Engine Break-in: Recommended Procedures

Introduction:

Please read this document in its entirety before beginning. It is imperative that the engine is broken-in and the rings seated properly to ensure a long life and the highest performance from your MAHLE Motorsport pistons and rings. Below, we have outlined steps to guide the engine break-in process. Due to the nature of performance applications, this information should not be considered absolute. MAHLE Motorsports shall not, under any circumstances, be liable for any special, incidental or consequential damages, including, but not limited to, damage or loss of property or equipment, loss of profits or revenues, cost of purchased or replacement goods, or claims of customers of the purchaser which may arise and/or result from the sale, installation or use of these parts and/or recommendations. The final decisions concerning the installation and use of these products are ultimately the responsibility of the customer.

Safety:

First and foremost, please ensure all necessary safety precautions are taken into account when breaking in your engine. The following is a list of recommendations but it is not intended to be all encompassing. Always use the highest safety precautions when working with machinery.

- Keep a fire extinguisher nearby in case of fire.
- Fuel and oil should be stored in proper containers and away from the engine while operating or still hot. Fire can result if spilled.
- Keep yourself, rags and tools clear from moving parts; pulleys, belts, fans etc.
- Use caution around ignition components. Potentially deadly electric shock can occur.
- If the engine is installed in the vehicle, make sure the transmission is in neutral and the wheels are chocked if they are touching the ground. Setting the emergency brake is also recommended.
- When running the engine, ensure sufficient ventilation for fumes emitted by the engine. Do not operate in confined areas. Having the exhaust routed outside is recommended.
- Engine will be hot during operation; caution should be taken to avoid burns or potential fires.
- When operating the vehicle on the road or track, obey all applicable traffic rules and laws.

Engine Assembly:

The first step in a proper break-in and ring seating is correct machine work and assembly.

- The cylinder walls should be machined to the appropriate hone specifications provided by MAHLE Motorsport.
- Rings should be properly gapped per the instructions supplied.
- Cylinders, pistons and components should be thoroughly cleaned and free of debris.
- After cleaning, a light coat of conventional break-in oil should be applied to the cylinder and skirt of the pistons.
- Similarly, a light coat of oil should also be applied to the top and bottom of each ring before being installed on the piston. The rings DO NOT need to be dripping wet with oil! Once the ring is lubricated, wipe off any excess oil to leave only a thin film. This is all that is required for corrosion protection and initial startup lubrication.
- Rings should be installed with ring pliers. DO NOT “spiral” the rings onto the piston.
- DO NOT use thick assembly oil or grease on any component in contact with the rings or cylinder!
- Rings and pistons should be installed and oriented per the instructions supplied.

Prestart Checks & Procedures:

Before the first startup, several checks need to take place to ensure a quick and trouble free startup of the engine.

- Double check that all hose, line and belt connections are tight and leak free.
- Ensure all filters are in place and installed properly.
- Ensure all fluids are filled to the correct levels. Oil, coolant, fuel etc…
- Prime the oil system. (Several options)

  - Preferred method: remove the distributor and use an oil pump priming tool while manually rotating the engine by hand.
    - This can also be accomplished on a dry sump by removing the belt and turning the oil pump with a drill.
  - Second method: use a pressurized oil tank with the correct amount of oil for the engine to feed oil into the oil pressure port.
  - Third method: remove spark plugs and ability to deliver fuel. Then use the starter to crank the engine over until oil pressure is stable.
- Verify correct firing order and ignition timing is set as close as possible.
- Verify correct carburetor is being used or proper tune is loaded into the ECU.
- Ensure the battery is fully charged and properly sized for your application.
- Ensure all electrical connections are correct and functioning.
- Double check for fuel / coolant leaks.
- Place a large fan in front of the radiator for added cooling.
- If equipped, it is recommended to remove the vacuum pump belt or hose connection to the engine. Increased crankcase vacuum reduces the oil in suspension inside the crankcase and reduces “splash” lubrication.
- Use mufflers if possible. If something sounds incorrect it is difficult to tell with open exhaust.

Initial Startup Procedure:

It is imperative that the engine’s initial startup happen quickly to ensure proper break-in.

