



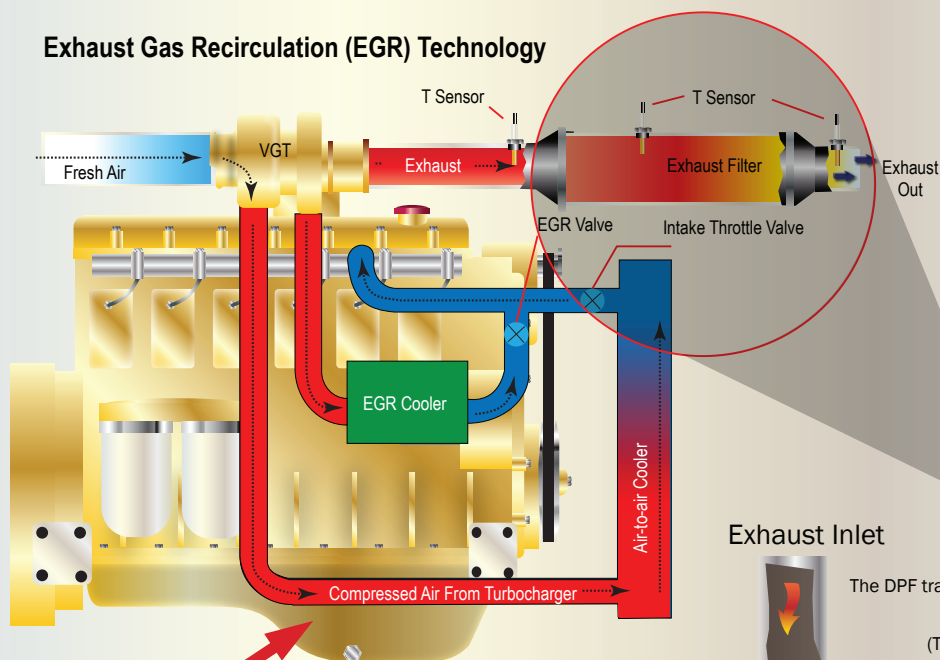
As the main driving force since 1990 for the development of the entire American Petroleum Institute (API), commercial "C" diesel engine classifications (e.g. CF-4, C-4, etc.) has been the concern about the environmental impact of diesel engine exhaust emissions. The number 4 indicates that these apply to 4-stroke diesel engines. This Information Sheet discusses the recommended lubrication oils for diesels used in generator set systems and why it is important to use the correct oil as specified by the engine manufacturer with the introduction of new emission technology.

1.0 OILS USED ON TIER 3 OFF-HIGHWAY ENGINES :

Tier 3 off-highway diesel engines can currently use the API CH-4 specification oil, first introduced in 1998, or the CI-4 specification that was introduced in 2002. However, as Tier 3 engines are replaced by next generation of Tier 4 engine service providers will have to use the lubrication oil recommended for these engines.

Diesel EGR and DPF Technology Requiring CJ-4 & E9 API Specified Lubricating Oil

Exhaust Gas Recirculation (EGR) Technology



The diagram to the left demonstrates a diesel engine utilizing exhaust gas recirculation (EGR) and variable geometry turbocharger (VGT) technologies in off-highway applications such as diesel generator set systems. Interim Tier 4 solutions also add a catalyzed exhaust filter to meet emissions regulations.

Use specially formulated CJ-4 & E9 API Oil

The oil change intervals with CJ-4 low ash oil will remain the same as the earlier grades. We suggest that you always utilize high quality heavy-duty engine oil with a suitable grade to meet the site ambient conditions. All engine manufacturers will specify the correct grade of oil in their support material supplied with the engine.

Exhaust Inlet

Exhaust Outlet

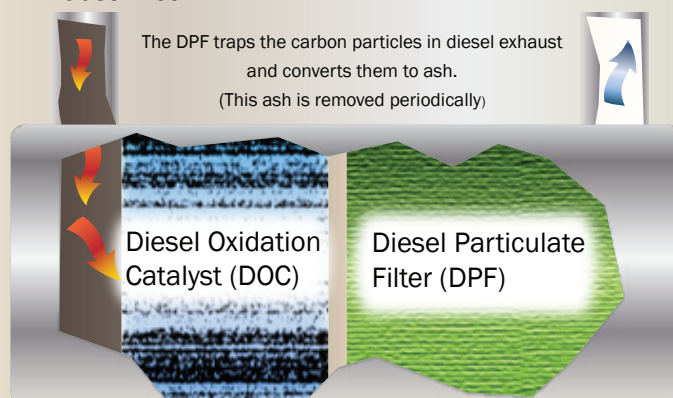


Diagram of Diesel Particulate Filter (DPF) Technology

The installation information provided in this information sheet is informational in nature only, and should not be considered the advice of a properly licensed and qualified electrician or used in place of a detailed review of the applicable National Electric Codes and local codes. Specific questions about how this information may affect any particular situation should be addressed to a licensed and qualified electrician.

