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Engine Installation and Break-In Procedures

for Remanufactured Engines

Suggested Precautions for Remanufactured Engines

Engines that have been carefully remanufactured to precision standards will perform properly if certain steps are taken by the technician making the installation. The following is a list of causes for a remanufactured engine to fail early in service, and suggested procedures to prevent failure.

When a properly remanufactured engine fails to give satisfactory service, it is usually due to: burning piston heads caused by detonation, pre-ignition or "lugging"; piston scuffing or seizing usually caused by overheating or excess fuel; bearing and crankshaft wear caused by under-lubrication, dirt or coolant seepage; excessive piston and cylinder wear caused by dirt, ineffective air filtering, coolant seepage or excessively rich, air-fuel ratio.

The customer and the remanufacturer have a mutual interest in this engine. We both want it to perform and give long and satisfactory life. We recommend these precautions:

1.) Be sure to prime the oil pump, oil lines and fill the oil filters with oil using an auxiliary pump, operating the internal oil pump with a hand drill, or an external pressure tank connected to the oil pressure gauge or sending-unit fitting before starting the engine. It is desirable to fill the crankcase in this manner. If using an air pressure tank be sure it does not run out of oil and blow air through the lines.

2.) Proper air-fuel ratio is vital in today's engines. Be sure the carburetor or fuel injection system has been remanufactured to manufacturer's specifications. Manifold and cylinder head surfaces should be checked and in good condition (resurface if necessary). Be sure the cylinder heads and manifolds are torqued and retorqued in proper sequence if required. Air seepage can cause lean air-fuel ratio which causes detonation. Check fuel pump for proper pressure.

3.) Ignition or diesel fuel injection system should be properly serviced or calibrated, and engine timing corrected. Proper valve lash or clearance is very important.

4.) Be sure to use spark plugs of the correct heat range and gap as specified by the engine manufacturer. Check electronic sensors and sending units for proper operation. Vacuum lines must be properly routed and connected to the appropriate fittings to ensure operation of emission control devices and related engine controls.

5.) Check the exhaust thermostat control (commonly called the heat riser) to be certain it is free and operating properly. Check the exhaust gas recirculation valve (EGR valve) for proper operation. Clean the intake manifold to remove deposits from the various passages.

6.) Rebuild or replace the radiator and hose lines to ensure they are free from deposits so that the cooling system can function properly. Restrictions can cause overheating. Thermostats should be checked or replaced with one of the correct temperature. Use the proper pressure cap as specified by the engine manufacturer, and make sure it is properly seated.

7.) Important! Replace filter elements. Thoroughly check engine accessories which are to be reused. Clean them internally and externally before installing.

8.) The coolant used should be compatible with aluminum engine components and blended to a mixture of no more than 60% antifreeze and 40% water. We recommend that a good sealer with rust inhibitors be added to the cooling system. This will tend to prevent rust and scale deposits and guard against coolant seepage.

9.) Before releasing the engine for regular service, check the air-fuel ratio. Caution the driver against "lugging."

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Recommended "Break-In" Procedures for Remanufactured Engines

Protect the investment you have in your engine. Take the time to read and follow these recommendations.

CAUTION:

1.) Before starting the engine for the first time, be sure it has been properly pre-lubricated.

2.) Never add cold water to the cooling system while the engine is running. The engine should be allowed to run at normal operating temperature.

3.) Start engine and run at fast idle, approximately 1500 RPM, and check the oil pressure. Run the engine for 30 minutes even though coolant may rise to operating temperature in a few minutes. Adjust tappets, if required, carburetor and ignition timing. If the coolant should "boil over," stop engine and allow to cool. Then start again and proceed as above.

4.) When required retorque cylinder heads and manifolds to engine manufacturer's specifications in proper sequence. Readjust tappets if necessary.

5.) Start engine again and make a test run on the road at 30 MPH in "drive" range or select the proper gears for standard transmission. Periodically accelerate to 50 MPH and decelerate rapidly. Repeat this procedure at least 10 times. For a large truck or industrial engine, accelerate in intermediate gears as above. NOTE: Applying loads to the engine for short periods of time causes increased ring pressure against the cylinder walls and helps to seat the rings. This is especially important because you are "breaking-in" the engine with heavy duty oils. The rapid deceleration increases vacuum and gives extra lubrication to the piston and ring assemblies.

Engine or Vehicle Service Recommendations

Passenger Cars

Drive normally but not at continuous high speeds or under heavy loads for the first 500 miles. Change oil and filters after 500 miles.

Trucks

Operate the vehicle with light loads up to 500 miles and avoid "lugging." Occasional acceleration and deceleration in proper gear during this period is advisable. Change oil and filters after 500 miles of service.

Industrial Engines

Follow the above instructions and operate under partial loads for several hours. Change oil and filters after approximately 20 hours of operation. As required by the engine or gasket manufacturer, after 1000 miles of service, retorque cylinder heads and manifolds to proper specifications. Readjust tappets when required. We suggest this be done again after 5000 miles. We know that this means extra work, but it assures long and satisfactory engine performance.

Designation, Identification and Descriptions of Oil Categories

The current and previous API (American Petroleum Institute) Service Categories are listed below. Vehicle owners should refer to their owner's manuals before consulting these charts. Oils may have more than one performance level.

For automotive gasoline engines, the latest engine oil service category includes the performance properties of each earlier category. If an automotive owner's manual calls for API SJ or SL oil, API SM oil will provide full protection.

Gasoline Engines

- **Performance Level: SM**
Status: Current
Usage: For all automotive engines currently in use. Introduced in 2004, SM oils are designed to provide improved oxidation resistance, improved deposit protection, better wear protection, and better low-temperature performance over the life of the oil. Some SM oils may also meet the latest ILSAC specification and/or qualify as Energy Conserving.