- *NOTE: For proper camshaft and tappet break-in, specific recommendations from the camshaft manufacturer will supersede the following Startup Procedure.*
- If the engine is properly assembled and installed (in vehicle, test stand or dyno) the engine should start after only a few revolutions. If the engine does not start, double check ignition and fuel settings.
- Once started, verify proper oil pressure and continuously monitor during break-in cycle.
- As soon as the engine starts, increase and hold the rpm between approximately 25-35% of maximum engine rpm while verifying the following:
    - *EXAMPLE: maximum engine rpm of 8000rpm would hold between 2000-2800rpm*
  - Ensure all cylinders are firing.
  - Verify and adjust for proper timing and fuel as soon as possible.
    - Excessive fuel can wash the oil from cylinders and prohibit break-in, leading to cylinder glazing.
- Once all timing, fueling and other parameters are verified correct, run the engine for approximately 15-30 minutes.
  - Vary the RPM between 25-35% of the maximum engine rpm for the duration of the break-in.
    - Allowing the engine to idle should be avoided if at all possible.
  - Listen for any unusual noises, shut down if necessary.
  - Allow the engine to reach full operating temperature, but shut down to investigate if exceeding normal operating temps.
  - In nearly all instances, it is best to shut down immediately if an issue is found and make adjustments as necessary.
- Initial startup procedure can be repeated as needed but caution should be taken as excessively running a new engine unloaded can lead to insufficient ring seating and poor performance. It is best to place the engine under a mild load as soon as possible after the initial startup procedure is complete.
  - A note concerning engine run stands: They should only be used to ensure no leaks, adjust timing and fuel or break-in flat tappet camshafts. An unloaded run stand WILL NOT properly seat the rings.
  - Change oil and filter from break-in to recommended conventional oil.

Running Procedure:

Once all checks are performed and the engine has no issues detected, the engine should be ran under a load to properly seat the rings. Loading the engine increases the cylinder pressure and forces the rings into the bore to help the seating process.

- In Vehicle:
  - *NOTE: Ensure brakes, steering and suspension all function properly before starting in-vehicle running procedure.*
  - Using part throttle, apply varying loads and rpm. Avoid using heavy throttle / acceleration and high rpm.
    - Street Vehicle:
      - This should be accomplished over a short 20-30 min drive.
    - Race Vehicle:
      - This should be accomplished over the first practice session.
  - Next, start at 25% of the max rpm with light throttle and accelerate at wide open throttle to 75% of max rpm. Then engine brake with the throttle closed, back to 25% max rpm. Repeat this 5-6 times.
    - *Example: 8000rpm max would start at 2000rpm and accelerate to 6000rpm then engine brake back to 2000rpm.*
- On Dyno:
  - Follow dyno recommended break-in procedure if available.
  - Part throttle load to 75% max rpm and observe crankcase pressure.
  - Keep applying higher loads and increase RPM in approximately 1000 rpm increments with subsequent pulls until max rpm and load is reached.
  - Once crankcase pressure has stabilized and is repeatable, the rings are seated.

- Double check to ensure no issues have arisen and change oil and filter again.
- Run as engine build was intended.

Maintenance:

During the break-in period it is important to closely watch the oil level and check the condition of the spark plugs (if equipped) in between running periods. The condition of these gives insight to the health of the engine.

Oil Recommendation:

Oil selection is a critical part of the break-in process. A quality, break-in oil should be used.

- Use the appropriate break-in oil.
  - Cam selection trumps other oil recommendations. Use what the cam manufacturer recommends.
  - Commercially formulated break-in oil is preferred as compared to mixing your own additives which can lead to unintended consequences, i.e. “overloading on ZDDP” that in turn negatively impacts other additive combinations.
- No synthetic oil recommended until after the break-in procedure is complete and the rings are fully seated. This should be completed no earlier than 100 miles for street vehicles or 1 practice session for a race vehicle.
  - The topic of using conventional vs synthetic for break-in or when to make the switch is a highly opinionated discussion. While we acknowledge that many new vehicles are delivered with synthetics, and countless engines have been successfully broken-in on such, this may not be applicable for every application. For the intent of this guide, our recommendation is to err on the side of caution and start with conventional oil.