Three primary factors are normally responsible for oil failure.

Oil that becomes too thin, too thick or too acidic has exceeded its useful life.

Dan Peterson | VICE PRESIDENT, TECHNICAL DEVELOPMENT

When motor oil exceeds its useful life or is affected by a mechanical defect, it most commonly becomes too thin to separate metal parts, too thick to pump or too acidic for continued use.

Too Thin

When oil becomes too thin, it fails to provide the required oil film thickness to separate metal surfaces. Different engine designs require different starting oil thickness, or viscosity. Viscosity at 100°C is one of the most highlighted oil properties and is a good indicator of adequate oil film thickness in an engine at operating temperature.

A number of things can cause motor oil to become too thin to protect engine parts. Excessive mechanical shear can thin oil to the point of causing issues with engine protection. As motor oil cycles through the engine, it is exposed to shear stress in the engine's upper end, piston walls and bearings that reduces its shear strength. Continuous exposure to these conditions causes oil built with inferior shear stability to thin excessively, leaving critical engine parts susceptible to metal-to-metal contact.

Fuel contamination of the oil sump is another major cause of excessively thin motor oil. Both gasoline and diesel fuel are thinner than motor oil and, when mixed, the oil's viscosity, film thickness and ability to separate parts are significantly reduced. While a small amount of fuel dilution is relatively common and does not have a material impact on oil life, excessive fuel dilution in mechanically compromised equipment is much more harmful.

Too Thick

When it comes to oil, although it may seem like "the thicker, the better," oil that is too thick is just as detrimental as oil that is too thin. Excessively thick oil is a commonly discussed mode of oil failure.

When oil becomes too thick to flow to engine parts, these areas are starved of oil, resulting in metal-to-metal contact that can lead to catastrophic engine damage. The precursor to sludge is oil that has become much thicker than its original design. The cause is a complex chemical reaction involving heat, combustion by-products and oxygen combining to create a chemical attack on the oil molecules. The resulting chemical reaction creates a much thicker substance that does not flow or protect as well as the original oil. When the reaction continues, sludge begins to form in areas of higher localized temperature and low flow. While some varnish is normal, sludge is a sign of excessively degraded oil that needs to be replaced. In order to inhibit sludge and varnish, the oil must resist attack by oxidation forces. Synthetic base oils have a much higher level of saturated molecules that inherently resist this constant bombardment. Additionally, antioxidants are added to either reduce the formation of free-radical oxidation precursors or soak up these precursors once they form.

Another cause of oil thickening, primarily affecting diesel oils, is excessive soot-loading in mechanically unsound engines. Diesel oil is designed to handle some soot contamination, but when the soot overloads the available dispersants in the oil, the oil thickens. The agglomerated soot particles reach a critical size and cause excessive wear commonly seen in diesel liners.

Too Acidic

Acids are a normal by-product of burning fossil fuels. Different fuel types, engines and combustion conditions create varying levels of acid formation. These acids, transferred via blow-by gases, are carried away to the motor oil. Motor oil is designed with a detergent that neutralizes these acids before they accumulate and cause engine damage. The detergent level is measured with a test called Total Base Number (TBN). This measure of alkalinity drops over the life of the oil and reaches a critical level when the oil can no longer consume the acids created by combustion. When TBN reaches a critical level, acids build up quickly and attack the surfaces most susceptible, including yellow metals and lead-lined bearings. Without correction, this condition quickly worsens and results in excessive chemical wear. Although less common, this failure mode can cause significant damage if left uncorrected.

AMSOIL synthetic motor oils are formulated to provide superior overall protection. They resist mechanical shear and viscosity increase due to oxidation while combatting harmful acids to help you maximize the performance and life of your engine. ■

Modern two-stroke engines require advanced oil

Engine designers are relying on technology that increases performance, but places more stress on motor oil

Leonard Groom III | TECHNICAL PRODUCT MANAGER - POWERSPORTS

Like the engine in your car or truck, the two-stroke engines that power your snowmobile, chainsaw or outboard motor are growing more sophisticated with each passing year. The same demands driving changes in the automotive market are influencing two-stoke equipment as well – the government mandates reduced exhaust emissions, while consumers want increased fuel economy and more power.

What's a two-stroke engine manufacturer to do? These three areas of importance – reduced emissions, increased fuel economy and maximum performance – don't play well together. Given the constraints of two-stroke engine design, it's extremely difficult to build an engine that hits all three targets. Because they don't contain intake and exhaust valves like a four-stroke engine, controlling emissions in two-strokes is a big challenge. One strategy in today's oil-injected engines is to adjust the fuel/oil ratio to use less oil. While this reduces emissions, it comes at a cost since using less oil increases operating temperatures and invites several problems.

Excessive heat breaks down the oil and leads to deposits that cause piston rings to stick, robbing the engine of horsepower and reducing performance. In extreme cases, stuck rings can score the cylinder wall and piston skirt, leading to catastrophic failure. To stand up in this intense environment, modern two-strokes require oils with improved heat resistance and lubricity to deliver the necessary level of wear protection. This bodes well for AMSOIL Dealers since conventional lubricants are quickly being left behind.

With snowmobile season gearing up, it's a great time to look at a couple snowmobile engines that offer examples of the innovation we're seeing in the two-stroke market. The Arctic Cat* C-TEC* uses electronics that adjust the fuel/oil ratio depending on operating conditions. In one promotional Arctic Cat video, we're told to expect fuel/oil ratios as high as 65:1, depending on conditions, in the C-TEC2 engine. Less oil means lubrication becomes more challenging. What little oil is available to protect critical engine parts must reach components quickly, particularly in sub-zero cold, and stand up to intense heat and friction once it's distributed throughout the engine.

The C-TEC uses an interesting configuration to deliver oil to the wrist pin and bearing. The fuel/oil mixture is injected into the boost-port side of the cylinder. At higher rpm, oil is also injected into the crankcase through a slot in the piston. The setup, according to Arctic Cat, improves performance, emissions and fuel economy.

The Ski-Doo* E-TEC* offers another example. Like many cars and trucks today, the E-TEC uses direct injection. Placing the fuel injectors directly in the combustion chamber allows precise control over the injection event, which improves power and reduces emissions. This arrangement, however, comes with challenges. In a traditional two-stroke engine, fuel and oil are mixed prior to being ingested by the engine, which helps the oil flow at lower temperatures since fuel reduces oil viscosity. In the E-TEC, fuel and oil are mixed only in the combustion chamber, so the bottom end of the engine – the crankshaft and rods – are lubricated by oil alone, making the oil's cold-flow properties critical.

The bottom line is two-strokes require higher-quality oils than before. In the snowmobile market specifically, an oil must excel in three areas: cold-flow, piston protection and exhaust power valve cleanliness. AMSOIL INTERCEPTOR®, our primary snowmobile recommendation, is proven to excel in all three areas. In 50 hours of extreme dyno testing, it completely prevented ring sticking and piston scuffing. It also boasts a -72°F cold-flow ability. Visit amsoil.com/proof for complete results.

We've invested countless hours in our Mechanical Test Lab, in the field and on the racetrack fine-tuning our two-stroke oils to deliver the benefits today's two-stroke engines need. As the two-stroke market continues to evolve, you can bet we'll continue to develop and manufacture synthetic two-stroke oils that meet and even exceed the demands of today's toughest two-stroke engines, regardless of who builds them. ■

The Arctic Cat C-TEC engine injects oil into the crankcase through a slot in the piston. This setup, according to Arctic Cat, improves performance, emissions and fuel economy.