- **Performance Level: SL**
Status: Current
Usage: For 2004 and older automotive engines

- **Performance Level: SJ**
Status: Current
Usage: For 2001 and older automotive engines

- **Performance Level: SH**
Status: Obsolete
Usage: For 1996 and older automotive engines

- **Performance Level: SG**
Status: Obsolete
Usage: For 1993 and older automotive engines

- **Performance Level: SF**
Status: Obsolete
Usage: For 1988 and older automotive engines

- **Performance Level: SE**
Status: Obsolete
Usage: CAUTION: Not suitable for use in gasoline-powered automotive engines built after 1979.

- **Performance Level: SD**
Status: Obsolete
Usage: CAUTION: Not suitable for use in gasoline-powered automotive engines built after 1971. Use in more modern engines may cause unsatisfactory performance or equipment harm.

- **Performance Level: SC**
Status: Obsolete
Usage: CAUTION: Not suitable for use in gasoline-powered automotive engines built after 1967. Use in more modern engines may cause unsatisfactory performance or equipment harm.

- **Performance Level: SB**
Status: Obsolete
Usage: CAUTION: Not suitable for use in gasoline-powered automotive engines built after 1951. Use in more modern engines may cause unsatisfactory performance or equipment harm.

- **Performance Level: SA**
Status: Obsolete
Usage: CAUTION: Contains no additives. Not suitable for use in gasoline-powered automotive engines built after 1930. Use in more modern engines may cause unsatisfactory performance or equipment harm.

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Diesel Engines

For diesel engines, the latest category usually – but not always – includes the performance properties of an earlier category.

• **Performance Level: CJ-4**
Status: Current
Usage: Introduced in 2006. For high-speed, four-stroke engines designed to meet 2007 model year on-highway exhaust emission standards. CJ-4 oils are compounded for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact exhaust after treatment system durability and/or oil drain interval. CJ-4 oils are effective at sustaining emission control system durability where particulate filters and other advanced after treatment systems are used. Optimum protection is provided for control of catalyst poisoning, particulate filter blocking, engine wear, piston deposits, low- and high-temperature stability, soot handling properties, oxidative thickening, foaming, and viscosity loss due to shear. API CJ-4 oils exceed the performance criteria of API CI-4 with CI-4 PLUS, CI-4, CH-4, CG-4 and CF-4 and can effectively lubricate engines calling for those API Service Categories. When using CJ-4 oil with higher than 15 ppm sulfur fuel, consult the engine manufacturer for service interval.

• **Performance Level: CI-4**
Status: Current
Usage: Introduced in 2002. For high-speed, four-stroke engines designed to meet 2004 exhaust emission standards implemented in 2002. CI-4 oils are formulated to sustain engine durability where exhaust gas recirculation (EGR) is used and are intended for use with diesel fuels ranging in sulfur content up to 0.5% weight. Can be used in place of CD, CE, CF-4, CG-4, and CH-4 oils. Some CI-4 oils may also qualify for the CI-4 PLUS designation.

• **Performance Level: CH-4**
Status: Current
Usage: Introduced in 1998. For high-speed, four-stroke engines designed to meet 1998 exhaust emission standards. CH-4 oils are specifically compounded for use with diesel fuels ranging in sulfur content up to 0.5% weight. Can be used in place of CD, CE, CF-4, and CG-4 oils.

• **Performance Level: CG-4**
Status: Current
Usage: Introduced in 1995. For severe duty, high-speed, four-stroke engines using fuel with less than 0.5% weight sulfur. CG-4 oils are required for engines meeting 1994 emission standards. Can be used in place of CD, CE and CF-4 oils.

• **Performance Level: CF-4**
Status: Current
Usage: Introduced in 1990. For high-speed, four-stroke, naturally aspirated and turbocharged engines. Can be used in place of CD and CE oils.

• **Performance Level: CF-2**
Status: Current
Usage: Introduced in 1994. For severe duty, two-stroke-cycle engines. Can be used in place of CD-II oils.

• **Performance Level: CF**
Status: Current
Usage: Introduced in 1994. For off-road, indirect-injected and other diesel engines including those using fuel with over 0.5% weight sulfur. Can be used in place of CD oils.

• **Performance Level: CE**
Status: Obsolete
Usage: Introduced in 1985. For high-speed, four-stroke, naturally aspirated and turbocharged engines. Can be used in place of CC and CD oils.

• **Performance Level: CD-II**
Status: Obsolete
Usage: Introduced in 1985. For two-stroke cycle engines.

• **Performance Level: CD**
Status: Obsolete
Usage: Introduced in 1955. For certain naturally aspirated and turbocharged engines.

• **Performance Level: CC**
Status: Obsolete
Usage: CAUTION: Not suitable for use in diesel-powered engines built after 1990.

• **Performance Level: CB**
Status: Obsolete
Usage: CAUTION: Not suitable for use in diesel-powered engines built after 1961.

• **Performance Level: CA**
Status: Obsolete
Usage: CAUTION: Not suitable for use in diesel-powered engines built after 1959.

(Information supplied by the American Petroleum Institute, 2009.)

Steve Fox has over 20 years experience in the engine building industry with eight of those years spent working in the machine shop. Steve is an ASE-certified Master Machinist, as well as a longtime member of the drag racing circut. **Dave Hagen,** our Senior Technician, has over 36 years of experience in our industry. As an ASE-certified Master Machinist, Dave specialized in cylinder head work and complete engine assemble for the first 17 years of his career. **Mike Caruso** brings over 42 years of rebuilding and high-performance experience to AERA. An ASE-certified Master Machinist, Mike came to us from FEL-PRO's high-performance R&D and tech line, where he worked for 11 years.