuel containing H_2S and various halides.

- Use an oil with higher TBN (10 TBN values as an example). Select a natural gas engine oil formulation by your oil company with higher TBN. Use the same performance requirements method for this oil as specified for the commercial oils mentioned previously.
- Scheduled Oil Sampling (S•O•S) must be used to evaluate the engine wear and oil condition. The oil change interval can be determined from the S•O•S results.
- Oils with higher TBN, (10 TBN or above), values also have higher ash levels, (one percent or more). Ash can cause deposit buildup which can lead to valve, combustion chamber and turbocharger damage over longer operating time. This ash, which is required for TBN to neutralize the acids, can also create deposits resulting in shorter engine service life.

- Oil with these specifications may require shortened oil change periods as determined by close monitoring of oil condition with Scheduled Oil Sampling (S•O•S) and infrared analysis. Oil sampling (S•O•S) with infrared analysis for gas engines is essential to determine satisfactory oil performance.
- Maintain jacket water temperatures and oil sump temperature at elevated values, above 88°C (190°F). These water temperature regulators are now standard on the gas engine. Higher temperatures will reduce the water vapor condensation and formation of acids in the engine.

Low engine loads can cause low jacket water temperatures. This can result in excessive moisture and nitration products accumulating in the crankcase. These materials react with the oil and form a sticky, gummy product that can plug the oil filters. When this happens, unfiltered oil can circulate through the engine and cause deposits on the pistons resulting in piston ring problems.

The oil filters must not cause more than a 105 kPa (15 psi) decrease in the oil pressure and the oil must not exceed the condemning limits. This will make sure that the oil remains acceptable.

NOTE: For information regarding lubrication oil condemning limits, refer to the S•O•S Oil Analysis topic.

Always consult with your Caterpillar dealer for the latest lubrication recommendations.

Multigrade Oils

The operation of gas engines using multigrade oils has been very limited. Results from tests have indicated poor oil performance as compared with single grade oils relative to deposits. Viscosity Index (VI) improvers are used in the multigrade oils. The VI improvers allow the oils to have multiviscosity, but the VI improvers also cause some performance loss.

At the present time, Caterpillar does not recommend the use of any multigrade oil in Caterpillar Gas Engines. There is some testing currently taking place with multigrade oils in order to better define the operational compatibility of the oils. Some oil companies offer a multigrade low ash oil, however, none of those oils have successfully completed Caterpillar's 7000 hour field test.

Actuators for gas engines equipped with electrical governors are not compatible with the polymers used for VI improvers in multigrade oil formulations. The engine crankcase oil lubricates these controls which do not provide the precise control of the engine with the multigrade oils.

Caterpillar NGEO is warranted by Caterpillar against oil related failures. The performance of other engine oil is the responsibility of that particular oil supplier.

Synthetic Oils

The performance requirements for synthetic oils are the same as single grade oils. Synthetic oils require a successful 7000 hour field test as previously described for commercial oils. The use of synthetic base stock oils is very limited in Caterpillar gas engines and would be limited to cold engine starting applications which are generally not a requirement. Therefore, any anticipated use of these oils should be discussed with your Caterpillar dealer or your oil supplier.

Synthetic Base Stock Oils (SPC)

The performance characteristics of the oil depends on the base oil and the additives. The additives in the oil will vary according to the properties of the base oil and the environment in which the oil will perform its function.

Synthetic base stock oils are acceptable for use in Caterpillar engines if these oils meet the performance requirements specified for a particular compartment.

The use of a synthetic base stock oil does NOT allow extension of the oil change interval simply because of the use of synthetic oil. Any drain period extension must be validated by S•O•S (oil analysis and test evaluation) to ensure no excessive component wear occurs in a particular application.

The synthetic oils have naturally low pour points which make them very good oils for low temperature applications. Caterpillar's recommendation for these arctic applications is synthetic base stock oils where startability at the cold conditions are a requirement.

Oils are changed because they become contaminated with dirt, soot, wear particles, etc, during normal use. The additives in the oil formulation are depleted as the oil functions in a compartment. The oil contamination and additive depletion occurs independently of the oil base stock type.

Synthetic lubricants may be superior to petroleum oils in specific areas. Many exhibit higher viscosity index (VI), better thermal and oxidation stability and sometimes lower volatility. Because synthetic lubricants are higher in cost than petroleum oils, they are used selectively where performance may exceed capabilities of conventional oils.

Re-refined Base Stock Oils

The Caterpillar requirement for oils is that any oil formulation meet the performance requirements as defined by the API classification and have the proper viscosity as defined by the SAE J300 Specification. The base stock oil used in the formulation can be either virgin or re-refined (or a combination) as long as the final oil formulation meets the requirements of both performance and viscosity.

The combination of the base stock oil and the additive must perform to the defined specifications. If the oil meets these requirements, then its' performance in an engine (or other compartment) should be acceptable. The military specifications and other engine manufacturers have also accepted the use of re-refined oil base stock with the same criteria.

Therefore, the use of oils with re-refined base stocks will depend on the company who has supplied the oil. Have they subjected the oil formulation to the qualifying tests, and passed the tests, as required to label the oils for the API performance and viscosity grade?

Various methods may be available for processing of the used oil. Caterpillar would normally recognize a re-refining process as one which subjects the used oil to the same refinery process (such as vacuum distillation and hydrotreating) as the virgin base stock was obtained from the original crude oil. The base stock obtained by this method should provide an acceptable base stock from which to formulate a proper oil. But the oil formulated must still pass the required performance and viscosity tests for the compartment and intended use.

Always consult with your Caterpillar dealer for the latest lubrication recommendations.

Lubricant Viscosity Recommendations

The proper SAE viscosity grade oil is determined by the minimum outside temperature at cold engine start-up, and the maximum outside temperature during engine operation. Use the minimum temperature column on the chart to determine the oil viscosity required for starting a "cold soaked" engine. Use the maximum temperature column on the chart to select the viscosity for operation at the highest temperature anticipated. In general, use the highest viscosity oil available that still meets the start-up temperature requirements.

Base stocks for blending the oil formulations do differ and variations can exist within a viscosity grade on low temperature characteristics. Therefore, a particular oil may allow lower starting temperatures than given in the following chart. Your oil supplier can provide additional information on oil properties.

Even though the ambient temperature may be low, operating engines can still be subjected to normal oil temperatures because of regulated temperature components. The higher viscosity oils will provide better protection to all components during the full operating cycle.

To determine if the oil in the crankcase will flow in cold weather, remove the oil dipstick before starting. If the oil will flow off, the oil is fluid enough to circulate properly.

Engine Oil Viscosity Protection

Caterpillar NGEO Viscosity Grade	Ambient Temperature	
	Minimum	Maximum
SAE 30[1]	0°C (32°F)	40°C (104°F)
SAE 40[1]	5°C (41°F)	50°C (122°F)

[1] Caterpillar NGEO is available in these grades only. If other viscosity grades are selected, confirm with your oil supplier that the oil does meet the gas engine oil requirements. Multigrade oils are NOT recommended for use in Caterpillar Gas Engines. Refer to the Multigrade oil topic.