2.0 LUBRICATION FOR DIESEL WITH ERG AND DPf TECHNOLOGY:

To attain Tier 4 emission levels, diesel manufacturers are building engines with Exhaust Gas Recirculation (ERG) and Diesel Particulate Filters (DPF) that run on ultra-low sulfur diesel fuel. These features significantly increase the demands on lube oil performance for the following reasons: **Details to be noted are:**

- **ERG** - EGR is an technology being used on some diesel generator systems to reduce NOx in diesel exhaust. An EGR system recirculates a small amount of cooled exhaust gas back into the combustion chamber. This produces a reduction of combustion temperatures which in turn reduces NOx. However, EGR increases particulate emissions and the necessity to use DPF technology for the engine to be compliant with Tier 4 Interim and Tier 4 Final EPA regulations. Recirculating exhaust gas also elevates the soot level in the engine's lubricating system.

Using the engine coolant system to reduce the exhaust gas temperature being recirculated increases the engine running temperature which in turn elevates the engine oil sump temperatures putting more demand on the engine oil lubricating properties.

CJ-4 and E9 oil specifications have been formulated to manage the additional stresses EGR technology puts on an engines lubrication oil.

- **DPF** - The small amounts of oil consumed during the combustion process lead to the formation of incombustible ash. The DPF traps this ash in the same manner it traps particulate matter (PM). Unlike the PM, which is oxidized, the ash remains uncombusted. When the ash collected in the DPF accumulates to a certain level, it has to be removed to prevent plugging and the DPF cleaned.

Both CJ-4 and E9 low ash oil help to extend the ash cleaning interval to its maximum level, as they contain the lower level of trace minerals within the additive package, to generate less ash.

The ash part of the CJ-4 specification, is intended to absorb acids in the oil resulting from combustion. Low ash oils also maintain the important lubricity capability of the lubricant and are specified to reduce the ash buildup in the filter. With low ash oil, the filter cleaning service event is anticipated at very long intervals extending to several thousands of hours (up to 5,000 hours), dependent on the duty cycle.

Note: The CI-4 specification introduced in 2002 does not include the low ash formulation package.

3.0 USE OF THE NEW CJ-4 OIL:

The new CJ-4 oil is 'backwards compatible' so it can be used in engines meeting Tier 3 and other emission regulations standards providing the engine is also operating with the Ultra-Low Sulfur Diesel (ULSD) fuel, with 15ppm or less sulfur content.

4.0 BYPASS OIL FILTRATION USED TO EXTEND OIL LIFE:

Some manufacturers have incorporated a bypass oil filtration system into their engine design, in order to attain the desired extended oil change intervals. This will remove a higher level of contaminants from the oil, before passing through the engine oil filter.

5.0 OIL TESTING:

In light of the potential for contaminated oil, oil analysis is more important than ever. This periodic testing monitors the oil's ability to function properly as well as evaluating the health of the engine. Condition-based oil change intervals are the best indicators for determining this interval. Soot limits of 1.5% were common in most previous heavy-duty diesel engines. Soot limits of 3% are now generally accepted with higher levels expected in the future.

6.0 AMERICAN PETROLEUM INDUSTRY (API) COMMENTS REGARDING ENGINE OIL UPGRADES:

API CJ-4 Oil - This specification represents the latest in a series of engine oil upgrades. In order to protect the exhaust gas after-treatment devices, chemical limits were set for the first time ever for heavy-duty diesel engine oil. These limits target the engine's oil sulfated ash, phosphorus and sulfur content – commonly referred to as SAPS.

Acting upon a request by the Engine Manufacturers Association (EMA), the API and Diesel Engine Oil Advisory Panel (DEOAP) have initiated the development of a new heavy-duty diesel engine oil performance category: PC-11. PC stands for 'performance category' that will offer performance features beyond the current API CJ-4 engine oils. This request was made June 21, 2011, and proposes first licensing by API no later than Jan. 1, 2016. The EMA request has been driven primarily by the recently adopted EPA/NHTSA fuel economy and greenhouse gas emission regulations for heavy-duty trucks. The EMA said engine lubricant performance can have a significant influence on an engine's ability to achieve EPA's fuel efficiency goals. The fuel efficiency effect of heavy-duty engine oils is directly related to high-temperature/high-shear (HTHS) performance – however many engines require the current HTHS level of performance to achieve acceptable engine durability. Therefore the EMA requested that the PC-11 category be split into two separate sub-categories with corresponding HTHS performance levels: one that preserves historical heavy-duty oil criteria, and one that provides fuel efficiency benefits.

The API CJ-4 oil specification limits include the following:

- 1.00 percent maximum sulfated ash (per ASTM D874)
- 0.12 percent maximum phosphorus (per ASTM D49510)
- 0.40 percent maximum sulfur (per ASTM D4951 or ASTM S2622)

To fulfill our commitment to be the leading supplier in the power generation industry, the Buckeye Power Sales team ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service, our Information Sheets are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.



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