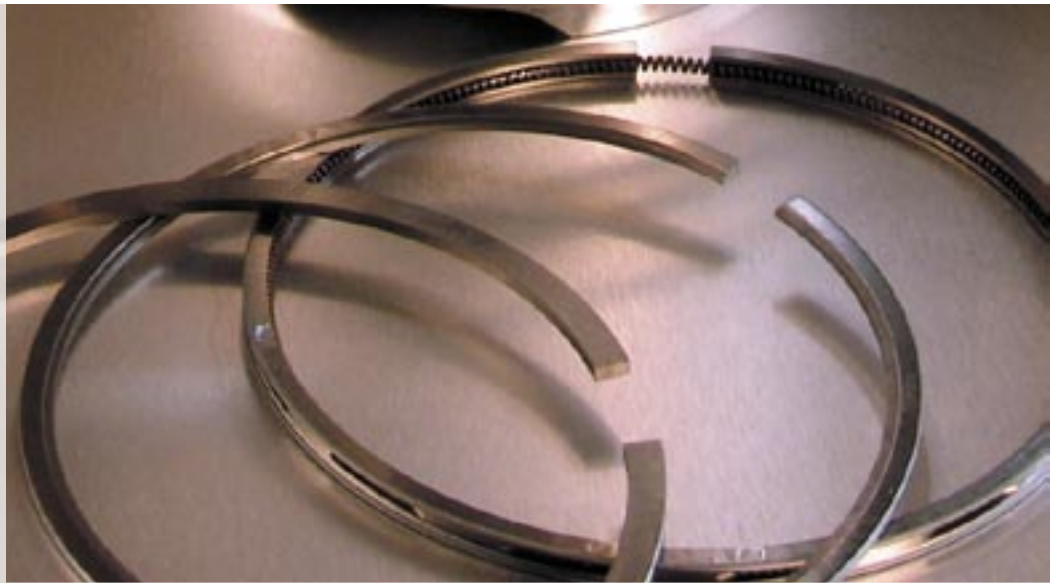
Piston Rings: Not all made Equal



A Piston Ring is an open-ended ring that fits into a groove on the outer diameter of the piston. Most pistons have three rings: two for compression sealing; one for oil sealing. Its primary function is to form a seal between the piston and cylinder wall, sealing high quantities of combustions pressure trying to slip by the piston. In addition to this, they stabilize the piston as it travels up and down in the bore, help cool the piston by transferring heat into the engine block, and they scrape oil off the cylinder walls. Rings can be round, squared, tapered, flat, slanted but most importantly, custom made. The design and material of the piston ring will vary for different engines and power levels. Oil control, RPM, horsepower and compression are all to be considered when creating a piston ring.

Piston rings are subject to wear as they rub up and down the cylinder bore. To minimize this, they are made with wear resistant materials (cast irons and steels) and coated or treated to enhance the wear resistance. Typically, top and oil control rings will be coated with Chromium or Nitride, plasma sprayed, or have a PVD (physical vapor deposit) ceramic coating. The lower oil control ring is designed to leave a film of lubricating oil a few micrometers thick on the bore, as the piston descends.

Why are piston rings so important? If incorrect or worn rings are used, a problem called blow-by occurs. This happens when hot combustion gases leak past the rings and into the crankcase. Besides the obvious loss of power and efficiency, many people aren't aware of another consequence, which is the damage caused by hot exhaust and flames into the crankcase. Another complication is the contamination of the lubricating oil.

Based on these negative side affects alone, blow-by should be avoided. Signs of blow-by are carbon build up and/or heat discoloration on the piston land (between the top and second ring). Bad cases of blow-by will even discolor the piston skirt to a black/brown color.

On the other hand, there are multiple problems that can result when the piston and ring mating areas are ignored. Excessive clearance between the backside of the ring and the ring groove in the piston results in pressure building too slowly behind the ring, and leakage occurs because the ring is not being pushed out against the cylinder. This gap should be as small as possible.

Also, if the ring is not sealed against the bottom of the ring land, the pressure will leak past this area. Once the ring is leaking, the hot gasses from the chamber are like a torch to the metal surface of the piston land and the ring itself. This excessive temperature bakes the oil in that area and turns it to carbon, which reduces ring clearance to nothing and grabs the ring solid.

A properly prepped piston and ring contact area effectively creates an internal pressure system that is a self-sealing force. The top and bottom surfaces of every ring groove must be completely smooth so the ring has something to seal against. Piston rings are designed to rotate in the groove during engine operation, and they must be able to rotate freely so that any carbon particles are cleaned away and out of the groove. In addition to this, the ring must be free to move so it can easily push out against the cylinder wall as combustion pressure falls behind it, and it can make an effective seal.

Piston rings also play an integral part in two other aspects of engine operation. The rings transfer heat from the piston to the cylinder, from which the cooling system can carry it away. The rings are at the top of the piston, where it is hottest. The rings are the PRIMARY contact between the cylinder and piston, since the piston is floating on a layer of oil. If the rings don't properly seal against the cylinder, the piston temperature will increase, and you have even more overheating.

The third piston ring is responsible for scraping oil off of the cylinder wall, and returning it to the crankcase (via the small oil return holes in the piston behind the ring). If the compression rings are leaking, then the hot combustion gasses are reaching the oil scraping ring and turning the oil to carbon. Once again, carbon-build up leads to ring seizure. When the oil ring seizes, it can no longer effectively keep the cylinder free of excess oil. That excess oil now can reach the compression rings, turns to carbon and causing their failure too. This excess oil can also bring the engine into detonation.

When going through all the engine parts, there is no individual component that can be disregarded. Piston rings, as well as every other part of the engine system, must be checked regularly since the most insignificant detail could cause a complete meltdown of your machine. Everything has to be considered as part of a total package.